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Funding for WRDS and the creation of this electronic document was provided by the Wyoming Water Development Commission (http://wwdc.state.wy.us)

FINAL REPORT
HORSE CREEK
WATERSHED LEVEL I STUDY

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

Prepared by:

Anderson Consulting Engineers, Inc.
375 E. Horsetooth Road, Bldg. 5
Fort Collins, CO 80525
(ACE Project No. WYWDC39)

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

Hinckley Consulting

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Professional Engineer (Civil)
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5150
Date 12/13/19
WYOMING

December 13, 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 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.

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Final Report
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I. INTRODUCTION AND OVERVIEW

1.1 Introduction

In 2016 the South Goshen Conservation District (SGCD) requested funding from the Wyoming Water Development Commission (WWDC) for the completion of a watershed management plan for the Horse Creek 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.

Six other requests for funding of watershed studies were also received and considered during the 2017 legislative session. Following a prioritization of the projects which resulted in the Horse Creek study to not be funded in 2017, it was funded the following year in 2018. Anderson Consulting Engineers, Inc. (ACE) was ultimately contracted in June 2018 to complete the project.

While the project sponsor is “officially” listed as the SGCD as they represent the entity which initially applied for the project and its funding, the Laramie County Conservation District (LCCD) is also a participating entity. There is actually more land within the project study area that is in Laramie County (46.1%) than in Goshen County (44.6%). Nonetheless, throughout this report, the SGCD is referred to as the project sponsor for simplicity.

1.2 Project Overview

The Horse Creek 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 SGCD (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 Goshen and Laramie Counties, Wyoming (Figure 1.2-1). Horse Creek is defined by the United States Geologic Survey (USGS) as the fourth order basin: Horse Creek (Hydrologic Unit Code 10180012). Consequently, the project study area consists of Horse Creek and its principal tributaries: Bear Creek, Fox Creek, Little Bear Creek, and Kiowa Creek.

Horse Creek is a perennial stream with headwaters in the Laramie Mountains at elevations of approximately 8,400 ft. It extends approximately 130 miles easterly to its confluence with the North Platte River near Lyman, Nebraska at an elevation of approximately 4,500 ft. (Note, the Nebraska portion of the watershed is not included in the project study area).

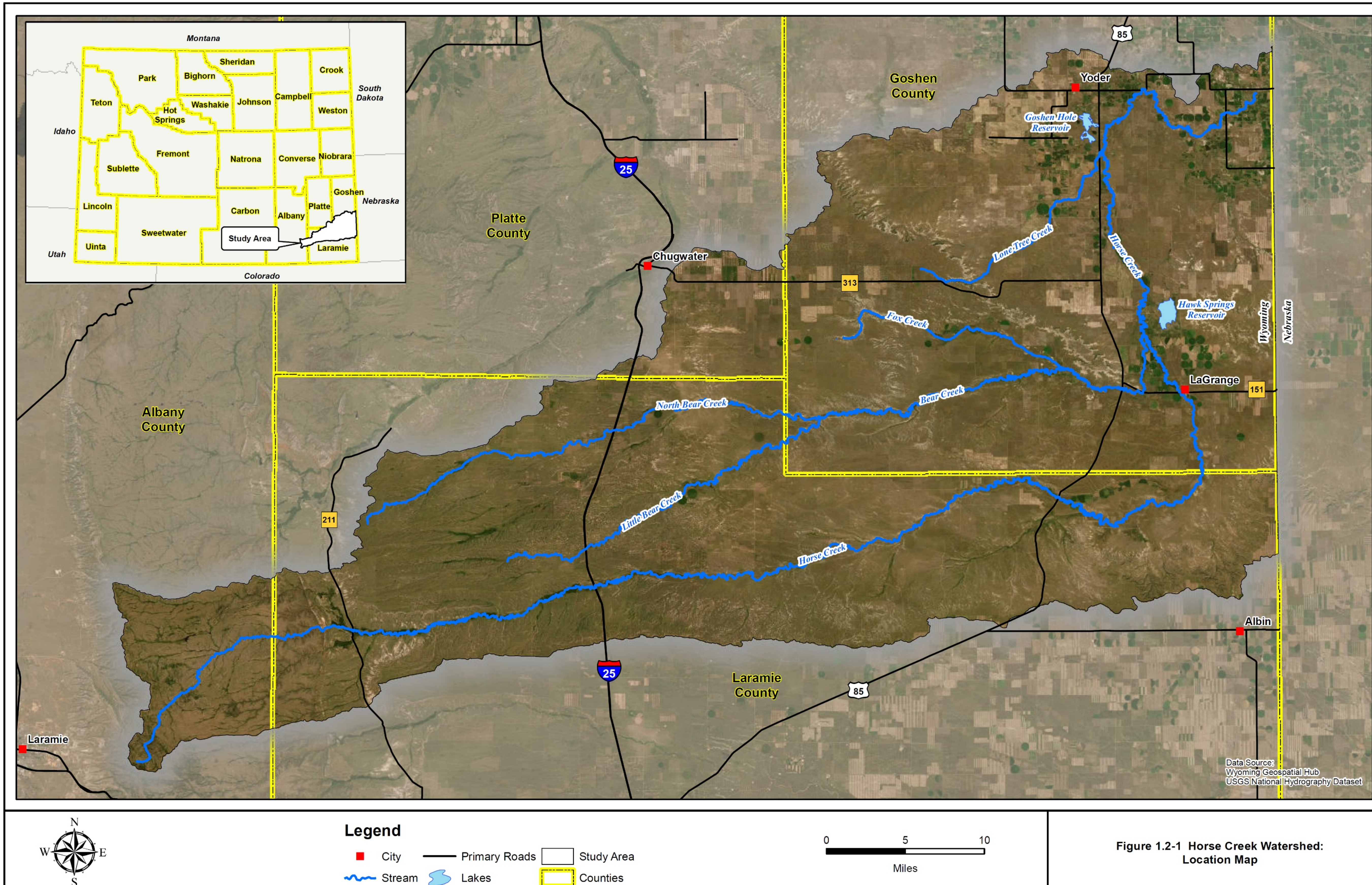


Figure 1.2-1 Horse Creek Watershed: Location Map

The study area covers approximately 1,039,966 acres (1,625 sq. mi.) in southeast Wyoming. The watershed is mostly contained in Laramie and Goshen counties, with a small portion in Platte and Albany counties. The towns of La Grange and Yoder lie within the watershed boundary. The study area is sparsely populated and consists primarily of open range lands.

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."

Types of projects eligible for funding include 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. Applicants can receive up to $35,000 towards these costs. Individuals would apply for funding through the SGCD which would serve as the applicant's sponsor. Application deadlines are December 31st of the year for consideration.

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 as a funding priority at the discretion of the WWDC. A typical project funded through the SWPP is shown in Figure 1.2-2. The photo displays a stock tank where a failed windmill has been replaced with a solar platform. The SWPP and its operating criteria are discussed in greater detail in Chapter 8: Economic Analysis.

Figure 1.2-2 Typical SWPP Project: Failed Windmill Replaced with Solar Pump and Platform.

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, SGCD contacts, and advertisements.*
- *Conduct an evaluation and description of the Horse Creek 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 (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 SGCD, 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 <u>not</u> meeting criteria of the SWPP are included as recommendations in the Plan (ex. Projects types not 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 SGCD. 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, individual onsite meetings 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 potential impacts upon watershed improvement recommendations. Source references for data utilized are also provided so the SGCD 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
- Groundwater Recharge
- Wetland Development and Enhancement
- Grazing Management

In addition, we present 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, we present 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 SGCD 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, we provide information to help guide the SGCD through the permitting process and agency contact information.

Chapter 10 – Conclusions and Recommendations: Here we summarize the highlights of the Plan and make concise and feasible recommendations for further action on behalf of the WWDC and the SGCD.

II. TASK 1: PROJECT MEETINGS

2.1 Meetings and Workshops

An integral part of the Horse Creek 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 (Figure 2.1-1). 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.

Figure 2.1-1 Horse Creek Watershed Study Open Houses in Torrington and Horse Creek.

- September 13, 2018 Project Scoping Meeting at Platte Valley Bank, Torrington
- September 19, 2018 Project Scoping Meeting at Stone House, Horse Creek Ranch
- November 27, 2018 Project Workshop / Open House at LaGrange Community Building
- February 12, 2019 Project Workshop / Open House at Platte Valley Bank, Torrington
- April 9, 2019 Project Workshop / Open House at LaGrange Community Building
- November 5, 2019 Final Draft Results Presentation (Appendix 2A contains Record Materials)

Meetings and workshops were advertised in advance 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.
- 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.

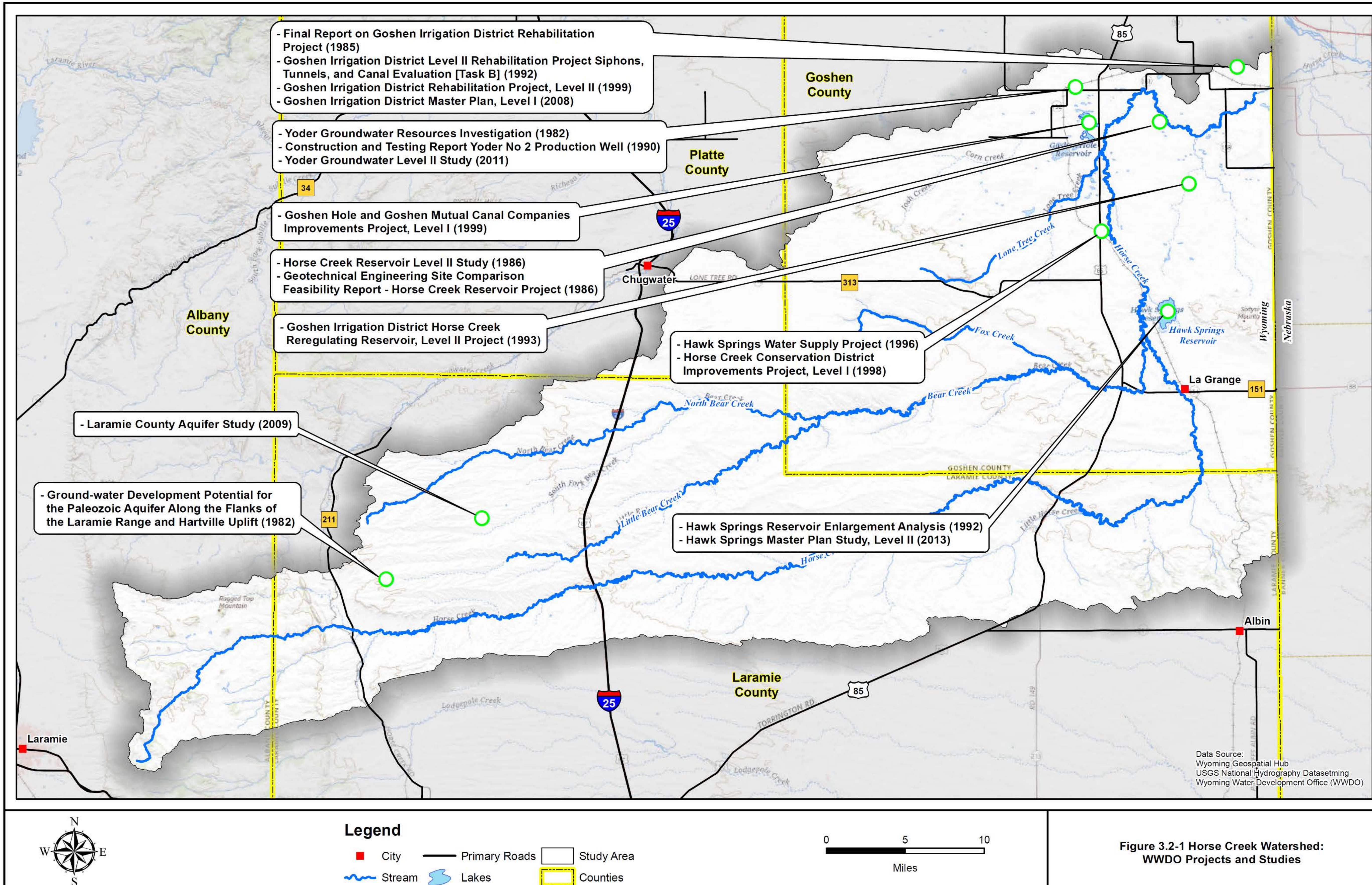


Figure 3.2-1 Horse Creek Watershed: WWDO Projects and Studies

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

A considerable amount of information exists pertaining to the Horse Creek Study Area and its resources. The data spans a wide variety of disciplines and includes basin hydrology, water quality, land use and ownership, geology and soils, and agricultural practices as typical examples. The primary objective of the watershed inventory phase of this project was to accomplish the following objectives:

1. collect, review, and compile 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.

Throughout the remainder of this chapter, an overview of existing conditions of natural resources found within the study area are discussed. 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. 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 is considered a semi-arid continental climate with some variation due to topography. Historic climate data for four 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 display the data graphically as bar charts. As indicated in the bar charts, summers are warm with July high temperatures averaging around 90 °F (27.2 °C) in La Grange and Yoder. The community of Horse Creek,

Table 4.2-1 Summary of Monthly Climatic Data: Horse Creek Watershed.

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Yoder 4 SW, Wyoming 489925: 10/01/1921 to 06/02/2011													
Average Max. Temperature (F)	40.7	45.3	51.8	62.1	71.3	81.9	90.1	88.3	78.9	66.8	51.4	42.8	64.3
Average Min. Temperature (F)	13.4	16.5	22.4	30.7	40	48.9	55	52.5	42.3	31.8	21.9	15.7	32.6
Average Total Precipitation (in.)	0.28	0.32	0.88	1.76	2.77	2.45	1.75	1.18	1.27	0.98	0.48	0.35	14.46
Phillips, Wyoming 487200: 08/01/1948 to 04/30/2016													
Average Max. Temperature (F)	40.9	43.8	50.1	59.3	68.5	79	87	85.2	76.5	64.6	50.5	42.3	62.3
Average Min. Temperature (F)	16.1	18.4	23.3	30.9	40	48.5	54.7	52.6	43.3	33.3	23.6	17.4	33.5
Average Total Precipitation (in.)	0.37	0.38	0.82	1.52	2.79	2.36	1.99	1.48	1.19	0.96	0.55	0.44	14.84
Horse Creek 2 NW, Wyoming 484700: 12/07/1955 to 02/28/1978													
Average Max. Temperature (F)	37.2	39.4	43.5	53.3	64.9	74.7	82.2	80.7	72	61.5	46.5	39.3	57.9
Average Min. Temperature (F)	16.2	18.2	20.9	28.7	38.7	47.4	53.3	52.1	42.6	34.5	24.3	18.8	33
Average Total Precipitation (in.)	0.58	0.59	1.1	1.85	2.36	2.21	1.99	1.2	1.23	0.92	0.68	0.57	15.29
La Grange, Wyoming 485260: 08/01/1948 to 03/31/2010													
Average Max. Temperature (F)	40.6	44.2	50.7	60.7	70.7	81.1	89.1	87.5	77.5	65.2	50.5	41.8	63.3
Average Min. Temperature (F)	14	17.4	22.5	30.4	40	48.9	55.1	53.4	42.8	32.1	22.1	15.5	32.9
Average Total Precipitation (in.)	0.48	0.49	1.16	1.78	2.68	2.42	1.94	1.52	1.27	1.08	0.62	0.63	16.08

located in the far western portion of the study area, is approximately 1,000 feet higher, where the July highs average is 82 °F (23.9 °C). Summer nights throughout the watershed are characterized by a rapid cool down; with mean summer lows averaging 48°F. Winters are cold, but are variable with periods of sometimes extreme cold interspersed between generally mild periods. Chinook winds can provide unusually warm temperatures in some locations.

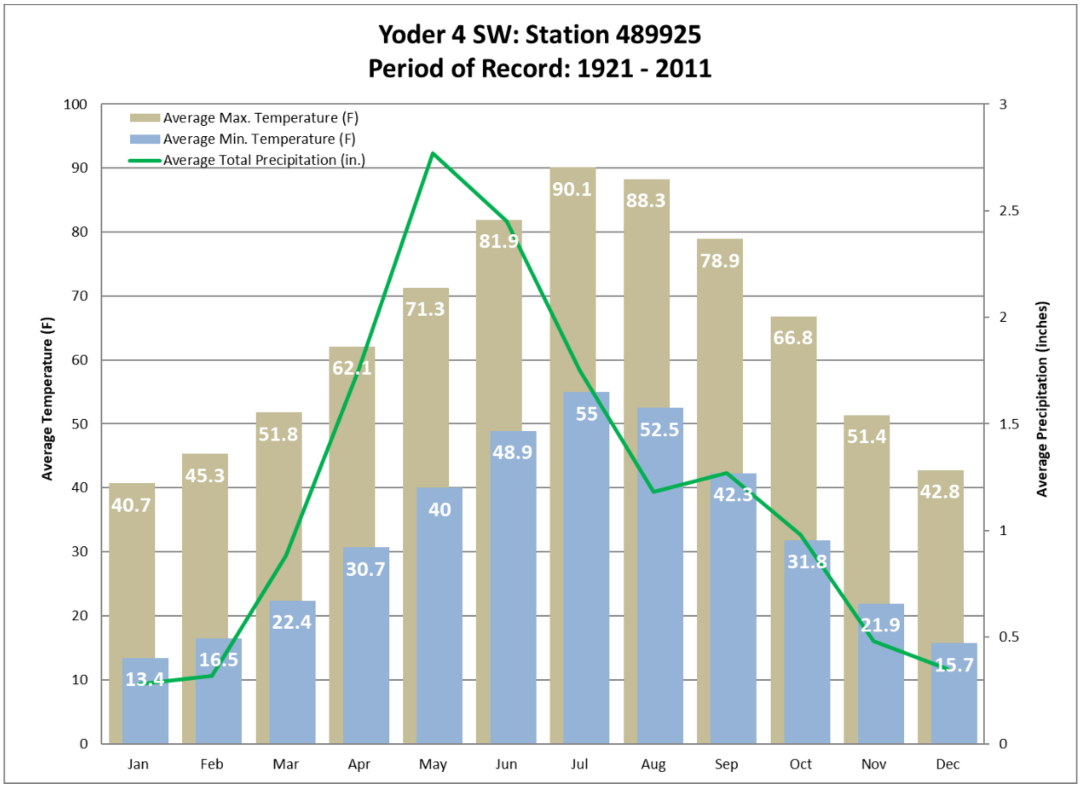
Figure 4.2-2 displays the mean annual precipitation throughout the watershed. The data used to generate this figure were obtained from the Wyoming Geographic Information Science Center (WyGISC). These data represent the results of PRISM spatial climate data generated at the Oregon Climate Center, Oregon State University. As indicated in this figure, the mean annual precipitation varies from a minimum of about 15-inches at the lower elevations to 21-inches at the higher elevations. A majority of the watershed receives 16 inches of rainfall or less on an annual basis. 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 project area lies 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.



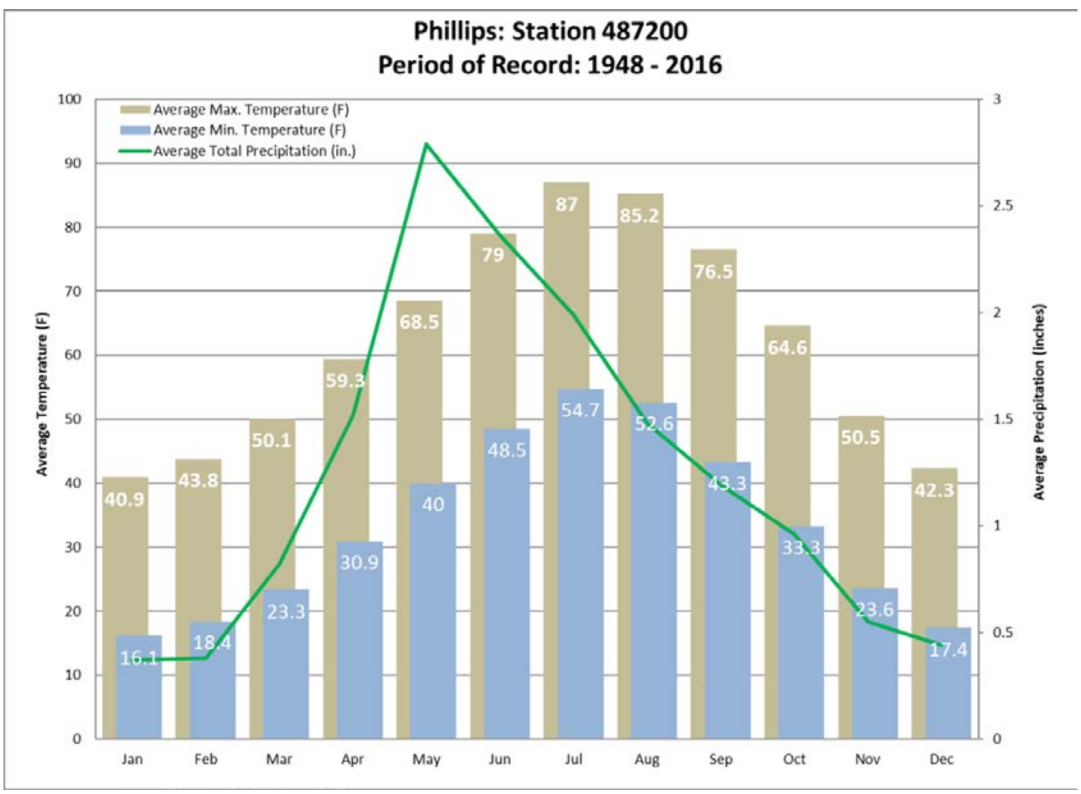
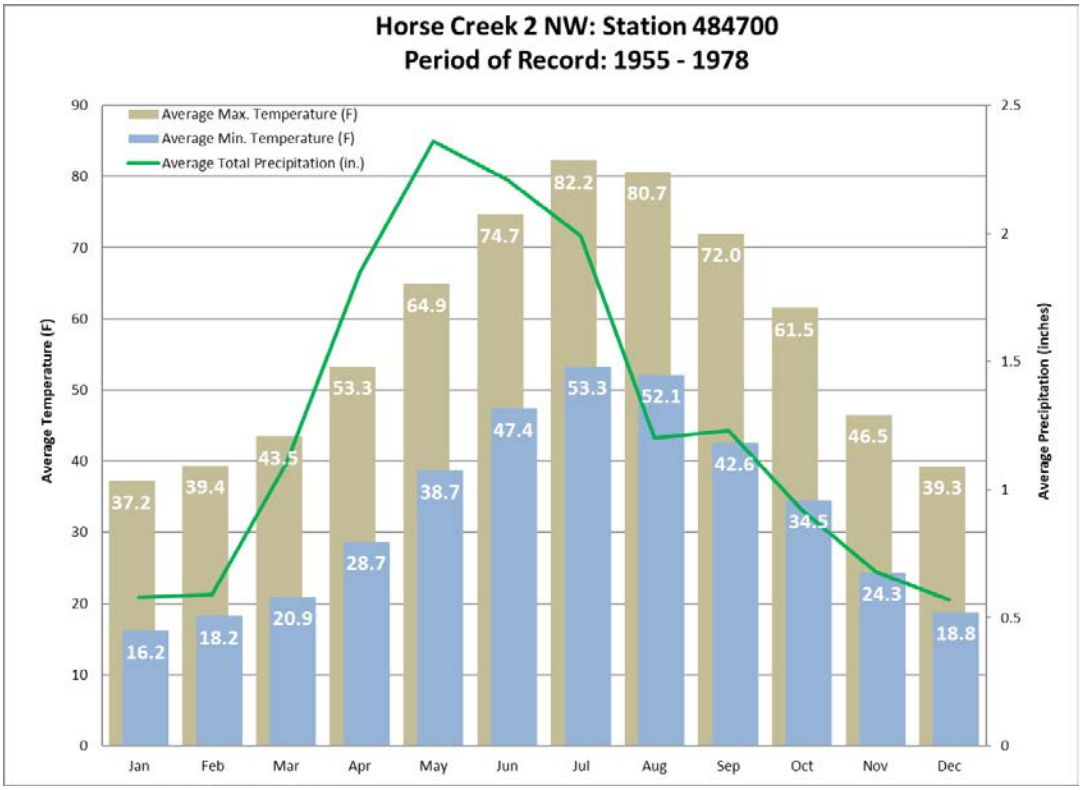


Figure 4.2-1 Mean Monthly Climatic Factors for Horse Creek Watershed.



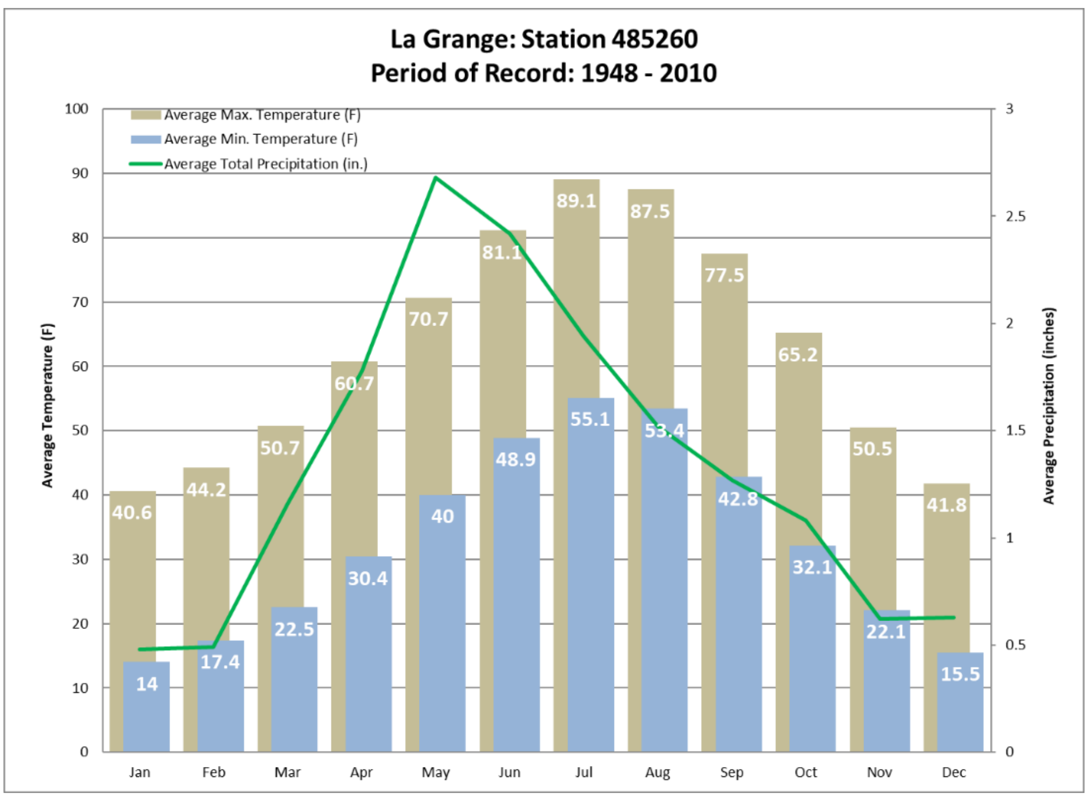


Figure 4.2-1 Mean Monthly Climatic Factors for Horse Creek Watershed (continued).

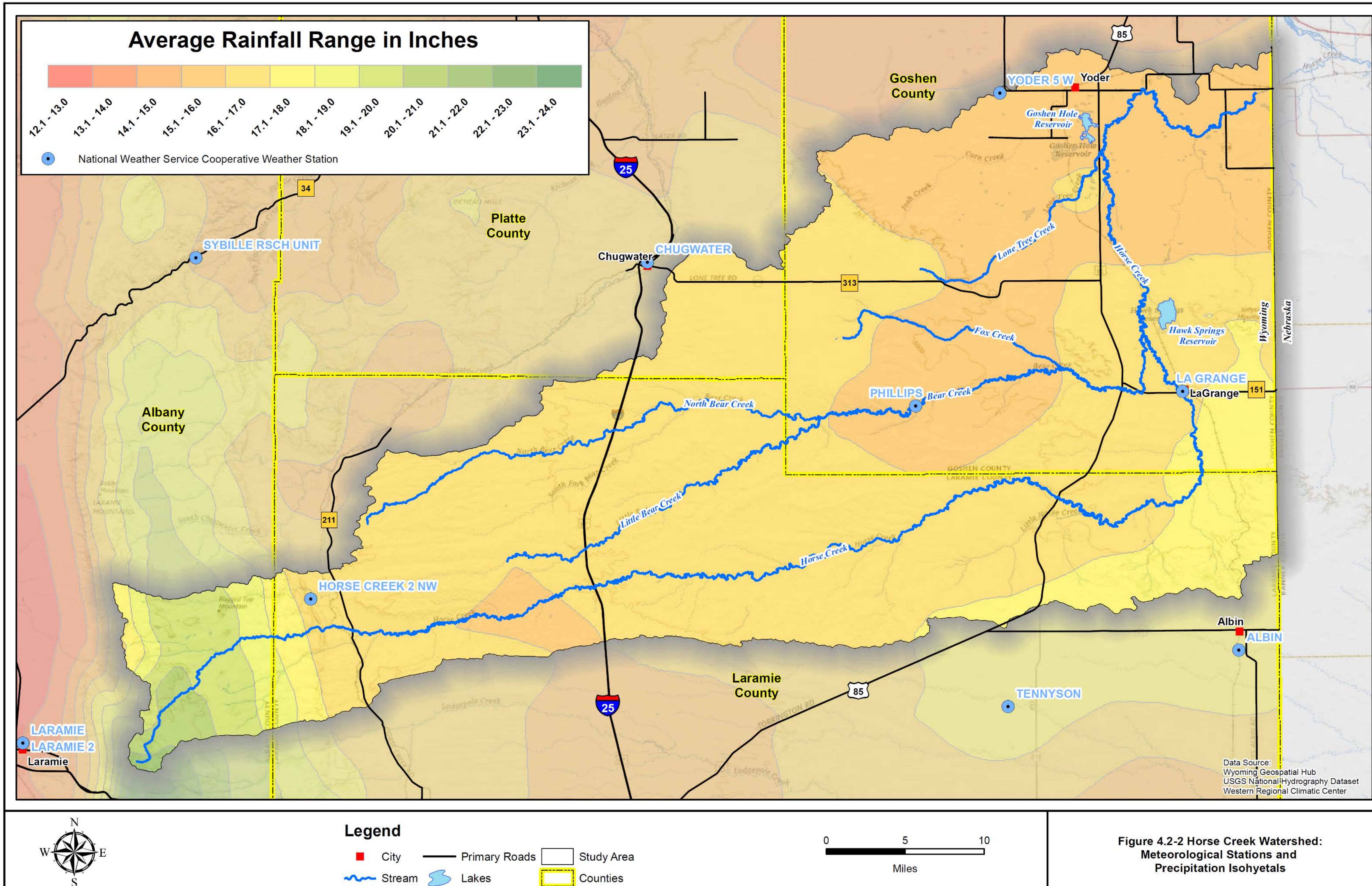


Figure 4.2-2 Horse Creek Watershed: Meteorological Stations and Precipitation Isohyetals

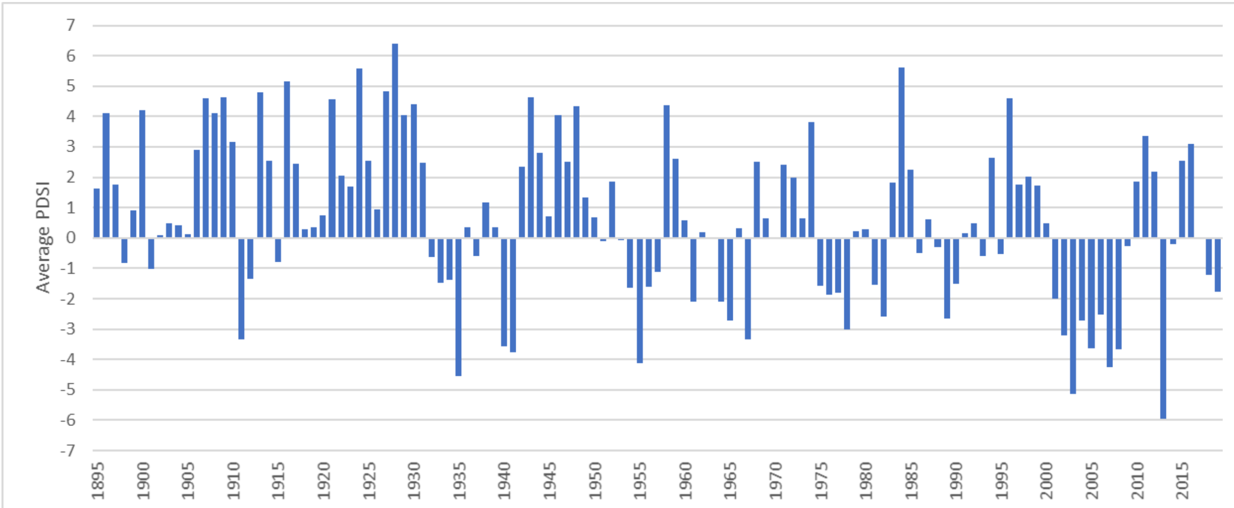


Figure 4.2-3 Palmer Drought Severity Index (PDSI) for Wyoming Climate Division 8.

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 crops.

It must be kept in mind that 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*

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)
Yoder 4 SW	1921-2011	28°F	8-May	27-Sep	140
		32°F	17-May	21-Sep	124
Phillips	1948-2016	28°F	10-May	27-Sep	138
		32°F	19-May	18-Sep	122
Horse Creek 2 NW	1955-1978	28°F	7-May	27-Sep	145
		32°F	22-May	19-Sep	117
La Grange	1948-2010	28°F	7-May	28-Sep	144
		32°F	19-May	18-Sep	122

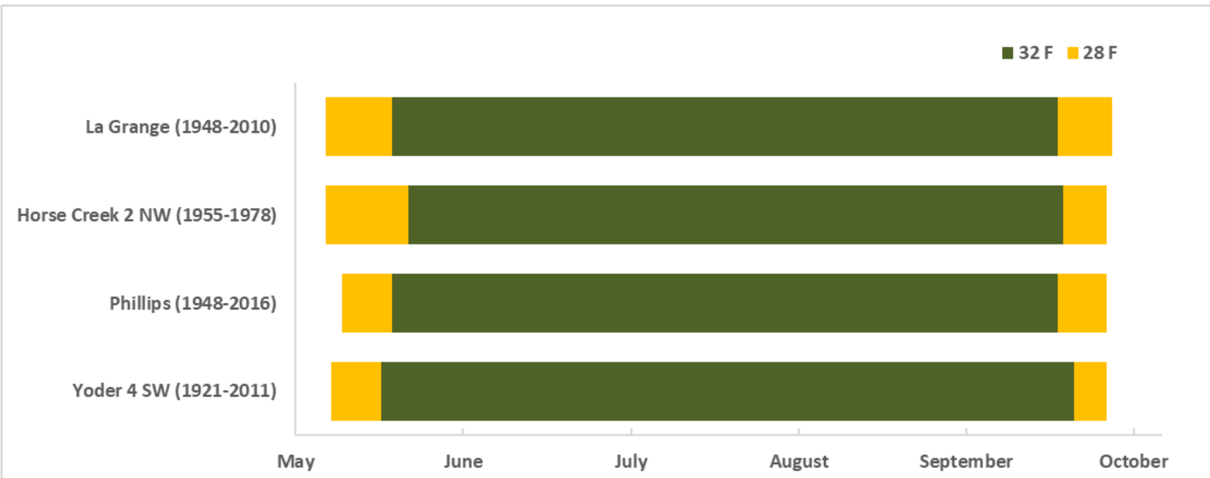


Figure 4.2-4 Average Frost-Free Periods at NOAA Cooperative Weather Stations.

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 changes will present unpredictable challenges for land managers; impacts of long-term climatic variability 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 Horse Creek 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 core of the Laramie Range at elevations up to 8,700 feet at the head of Horse Creek. In contrast, the valley of Horse Creek in the LaGrange area, at elevations below 4,500 ft., is 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 and availability and quality of groundwater.

This section begins with a brief 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 Horse Creek watershed are presented on Figure 4.2-5. 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 11 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.)

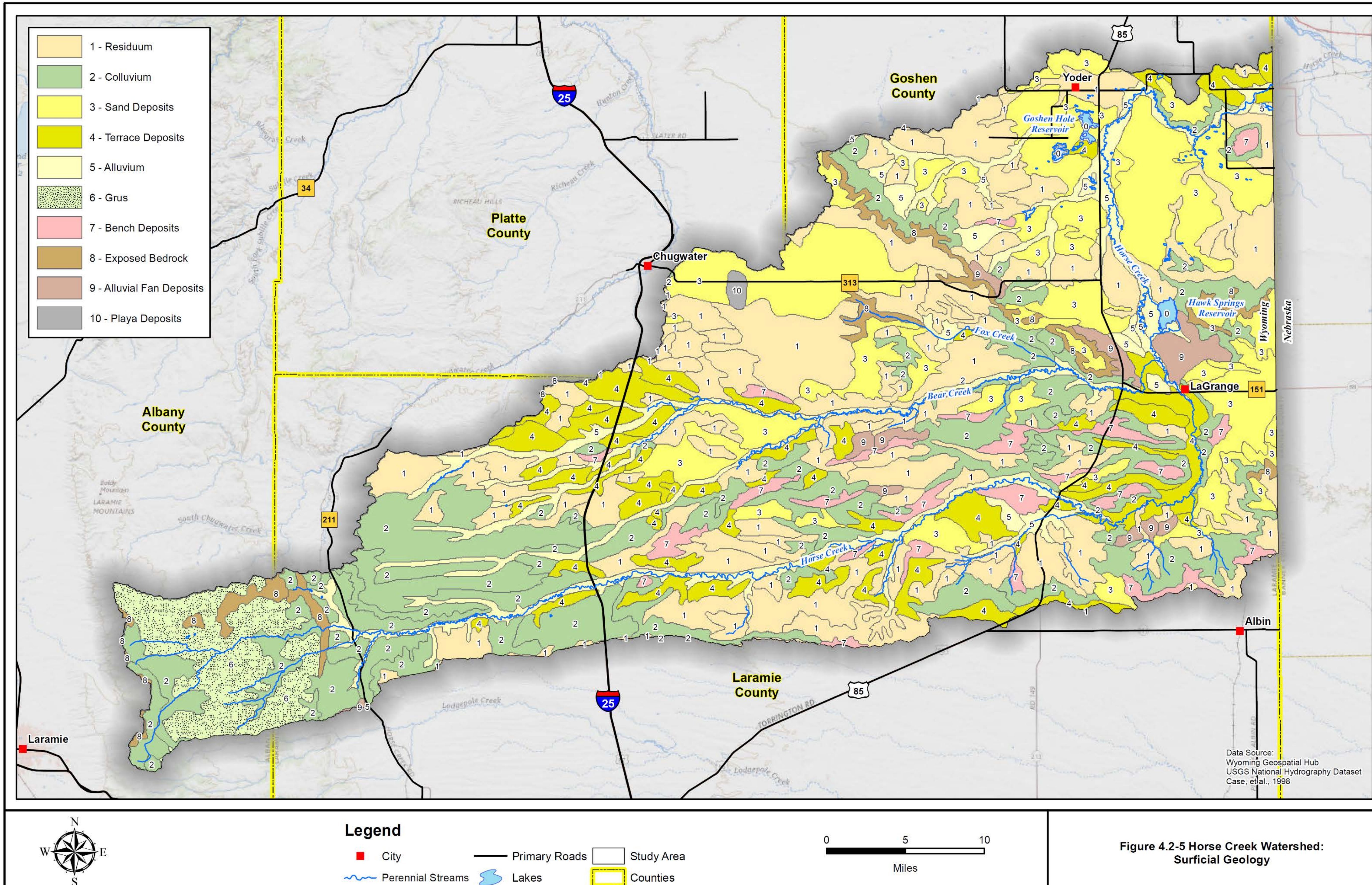


Figure 4.2-5 Horse Creek Watershed: Surficial Geology

The largest fraction of the Horse Creek watershed has been mapped as “residuum” and “exposed bedrock” (31% of the total). These are areas in which there is a mantle of the direct breakdown products of the underlying rock or where there has been little accumulation of weathering products, leaving the bedrock material exposed at the surface. 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 are “sand deposits” and “grus” (23% of the total area) and “colluvium” (23% of the total area). The sand deposits are wind-blown materials, i.e. sand dunes which were active in the geologic past but are now stabilized by vegetation. “Grus” is the thin, coarse gravel-like material produced by the local weathering of granitic rocks in the Laramie Range. In terms of groundwater, these are deposits that readily accept infiltration, providing recharge to underlying aquifers.

Colluvium 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 infiltration rates and erosion potential.

Next most common are “terrace”, “alluvial” and “bench” deposits (22% of the total area). 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” (minor coverage). 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. “Playa Deposits” (minor coverage). These are small areas without external drainage in which silt and clay accumulate, e.g. shallow ephemeral ponds.

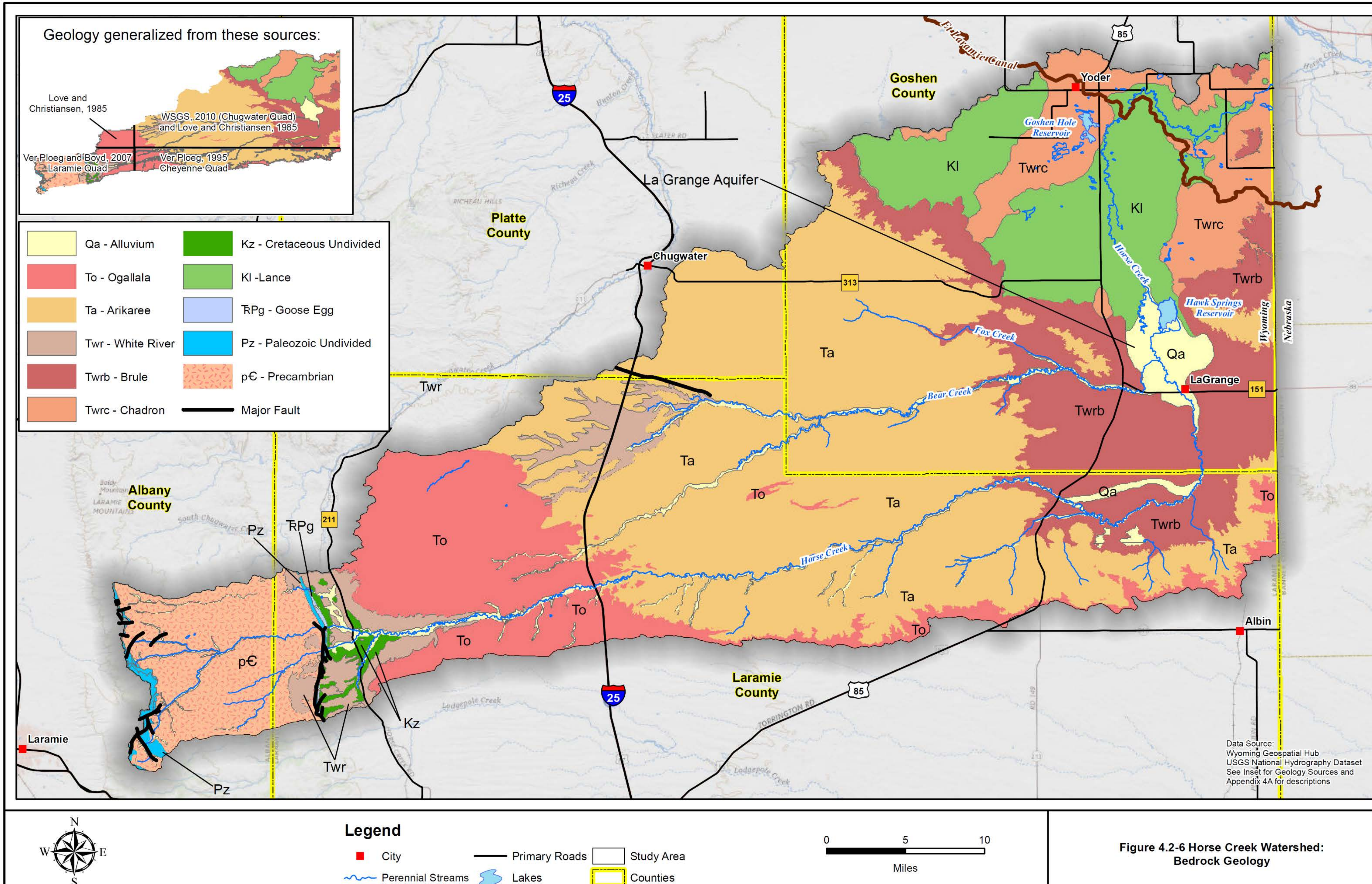


Figure 4.2-6 Horse Creek Watershed: Bedrock Geology

4.2.3.2 Bedrock Geology

The following paragraphs outline the basic geology of the Horse Creek 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's geology is beyond the scope of this investigation. 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 Rapp (1957), Geology and Ground-Water Resources of Goshen County, Wyoming. The most recent hydrogeologic evaluation is that of Hinckley and AMEC (2011) focusing on the intensively developed aquifer around LaGrange.

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 Survey (WSGS) at 1:100,000 scale (VerPloeg, 1995; VerPloeg and Boyd, 2007; WGS, 2010). Only the map units with significant coverage are labeled. Appendix 4A expands on the figure key and provides basic descriptions of the geologic units of the study area, both those mapped at the surface and those only present in the subsurface. (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 Horse Creek 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. The older bedrock sedimentary formations are present beneath the Tertiary rocks throughout the watershed, but only show up at the surface in a narrow band along the edge of the mountain uplift in the far headwaters of Horse Creek. The full sedimentary sequence (the rocks above the basement "granites") may be as much as 12,000 feet thick in the Horse Creek watershed, depending on the location and the sub-Tertiary geology.

Appendix 4A provides summary descriptions of the geologic strata of the Horse Creek watershed, in 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.

With respect to groundwater-development potential, the strata of primary interest in the Horse Creek watershed are in the Arikaree Formation, in the alluvial deposits along Horse Creek and Bear Creek, and in the areas where the upper portion of the Brule Member of the White River Formation hosts high-permeability fracture systems around LaGrange.

The Arikaree Formation provides the most extensive source of modest supplies of groundwater across the Horse Creek watershed. It is composed of sandstone and siltstone, with interbeded strata of volcanic ash. It has largely been removed by erosion in the eastern portion of the watershed, but is widespread upstream. It is modestly productive of groundwater and has been developed for groundwater irrigation at scattered locations. However, it is common to combine several irrigation wells to provide sufficient water to operate a center-pivot irrigation system.

Lithologically, the underlying Brule Formation is a siltstone/claystone. It is widely quarried and applied to line ponds and canals to reduce seepage losses. Babcock and Rapp (1952) described “contact” springs where infiltration downward in the Arikaree Formation encounters the relatively impermeable strata of the underlying Brule, forcing groundwater to flow laterally to discharge where that contact is exposed at the ground surface. In the LaGrange area, however, relatively thick alluvial deposits and localized high-permeability at the top of the underlying Brule Formation combine to form a highly productive aquifer. This combination has received a specific name, the “LaGrange Aquifer” (e.g. Borchert, 1985; Borchert, 1976; see Figure 4.2-6 for location). There, the Brule includes factures, gravel stringers, and cavities that are very productive. Quoting from Hinckley and AMEC (2011):

> The nature of these high-permeability zones is unclear. Various geologists have described “fractures”, “fissures”, “pipes”, and “solution cavities”. Common driller descriptions include “broken hardpan”, “fractured Brule”, etc. Permit U.W. 1900 states “at 45 feet we hit an underground stream”.
>
> A sampling of the WSEO Statements of Completion filed for Brule Formation wells in the Horse Creek Basin outside of the LaGrange Aquifer found specific capacities ranging from near zero to highs around 10 gpm/ft. Tests reported for Brule wells within the LaGrange Aquifer, however, are commonly in the tens of gpm/ft and, occasionally, over 100 gpm/ft. The driller-identified “main water bearing zones” in wells we have identified as primarily producing from the Brule Formation in the LaGrange area start at an average depth of 60 feet and extend to a depth of 100 feet. In only 5 of the 55 wells with available records, is the “main water bearing zone” identified as extending to below 150 ft; the deepest of these zones is 200 ft. (The deepest of these wells is reported to be 350 ft deep, but the main water bearing zone in that well is identified as extending only to 145 ft. Presumably, the deeper drilling represents an unsuccessful attempt to find deeper

production zones.) The material at the base of the productive zones of the Brule is most commonly described as “clay”, “shale”, or “Chadron” (referring to the underlying Chadron Fm.)

The famous Ogalalla Formation is present along the upper reaches of Horse Creek. Although providing an important aquifer further south in Wyoming and across the Great Plains to the east, in this watershed, the Ogalalla is found only in upland areas where it is generally dissected by streams and may be well drained (i.e. the groundwater level is below the bottom of the formation).

In two small areas on either side of the granitic rocks that form the headwaters of Horse Creek, the Casper Formation may provide a productive aquifer (part of the “Pz” designation mapped on Figure 4.2-6). Particularly on the west side of the range, a tiny portion of which is within the Horse Creek watershed, the Casper has proven itself to be a highly productive aquifer, supplying the municipal wells of the City of Laramie and irrigation wells of >1,000 gpm capacity. There has been no significant evaluation of the very limited exposures of the Casper Formation in the Horse Creek watershed on either side of the Laramie Range, nor of the deep Hartville / Casper Formation that is present beneath much of the watershed.

Formations between the deeper aquifers (e.g. Hartville / Casper) and the widespread shallower aquifers (e.g. Ogalalla, Arikaree, and Brule) are dominated by fine-grained material generally poorly productive of groundwater. Nearly 50% of the total thickness of these formations is in the Pierre Shale, a regional confining bed consisting of low-permeability marine shale (with thin beds of sandstone). Table 4.2-3 provides a summary of the stratigraphy of the watershed. More complete formation descriptions are presented in Appendix 4A.

Table 4.2-3 - Major Stratigraphy of the Horse Creek Watershed.

Formation	Lithology	Thickness	Water Resources
alluvial deposits (Qa)	sand / silt / clay / gravel	0 - 50	prolific aquifer where sufficient saturated thickness, e.g. LaGrange area
Ogalalla	sand and gravel	220	present in upland areas, typically without substantial saturation
Arikaree	fine sand and silt, basal conglomerate locally	1,000	primary aquifer in the Horse Creek watershed outside the LaGrange area
Brule	siltstone	450	productive under the special circumstances of the LaGrange Aquifer.
Chadron	clay and silt	250	can be modestly productive in special circumstances

Formation	Lithology	Thickness	Water Resources
Lance	gray siltstone, dark to light gray sandstone, carbonaceous shale and thin coal beds	1,400	
Fox Hills	gray fine to medium-grained sandstone, siltstone and shale towards bottom	170	
Strata below the Fox Hills are dominated by thick shale formations. The section includes permeable strata in the Frontier, Cloverly, Sundance, and Minnekahta/Forelle 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.			
Hartville/Casper	sandstone / limestone	1200	potentially significant aquifer, but little-developed due to very limited opportunity
“basement” rocks	granite, gneiss, schist, quartzite	not applicable	yields small quantities of groundwater where fractured
Note: thicknesses from Rapp et al., 1957; Borchert, 1976			

Geologic Structure

In the case of the Horse Creek 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 Rocky Mountain uplift. The highest elevations are occupied by the oldest rocks, forming the Laramie Mountains. Older strata, i.e. beneath the White River Group (Brule and Chadron Formations), were steeply deformed by the uplift of the mountains, but the younger strata of the Chadron, Brule, Arikaree, and Ogalalla Formations are primarily post-mountain building and dip only gently eastward from the mountains, as does the ground surface. The erosion of the “Goshen Hole” - the eastern portion of the Horse Creek watershed - has removed the younger Ogalalla and Arikaree Formations, exposing the underlying Brule, Chadron, and Lance (Figure 4.2-6).

There are no regional geologic structures that separate the Horse Creek drainage from the North Platte to the north or from the Lodgepole Creek drainage to the south. The outcrop patterns of Figure 4.2-6 are largely a function of topography, with erosion having cut down through younger beds to expose older beds at lower elevations. For example, the Arikaree Formation has been removed from most of the lower portion of the watershed, but remains in scattered outcrops on the tops of hills, e.g. Sixty Six Mountain and Bear Mountain east and west of LaGrange, respectively.

In the northernmost part of the Horse Creek watershed, the erosion of the Horse Creek valley down through the Brule Formation exposes the Chadron and Lance Formations at the surface. These relatively low-permeability units produce a hydrogeologic barrier with respect to groundwater flow. To the south, the Arikaree and Ogalalla Formations extend without interruption, and groundwater flow is primarily controlled by recharge rates and topography. Thus, the groundwater "watershed" is bounded by:

- a groundwater divide between Horse Creek and Lodgepole Creek on the south;
- the Laramie Mountains on the west;
- a groundwater divide between Horse Creek and Chugwater Creek on the northwest;
- a groundwater divide between Horse Creek and Pumpkin Creek (Nebraska) on the east; and
- a groundwater barrier north of LaGrange on the north.

The portion of the Horse Creek surface watershed downstream of the latter barrier is both hydrologically and hydrogeologically part of the North Platte River valley. The tiny portion of the watershed west of the Laramie Range is, of course, part of the Upper Laramie Basin for most practical purposes.

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 Horse Creek watershed are relatively young, i.e. 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 primarily present in this watershed only along the east and west toes of the Laramie Range. In those areas, faulting is complex, as normal and thrust faults leave the impacted formations dipping steeply along the mountain flanks or entirely overridden by granitic rocks. While this faulting may provide local fracturing, it greatly reduces or eliminates outcrop areas available for recharge.

The one fault mapped on Figure 4.2-6 away from the mountains is on upper Bear Creek. Of young enough activity to displace Arikaree strata (25 m.y.), the fault is mapped with normal displacement - north side down.

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, the faults do not represent a constraint on development activity with respect to earthquakes.

Based on review of the earthquake record maintained by the National Earthquake Information Center (NEIC, 2018), there have been no recorded earthquakes of magnitude 3.0 or greater in the Horse Creek watershed. (A magnitude 3.0 earthquake is just into the range that can be felt.)

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 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.

Similarly, no significant landslide occurrences have been mapped in the Horse Creek watershed (e.g. WRDS, 2004). While the materials of the watershed are not conducive to landslides, any steep slopes subject to sporadic saturation are potential candidates for local landslide activity. Canals and ditches with substantial downslope embankments, for example, are candidates for local slope failure.

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 Horse Creek 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). A comprehensive, although dated, discussion of groundwater resources through much of the study area is Rapp et al. (1957), “Geology and Ground-Water Resources of Goshen County, Wyoming”. The most comprehensive recent study of groundwater in the Horse Creek watershed is that of Hinckley and AMEC (2011), which included numerical modeling of the aquifer in the LaGrange area.

Groundwater information specific to the LaGrange area are abundant, due to widespread development for irrigation purposes and special evaluations related to sustainability concerns and water-rights disputes in that 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. sandy surfaces, and most importantly for the LaGrange area, where Horse Creek and Bear Creek water is distributed via the irrigation system upstream of Hawk Springs Reservoir. Natural recharge is highly variable temporally, typically most abundant in spring and relatively scarce in late-fall.

Because of the water-rights and groundwater development situation on Horse Creek, irrigation recharge is not confined to the summer growing season, but is actively encouraged virtually year round in the LaGrange area. In 1957, Rapp et al. (p. 55) estimated that about "half of the water diverted from streams for irrigation in the valley of Horse and Bear Creeks is recharged to the groundwater reservoir."

Unlike elsewhere in the state, where groundwater recharge by the infiltration of irrigation water is incidental to irrigation, it is a deliberate process in the LaGrange area. Quoting from Hinckley and AMEC (2011):

> Borchert (1976, p. 42) states that, "Water is diverted by Horse Creek No. 1 Ditch from Horse Creek to recharge the aquifers northeast of LaGrange." He goes on to quote long-time Hydrographer James Ward, as opining that the "increase in pumping [between 1969 and 1975] resulted in greater than normal amounts of surface water diverted by Horse Creek No. 1 ... beginning in 1969, to provide water for recharging the aquifers where increased pumping had occurred." Also (p. 58), "Surface water diversions to Horse Creek No. 1 Ditch are used primarily to recharge the alluvium and Brule Formations north and northeast of LaGrange." and (Borchert, 1985, p. 26), "the total estimated surface water diverted [by the Horse Creek No. 1 Ditch] is assumed to recharge the LaGrange aquifer." In 1979, the Board of Control found that "no water was applied through surface irrigation from ditches or laterals extending from the Horse Creek Ditch No. 1, except in 1975 when water was accidentally diverted into a lateral ..."

This practice has led to extensive disagreements between the operators of the Hawk Springs Reservoir and upstream senior irrigation rights, culminating in the 2011 Hinckley and AMEC report and the subsequent Wyoming State Engineer special management order for the area (discussed further below).

The generalized annual natural recharge rates developed by Hammerlink and Arneson (1998) are shown on Figure 4.2-7. These were developed with a grid system incorporating estimates of infiltration rates, soil characteristics, and annual precipitation. It should be noted that linear boundaries on Figure 4.2-7 are aberrations reflecting the boundaries of the different county-based maps used for the analysis rather than real changes in recharge rate at those boundaries. The highest estimated recharge rates - 7 to 9 inches - correspond with the highest elevations, i.e. the headwaters of the watershed in the Laramie Range. Most of the watershed was estimated to receive an inch or less of natural groundwater recharge.

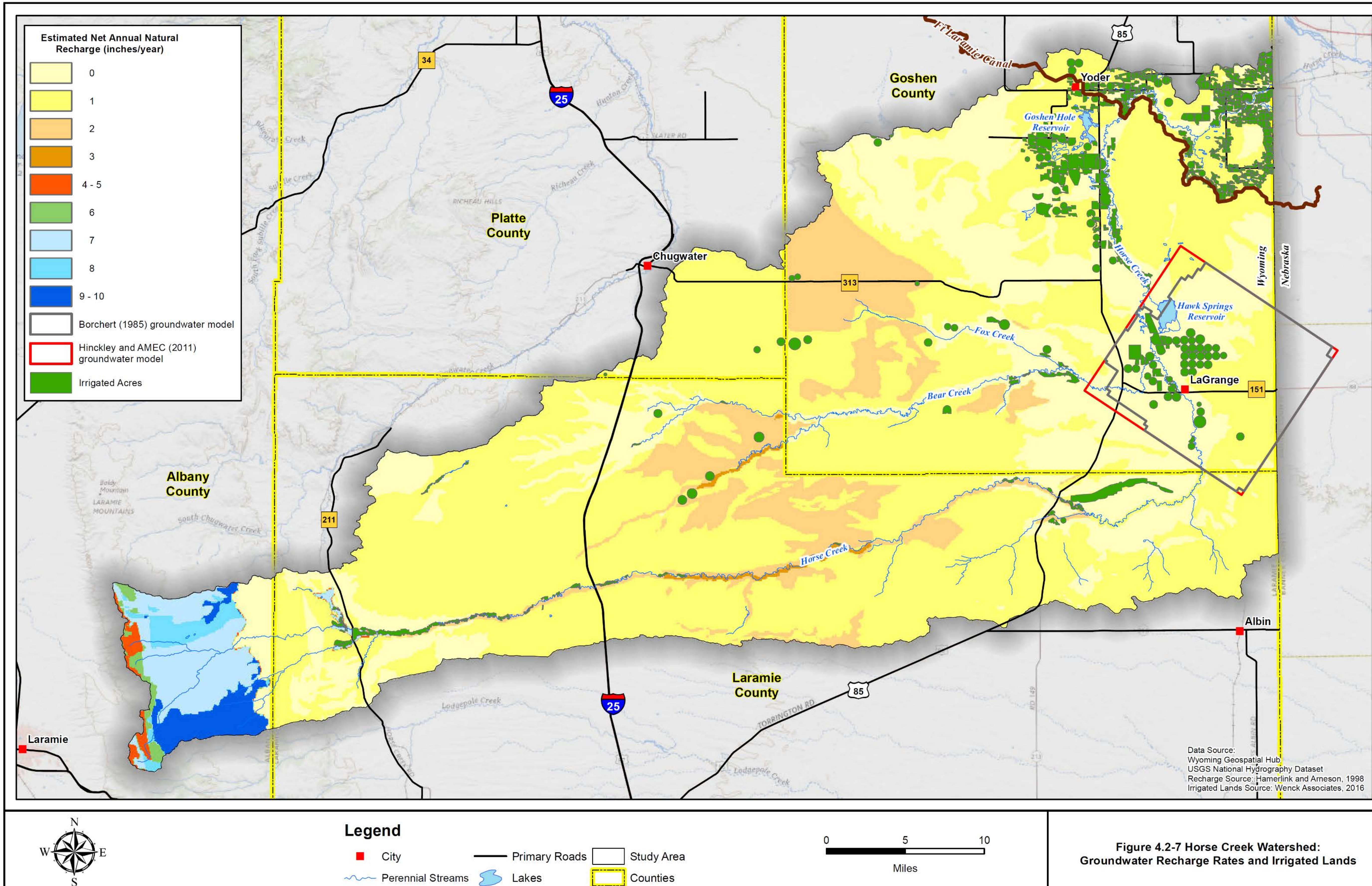


Figure 4.2-7 Horse Creek Watershed: Groundwater Recharge Rates and Irrigated Lands

Further processing of those estimates by Taucher et al. (2013, Fig. 6-7) concluded that for most of the Horse Creek portion of the North Platte River basin, 1.5 - 10% of the local precipitation found its way into the underlying aquifers. (The remainder is lost to evaporation, runoff, and vegetation evapotranspiration.) Borchert (1985) concluded use of a rate of 5% of precipitation provided satisfactory results for his numerical groundwater modeling in the LaGrange area. This factor was also used in the Hinckley and AMEC (2011) groundwater model. In the latter model, irrigation recharge was judged to constitute approximately 60% of the groundwater recharge in the watershed between the Laramie County line and Hawk Springs Reservoir.

Included on Figure 4.2-7 are the areas receiving irrigation by surface water, groundwater, or both, and the boundaries of the groundwater models developed by Borchert (1985) and Hinckley and AMEC (2011). For the area modeled, the latter provides the most well-integrated view available of groundwater recharge, movement and discharge.

4.2.4.2 Groundwater Levels and Flow

Over days, years, centuries, or even millennia (where groundwater circulation is long and deep), 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.

Figure 4.2-8 is an approximate contour map of the groundwater table composited from the work of Borchert (1976), Rapp et al. (1957), Bartos and Halberg (2011), and Morris and Babcock (1960). Due to the range of dates and the data available to these different authors, some liberty has been taken to match contour lines between maps to create the Figure 4.2-8 composite. Current and local measurements will be superior to this generalized mapping for assessment of depth to water at a specific location, but these basic patterns of groundwater flow persist through time.

Like surface water, groundwater flows “downhill”, from areas of high groundwater level elevation to areas of lower groundwater level elevation. Like surface topographic contours, the groundwater elevation contours of Figure 4.2-8 show “uphill” and “downhill” with respect to groundwater flow, and the groundwater elevation map is quite similar to the surface elevation (i.e. topographic) map. Groundwater in the Horse Creek watershed flows generally from west to east, reflecting the higher recharge elevations in the upper watershed. On a more local scale, the contours show a convergence of groundwater flow on Horse Creek, Bear Creek, and Fox Creek, as the aquifers contribute groundwater to maintain the flow of these perennial streams.

In the lower Horse Creek watershed, natural stream gains are overwhelmed by irrigation diversions from Horse Creek and Bear Creek, and despite their groundwater gains, the streams are commonly dried up at

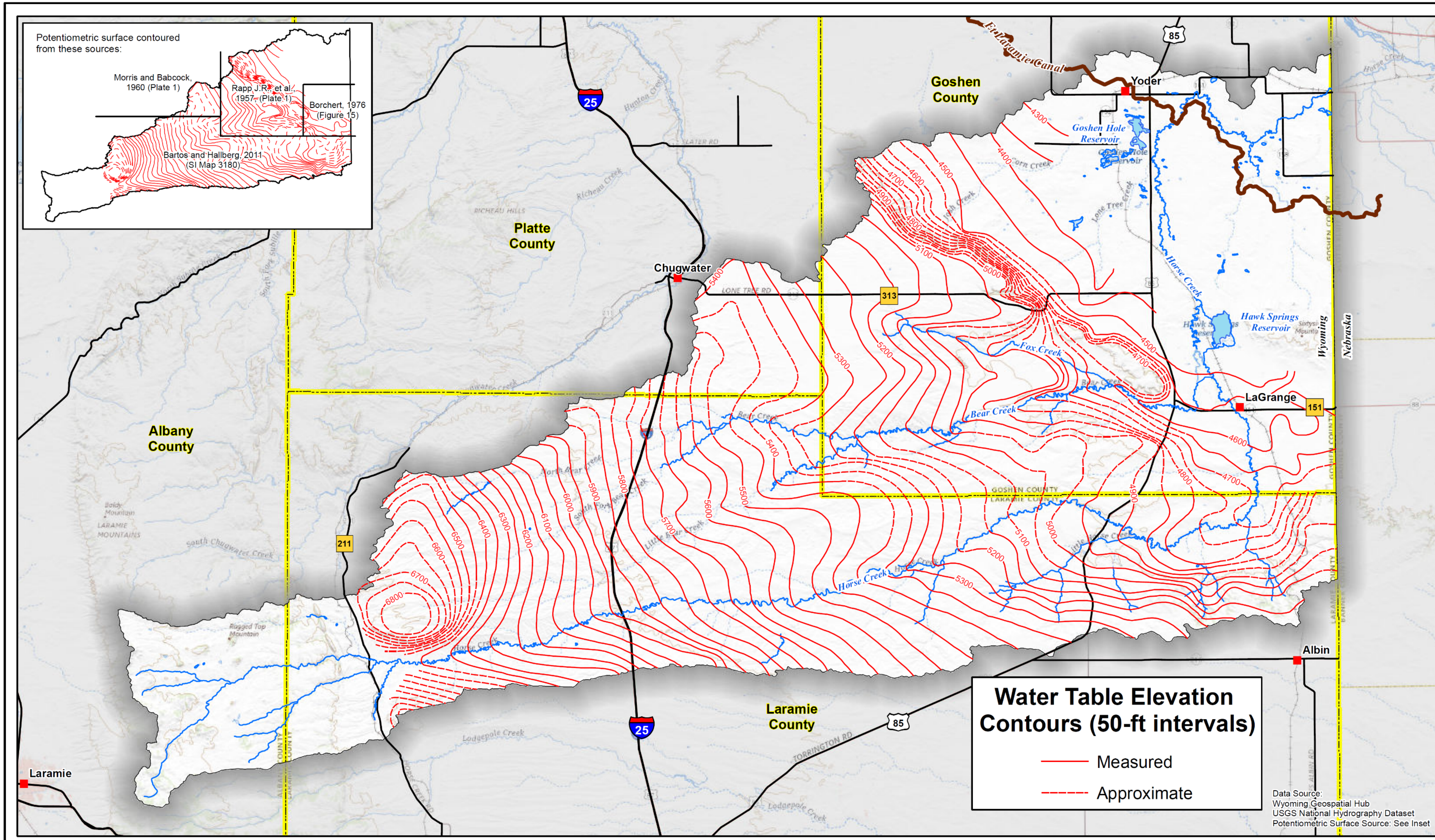


Figure 4.2-8 Horse Creek Watershed: Potentiometric Surface

many diversion headgates (Hinckley and AMEC, 2011). This condition has been present for a long time, as described in 1902 (Adams), "These streams [Bear Creek and Horse Creek] head in the foothills of the southern extension of the Laramie Mountains, and have long, narrow drainage basins. They flow throughout the year, although in places, as a result of the diversion of water for irrigation and the disappearance of the remaining small flow in the gravels and sands, their channels are sometimes nearly dry."

On the scale of the entire watershed and the deeper aquifers, groundwater flow was investigated for the Nebraska v. Wyoming lawsuit. Hinckley et al. (2000) concluded that the low permeability of the Lance Formation essentially created a barrier to significant groundwater flow from beneath the Horse Creek watershed above (south of) the Fort Laramie Canal, creating a more-or-less "closed system" in which virtually all groundwater recharge returns to the surface within the watershed. This situation is indicated on Figure 4.2-8 by the "piling up" of the groundwater contours against the low-permeability strata north and northwest of LaGrange. (See Figure 4.2-6.) The absence of contouring in this area reflects the inconsistent nature of water-bearing strata in the White River (Brule and Chadron) and Lance Formations and the absence of good water-level data.

Similarly, the contouring stops along uppermost Horse Creek because the geology becomes complex and there is no regional-scale water table. Depth to groundwater in those areas is a function of quite local conditions, and where the bedrock is the granitic rocks of the Laramie Range there is no consistent aquifer present.

A groundwater divide is indicated in the far eastern portion of the watershed, from which groundwater moves east into the drainage of Pumpkin Creek in western Nebraska.

Finally, Figure 4.2-8 indicates the flow of groundwater into the Horse Creek watershed from the south. In this case, the groundwater "basin" is somewhat larger than the topographic watershed as Horse Creek receives groundwater inflow from beneath the northern portion of the Lodgepole Creek watershed.

Unlike the surface topography, the groundwater table is dynamic, with water levels varying through time as a function of the ever-changing balance between recharge and discharge, including the impacts of active irrigation. Hinckley and AMEC (2011, p. 2-16) examined the records for long-term monitoring wells in the Horse Creek watershed, and provide representative hydrographs. They concluded:

1. There had been "no significant upward or downward trend in groundwater levels since the mid-1970s"
2. But same-time-of-year measurements over that long period document long-term variations (e.g. the 2000s drought) of approximately 10 feet.
3. In areas unimpacted by irrigation pumping, natural seasonal variations of 2 - 3 feet were identified - highest in late spring and falling through summer and fall.

4. The largest seasonal swings in groundwater levels are, as expected, in areas of deliberate groundwater recharge with surface diversions (winter and spring) followed by groundwater withdrawals for irrigation (summer and fall). These fluctuations are on the order of 10 - 15 feet.

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 4.2-9 includes perennial streams in the Horse Creek watershed as mapped by the U.S. Geological Survey at a scale of 1:100,000 (WGS, 2010). Horse Creek begins in the area where higher precipitation and lower infiltration rates promote perennial flow. It is sustained by groundwater influx from north and south. And, finally, it is depleted by irrigation diversions in the LaGrange area. As shown on Figure 4.2-9, Horse Creek has largely been diverted from its natural channel to flow directly into Hawk Springs Reservoir. However, the creek is revivified shortly below that point by groundwater return flows.

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 4.2-9 presents mapped springs for the Horse Creek 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 (WSGS, 2010), with additions using the same process for the present report. 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.

Those springs on Figure 4.2-9 marked as “SEO” were extracted from the database of water rights maintained by the Wyoming State Engineer’s Office. (The “SEO” springs are plotted on top of the “USGS”

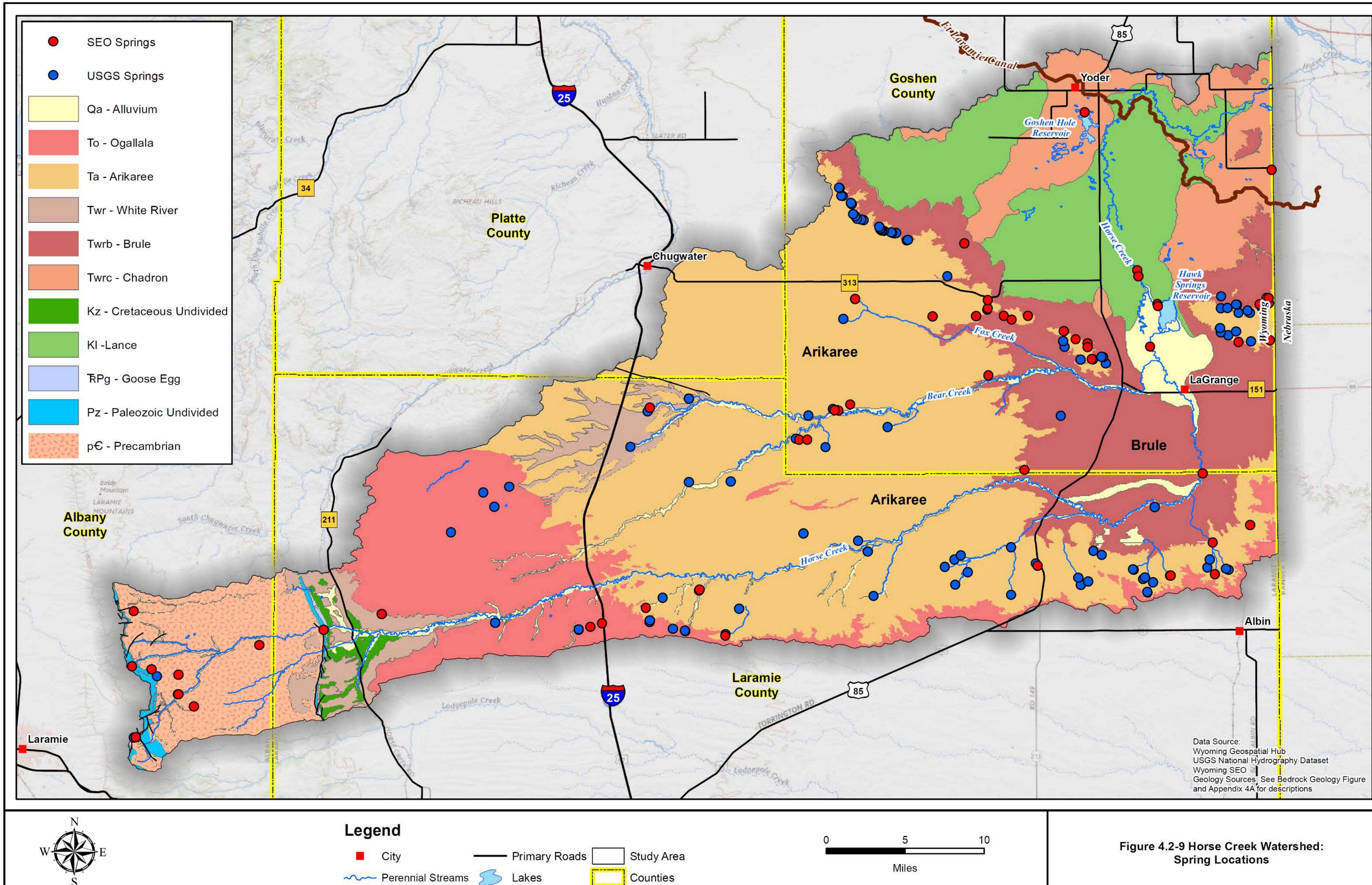


Figure 4.2-9 Horse Creek Watershed: Spring Locations

springs on Figure 4.2-9 where the two coincide. Consult the relevant electronic GIS files to discriminate.) 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 Horse Creek 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 based on that information.

81% 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 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 quarter-quarter 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.

As can be seen by reference to the underling geology, most of the springs in the Horse Creek watershed are a function of groundwater in relatively higher permeability encountering underlying lower-permeability strata and moving laterally to exit at the contact between the two. This occurs along the Arikaree / Brule contact in the northeast portion of the watershed and along upper Bear Creek. It occurs along the Ogalalla / Arikaree contact in the southwest. This correctly identifies the relative permeabilities of the three units: Ogalalla - highest; Arikaree - intermediate; and Brule - lowest. Springs along the south side of middle Horse Creek flow and along middle Bear Creek are generated by similar contrasts between strata within the Arikaree Formation. In many cases, spring flow (or combined spring flow) is sufficient to create a perennial stream.

As suggested by the wide distribution of springs in the Horse Creek watershed and their association with specific stratigraphy, they tend to be the result of local recharge/discharge relationships with limited catchments. Thus, one does not see large springs representing regional groundwater discharge. As stated by Rapp et al. (1957), “There are many small springs and seeps in the county ... These springs and seeps supply small quantities of water, which are used primarily for watering livestock. All the springs observed in the area are gravity springs ...”. (By “gravity springs”, the authors mean the appearance at geologic contacts, as described above.)

The most notable exception in the watershed with respect to spring size is a set of springs long removed from surface appearance by the construction of the Hawk Springs Reservoir. Hawk Springs itself was found to flow 1,100 gpm between its 1893 original and 1908 enlargement water rights. Adams (1902) describes Hawk Springs as “perhaps the largest so-called spring in the Goshen Hole country”. (His use of “so-called” suggests he may be making a distinction between deep-sourced springs and those associated with shallower aquifers.) Like the springs described above, Hawk Springs issued from near the contact between a productive aquifer - the LaGrange Aquifer, in this case - and an underlying low-permeability unit - the Lance Formation, in this case.

Finally, substantial quantities of groundwater are discharged in the Horse Creek watershed through wells. These are discussed in detail below.

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 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 4.2-10, with customization to better match conditions in the Horse Creek 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, granitic rocks of mountain core.

The “major aquifers” of the Horse Creek watershed are the Ogalalla and Arikaree Formations, the alluvial deposits along major streams, and the special conjunction of alluvial deposits and fractured Brule making up the “LaGrange Aquifer” (discussed above). The two bedrock formations - Ogalalla and Arikaree - are not stand-out aquifers on a statewide basis, but under favorable circumstances can provide up to several

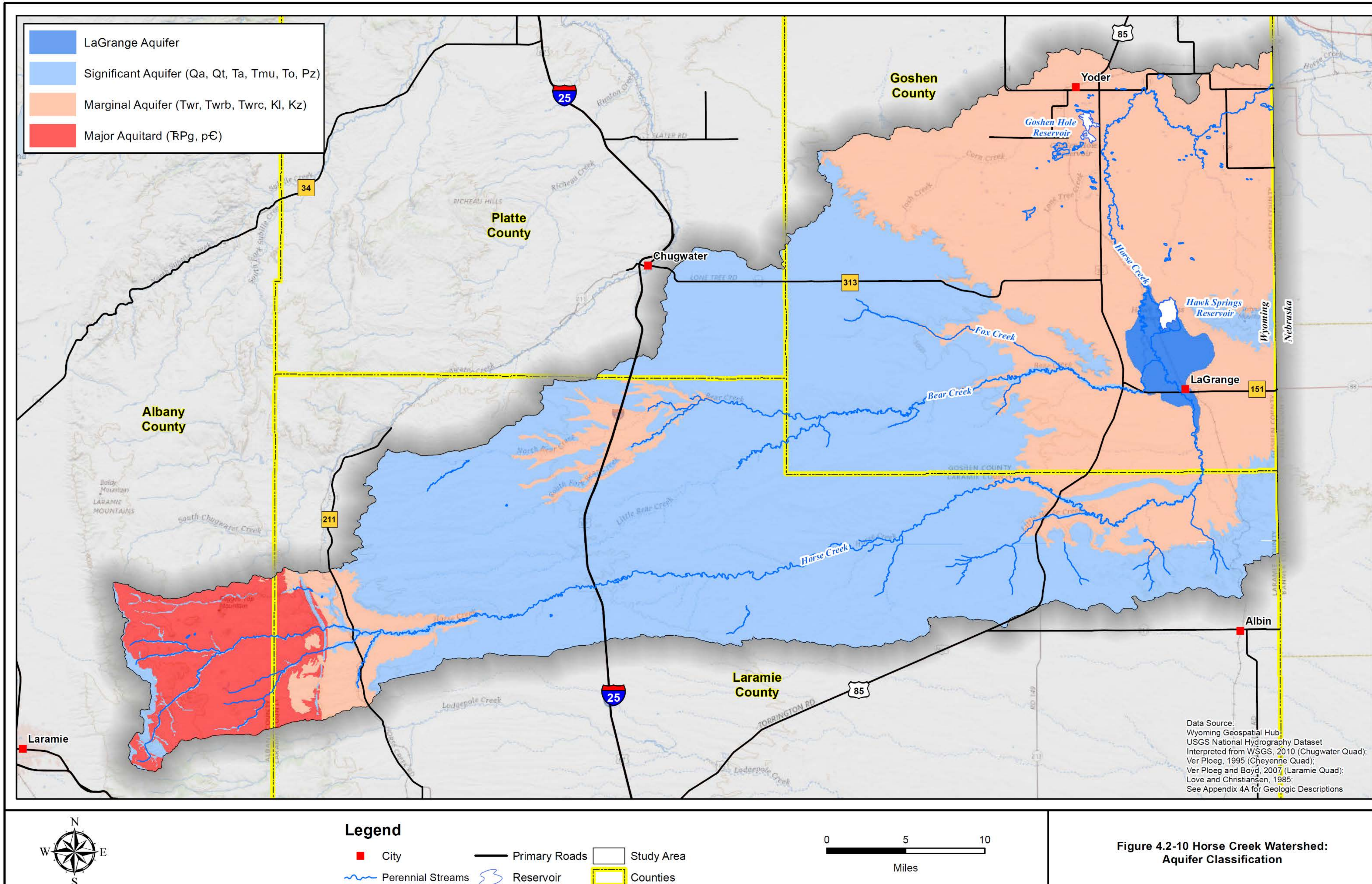


Figure 4.2-10 Horse Creek Watershed: Aquifer Classification

100 gpm of good-quality groundwater. “Favorable circumstances” include the local presence of higher permeability strata, large saturated thickness, and, ideally, fracture enhancement of permeability. The most widely-developed aquifer in the watershed is the Arikaree; the most intensely developed is the LaGrange Aquifer. (See the following section for development data.)

Hydrogeologic analyses in the Horse Creek watershed (e.g. Borchert, 1985; Hinckley and AMEC, 2011) have largely focused on the highly productive aquifer of the LaGrange area, from which well yields in excess of 1,000 gpm are not uncommon. This aquifer is a combination of a favorable accumulation of relative coarse alluvial deposits above the deeply weathered surface of the Brule Formation. Hinckley and AMEC (2011) concluded that the alluvial deposits, while creating fertile and relatively level farm ground, are basically an unsaturated mantle over the fractured Brule. The alluvial deposits serve primarily to collect precipitation and irrigation water to recharge the underlying Brule Formation, from which groundwater is subsequently produced.

The following description of the Brule Formation is drawn from Hinckley and AMEC (2011; pp. 2-6 to 2-8).

> The siltstone composition of the Brule indicates poor groundwater production; it is referred to as the “Brule Clay” over most of its outcrop and is commonly quarried for lining canals and ponds to reduce seepage in lieu of more expensive bentonite. As noted above, the contrast in permeability between the Brule and the overlying Arikaree (where present) commonly creates springs as groundwater is unable to readily flow on down in the underlying strata. However, in certain areas, including where it is overlain by alluvium around LaGrange, it contains fractures and cavities that are very productive.
>
> The nature of the permeability in the Brule creates large contrasts in well performance. Rapp et al. (1957), for example, state that “generally, the Brule Formation ... does not yield water abundantly to wells”, making it suitable for little more than low-yield domestic and stock wells. Near LaGrange, however, “fissures and fractured zones yield relatively large quantities of water to irrigation wells.” A sampling of the WSEO Statements of Completion filed for Brule Formation wells in the Horse Creek Basin outside of the LaGrange Aquifer found specific capacities ranging from near zero to highs around 10 gpm/ft. Tests reported for Brule wells within the LaGrange Aquifer, however, are commonly in the tens of gpm/ft and, occasionally, over 100 gpm/ft.

Groundwater modelers (e.g. Borchert, 1985; Hinckley and AMEC, 2011) have terminated the primary aquifer at LaGrange at the depth at which the upper Brule is no longer host to productive fracturing. This occurs at depths of < 150 feet, beneath which the Brule consists of the well-cemented siltstones which characterize the formation across the bulk of the Horse Creek watershed. However, this focus is a function of the large-capacity wells intended for irrigation use, and overlooks the potentially useful lower-productivity aquifers that can be found under favorable conditions in the underlying strata at select locations.

The Arikaree Formation outcrops across the central Horse Creek watershed. "It is modestly productive of groundwater and has been developed for groundwater irrigation at scattered locations. In the Arikaree Fm., several irrigation wells are commonly combined to provide sufficient water to operate a center-pivot irrigation system. For example, in T20N, R64W, Sec. 1, five wells, yielding from 43 to 70 gpm, are combined to supply one small (48 ac) pivot." (Hinckley and AMEC (2011), p. 2-8).

Overlying the Arikaree in the upper portion of the watershed is the Ogalalla Formation. Although a productive aquifer in Laramie County, in the Horse Creek watershed, "the Ogallala is present only along the tops of high points in the most upstream portions of the Horse Creek basin. Due to this location, it is rarely significantly saturated." (Hinckley and AMEC, 2011; p. 2-8). Recharge infiltrating into the Ogalalla will infiltrate on into the Arikaree. Therefore, the two are not distinguished on Figure 4.2-10. (Similarly, the extensive sand deposits northwest of LaGrange (Figure 4.2-6) serve primarily to facilitate recharge to the underlying Arikaree and are not considered an aquifer in themselves.)

Beneath the Arikaree Formation (and beneath the fractured Brule in the LaGrange Aquifer) are a group of formations classified as "marginal aquifers" on Figure 4.2-10. Because the Arikaree and younger formations have been eroded away in the eastern Horse Creek watershed (see Figure 4.2-6), users have developed small supplies of groundwater from locally productive sandstone strata in older formations for lack of more favorable water-supply alternatives. These include the unfractured Brule, the Chadron, and the Lance Formation, which outcrop (and receive limited recharge) in the area downstream of Hawk Springs Reservoir. Beneath these formations, the Fox Hills sandstone has been found to produce modest supplies of adequate water quality for those users willing to drill down to it. Beneath the Fox Hills are thousands of feet of unproductive strata in the Pierre Shale, putting a practical limit on the depth of potential aquifers. Thus, the only potentially useful aquifers beneath the Fox Hills are those associated with the short and narrow band of formations brought to shallow depths by the uplift of the Laramie Range. These are the strata labeled "Mz" and "Pz" on Figure 4.2-6, e.g. the Cloverly, Sundance, Forelle, and Casper Formations. Appendix 4A provides a complete listing of the formations beneath those shown on Figure 4.2-6.

In the area north of the Fort Laramie Canal, the bedrock is primarily the Lance Formation. Groundwater production and groundwater quality are typically poor, but abundant recharge from the widespread irrigation system can mitigate either condition under favorable conditions.

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. However, if the association with surface water is too intimate, filtering of bacteria and viruses may be incomplete, requiring disinfection to be suitable for consumption. 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 of somewhat higher salinity than the surface water.

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 becomes somewhat 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.

Table 4.2-4 provides examples of groundwater quality in the principal aquifers that have been developed in the Horse Creek watershed. Groundwater quality is likely much more variable for the less productive aquifers, as circulation, access to recharge, and residence times vary widely. Local conditions should be assessed in making development decisions wherever possible.

Table 4.2-4 - General Groundwater Quality - Average or Range of Values (mg/l).

	LaGrange Aquifer	Arikaree	Chadron	Lance	Fox Hills
Total Dissolved Solids		238 - 430	994	416 - 1250	799
Sodium	54 -56	7.5 - 37	311	237 - 429	215
Magnesium		1.6 - 16	2.7	1.0 - 19	0
Calcium		25 - 97	8.7	1.7 - 50	2
Chloride		2.0 - 22	45	7.5 - 113	8
Alkalinity		159 - 297	418	332 - 660	549
Sulphate		1.0 - 73	196	1.0 - 405	5
Iron		0.037	<.03 to 2.57	<.05 to 0.56	0.12 to 1.6
Uranium	0.023 - 0.024	0.007	<.0003 to 0.16	0.04 to 0.15	0.0004

Notes: 1) Lance data from BRS (1996), Rapp et al. (1957); Chadron and Fox Hills data from Wyoming Groundwater (2011); Arikaree from Rapp et al. (1957), Taucher et al. (2013); LaGrange from Town of LaGrange 2017 EPA Annual Water Quality Report (includes 0.95 - 6.05 mg/l range for nitrate).

Taucher et al. (2013) provide summaries of groundwater quality information for the entire North Platte Basin in Wyoming. 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.

The Chadron Formation was the long-time water supply for Yoder, but was found to contain unacceptable levels of uranium, i.e. up to 0.16 mg/l. (The EPA Primary Drinking Water Standard is 0.03 mg/l.) Investigations by Wyoming Groundwater 2011 found the Fox Hills at that location to be sufficiently productive to replace the Chadron water supply, eliminating the uranium exceedance and reducing the sulfate level, but leaving relatively high levels of Total Dissolved Solids and sodium. The "Secondary Standards", i.e. based on aesthetics rather than human health, for sulfate and TDS are 250 and 500 mg/l respectively.

There is an EPA "advisory" for sodium, recommending levels below 30 to 60 mg/l. The sodium adsorption ratios (SAR) of Chadron Formation groundwater samples in the Yoder area were also found to be "very high" (e.g. 30), which is considered to be unsuitable for irrigation use. The Fox Hills SAR was also found to be very high. (Wyoming Groundwater, 2011).

The 1996 study of a potential community water supply for the Hawk Springs community (BRS, 1996) concluded that "all existing wells in Hawk Springs and within the vicinity clearly show that the Lance Formation is not a suitable water supply source for a community water supply." They found that, "currently residents obtain their water from individual small capacity wells, the majority of which are completed in the Cretaceous Lance Formation. Water quality from this source is poor with elevated levels of TDS, sodium, and bicarbonate. Unfortunately, current residents with individual wells have little choice but to rely on the Lance as a water source. In addition, without a community sewage disposal system, the potential for individual well contamination from septic systems is very high." "Many of these residents maintain private Ion-Exchange systems to provide a palatable water supply." That study recommended construction of a 12-mile pipeline to bring in Arikaree Formation water from a wellfield to the southwest.

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.

Figure 4.2-11 presents this mapping of "Aquifer Sensitivity" for the Horse Creek watershed. It should be noted that boundaries in the classifications of Figure 4.2-11 are a result of the county-based maps used to develop the sensitivity ratings. 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. (Obviously surface water bodies themselves, e.g. the ponds and reservoirs of the watershed, are also quite vulnerable.) The alluvial aquifers are most sensitive, i.e. along Horse and Bear Creeks, along with the areas of highly-permeable sand deposits (stabilized sand dunes) northwest of LaGrange. For example, the 6.05 mg/l concentration

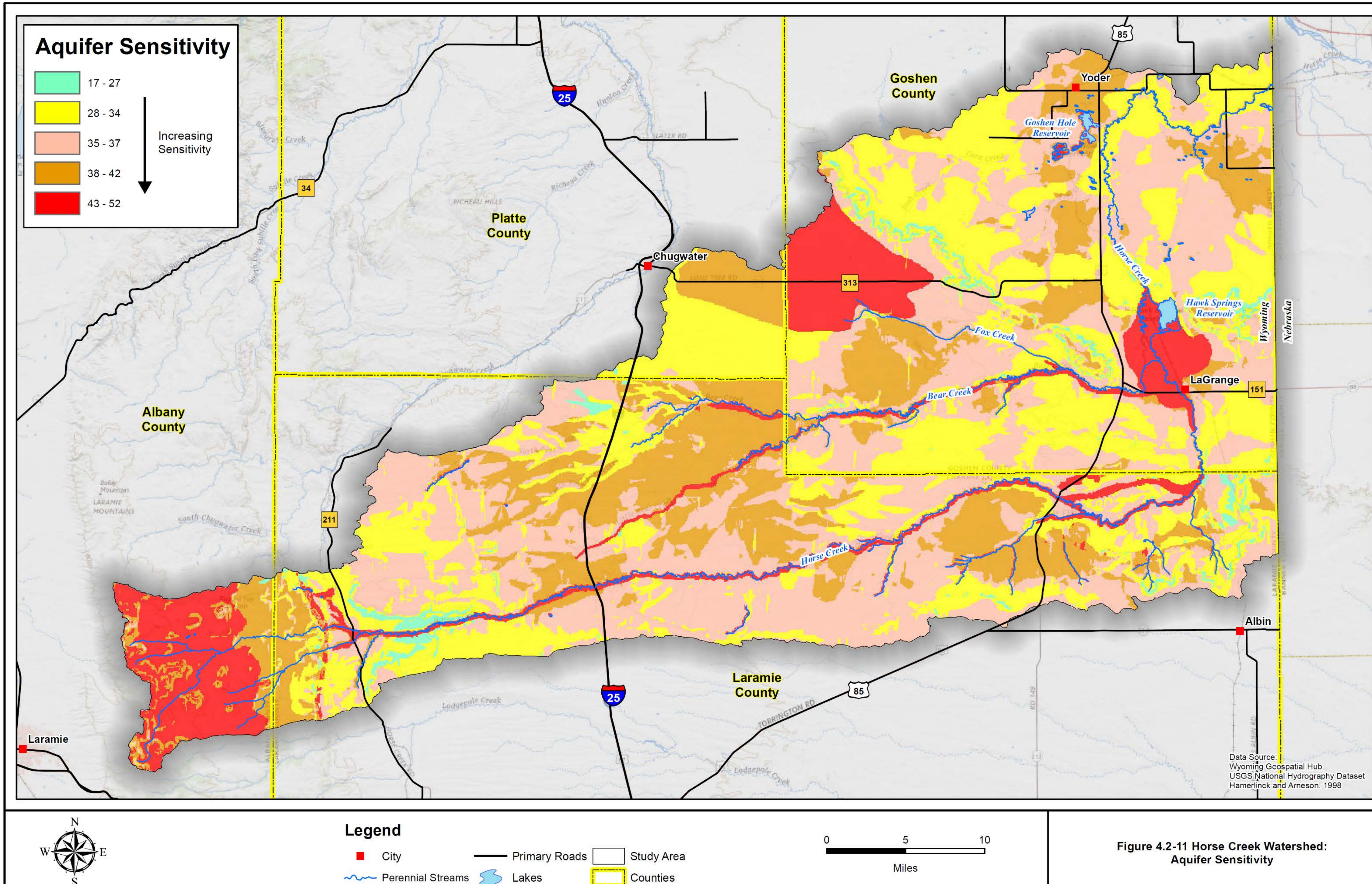


Figure 4.2-11 Horse Creek Watershed:
Aquifer Sensitivity

of nitrates reported for the Town of LaGrange municipal supply wells in 2017 may be an example of fertilizer impacts to this shallow aquifer. (The EPA Drinking Water Standard is 10 mg/l, but 6 mg/l is above normal “background” levels). Similarly, the grus-covered areas in the Laramie Range would allow rapid infiltration of any spilled material. The routine areas of the watershed are mostly of moderate aquifer sensitivity

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 2,200 groundwater permits in good standing in the Horse Creek watershed (monitor and test wells and cancelled permits not included), too many to be usefully listed here. A single well may have multiple permits, e.g. if the permit yield is increased or the types of use expanded. 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:

> 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. It should be noted 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 available.
>
> 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.

Wells that do not involve the routine extraction of groundwater are not included in this discussion, e.g. monitor and test wells. The 139 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).

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

http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

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 4.2-12 through 4.2-15 provide this empirical mapping of the groundwater resource, in ascending order of the quantity demanded. The base map for these figures is the geologic map of Figure 4.2-6.

As with the springs discussed above, the locations of the groundwater permits in the SEO database 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.)

Figures 4.2-12 and 4.2-13 display the least demanding wells. Livestock and domestic 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. Individual Statements of Completion may include more precise data for these wells.

The tables categorize wells by “surface formation”. This is the unit on Figure 4.2-6 in which the well location plots (i.e. subject to the location approximations discussed above). In some cases, a well will have been started in one formation, but drilled entirely through that formation to be completed in deeper strata. This has only been accommodated in these compilations for wells started in the relatively thin alluvial deposits along perennial streams. In those cases, a well over 100 feet deep is assumed to have been completed in the underlying bedrock and is re-classified accordingly. Detailed information on individual groundwater permits is often available on the Statement of Completion filed with the State Engineer’s Office under the permit number.

Review of domestic groundwater permits indicates that, in most cases, satisfactory supplies of groundwater for domestic use have been available within approximately 150 feet and have provided static (before pumping) depths to water of less than 100 feet. The Ogalalla is an exception. As noted above, its occurrence primarily in upland areas creates greater depths to water and requires deeper wells. (Some of the wells in Table 4.2-5 under “Ogalalla” may actually be completed in the underlying Arikaree.)

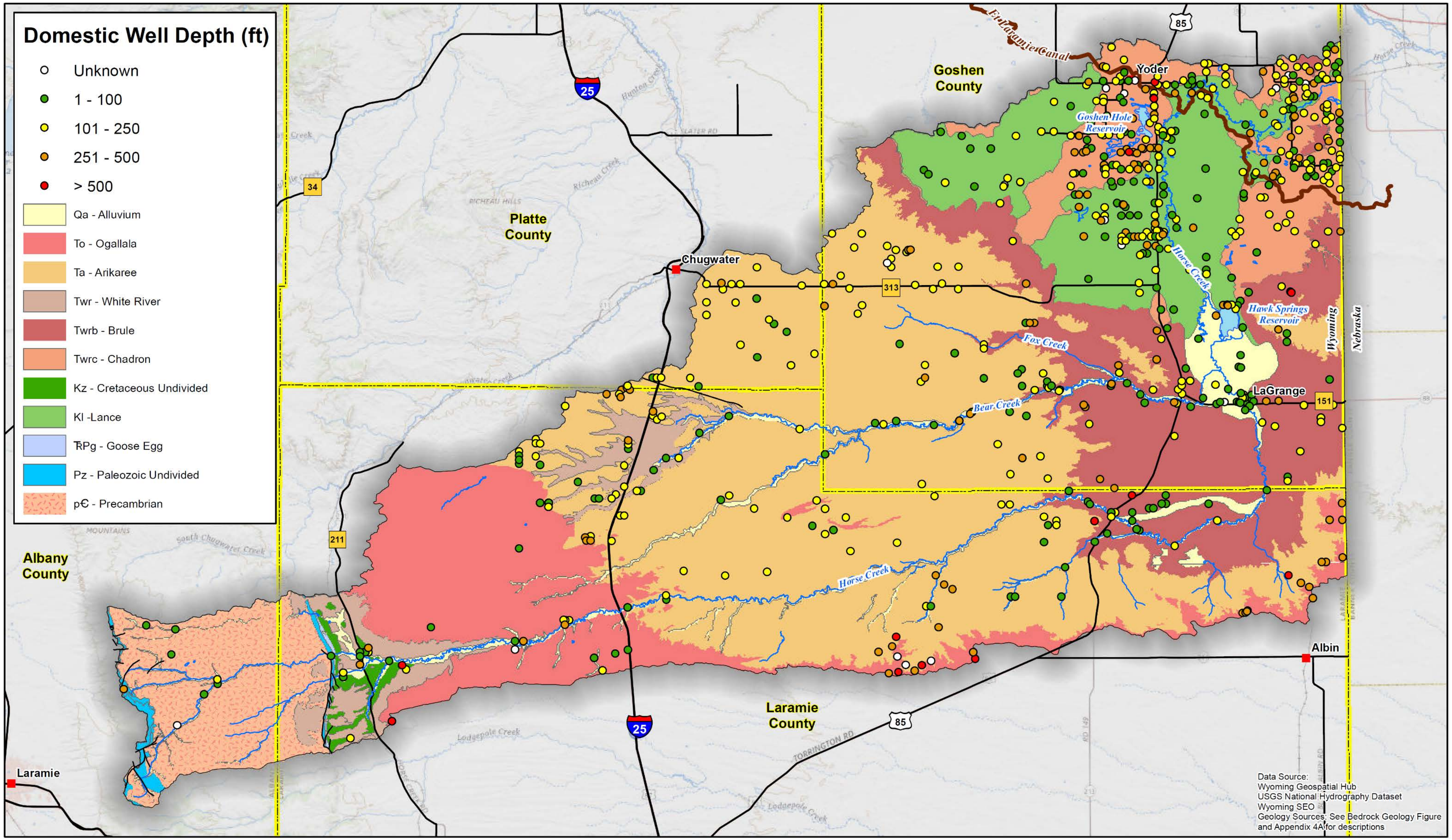


Figure 4.2-12 Horse Creek Watershed: Domestic and Domestic/Stock Permits

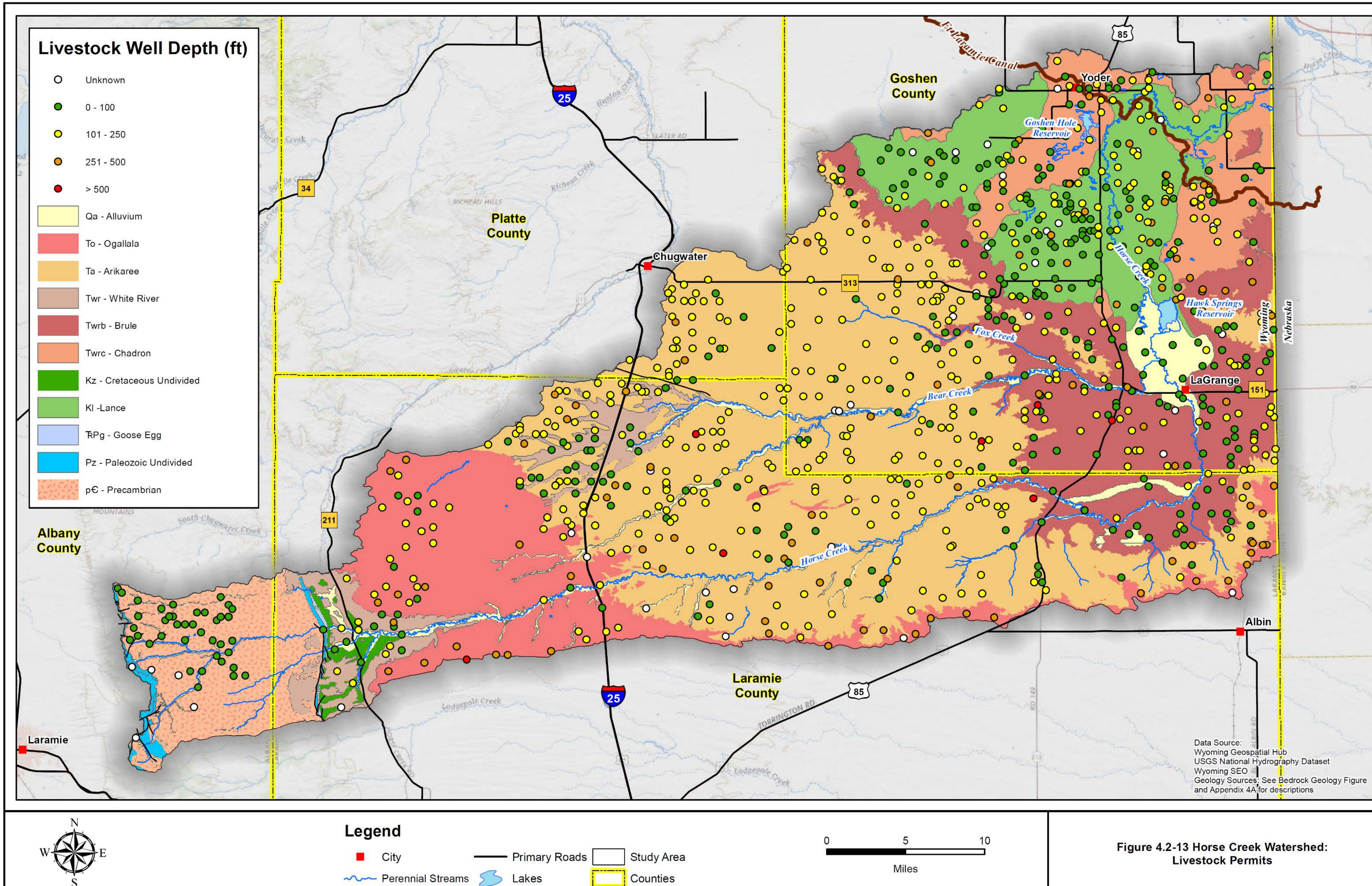


Figure 4.2-13 Horse Creek Watershed: Livestock Permits

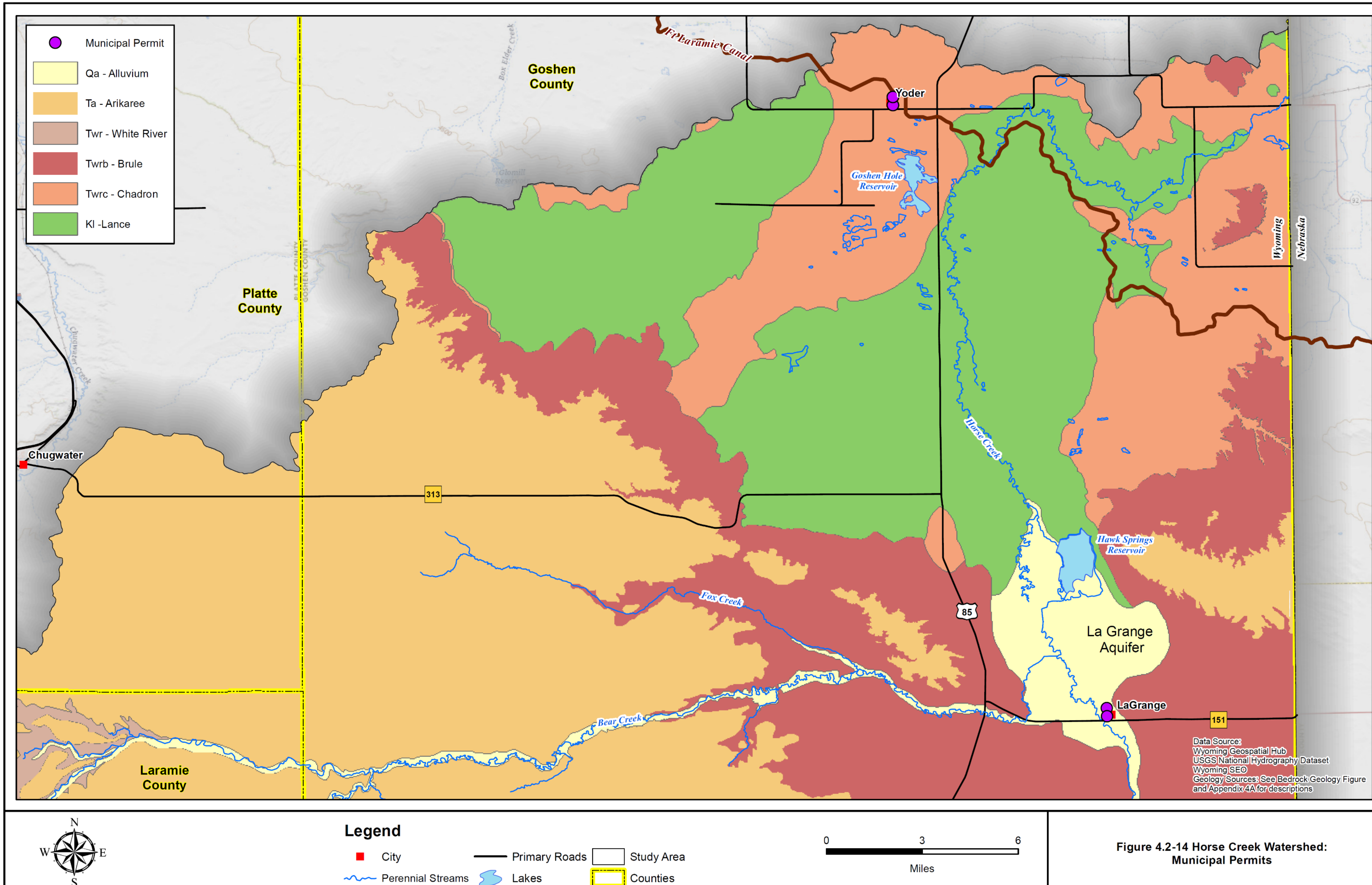


Figure 4.2-14 Horse Creek Watershed: Municipal Permits

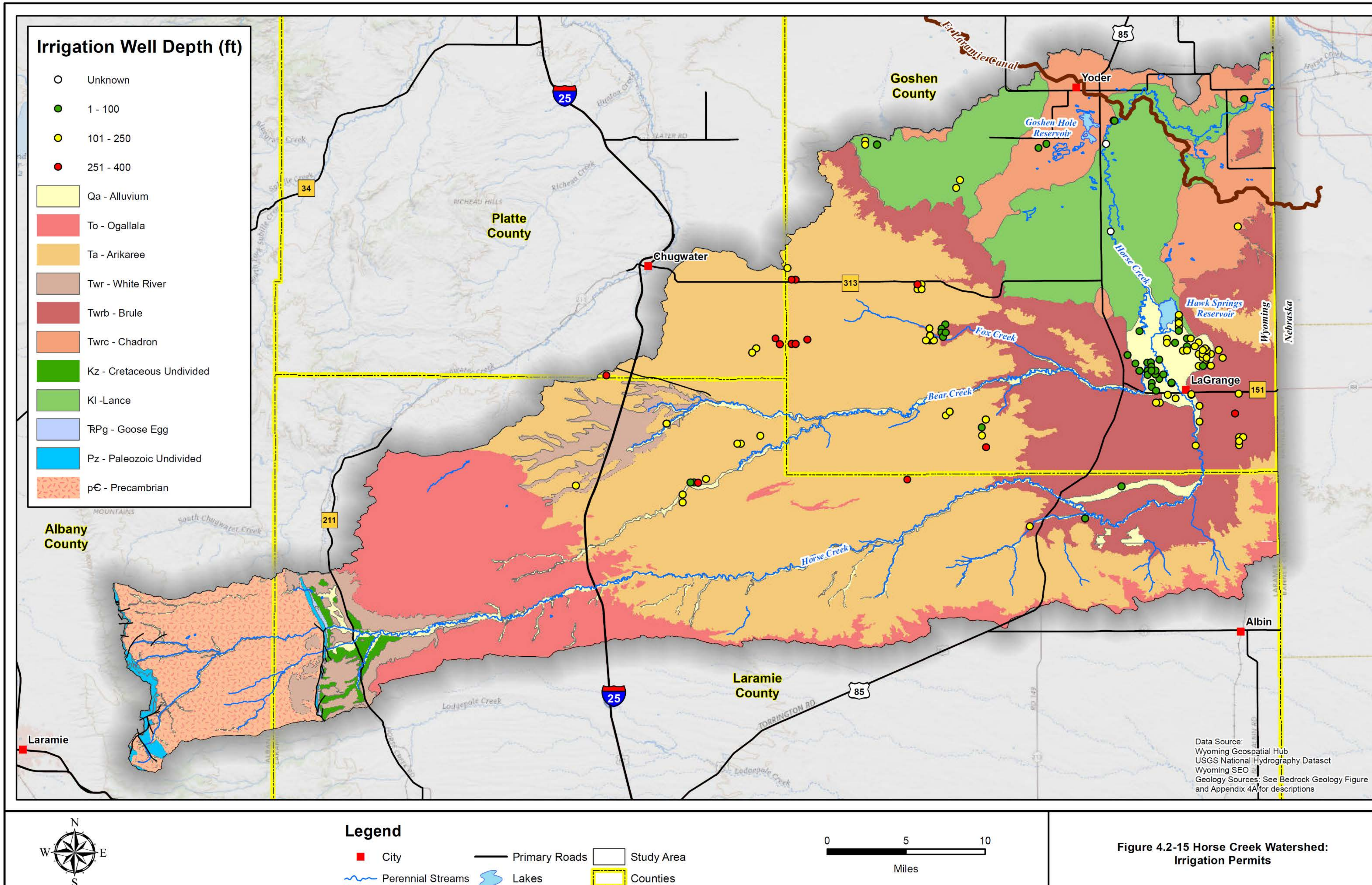


Figure 4.2-15 Horse Creek Watershed: Irrigation Permits

Table 4.2-5 - Domestic-Use Groundwater Permits - Horse Creek Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
"LaGrange" (72)	20	55	310	6	17	114	3	18	25
Ogalalla (31)	6	350	540	15	257	430	3	10	25
Arikaree (183)	8	165	600	7	90	337	3	10	25
Brule, Chadron, Lance (536)	6	125	1074	1	40	312	2	12	36
Precambrian (6)	6	15	160	2	9	12	5	8	18
other (39)	3	50	540	1	20	322	3	13	25
Notes: 1) includes DOM/STO permits									

Because domestic well construction tends toward lower elevations, e.g. along streams and across agricultural areas, the well depths and depths to water for any of these formations can be expected to be somewhat larger than listed in Table 4.2-5 in the upland areas of the watershed.

The distribution of domestic wells, Figure 4.2-12, is more a function of the location for residences than a reflection of general groundwater availability. For example, wells are most common across the agricultural areas under the Horse Creek Conservation District and the Goshen Irrigation District. While the majority of these wells are in less-than-ideal locations for groundwater development, particularly with respect to water quality, point-of-use water treatment, bottled water or hauling water to cisterns, or seeking out particularly favorable recharge situations can be used to mitigate.

The varying depths of domestic wells in the same area reflect attempts to achieve acceptable groundwater quality and quantity in these sometimes challenging conditions.

Table 4.2-6 provides summary data for stock wells. Although the reported depths of stock wells vary from 0 to 600 feet, the majority are less than 150 feet deep. Reported depths to water vary between 1 and 400 feet, but as with domestic wells, the great majority are far less than the maximum. 50% of reported depths to water are 100 feet or less. Wells in the LaGrange Aquifer are the most productive in terms of yield and are also relatively shallow and with small depths to water. Wells in the Precambrian rocks are commonly little more than developed springs.

Because demand is widely distributed across the landscape, the distribution of stock wells, Figure 4.2-13, provides a more general view than domestic wells of the basic availability of at least the small quantities of groundwater of a quality suitable for livestock.

Table 4.2-6 - Stock-Use Groundwater Permits - Horse Creek Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
“LaGrange” (11)	40	90	197	6	18	60	3	10	25
Ogalalla (70)	3	200	616	3	140	360	3	8	25
Arikaree (386)	1	155	603	1	92	410	1	8	25
Brule, Chadron, Lance (447)	3	100	600	1	43	410	2	8	25
Precambrian (42)	3	4	100	1	2	9	2	5	25
other (28)	3	45	230	1	12	80	3	9	25

Between the domestic and stock well groups, there is demonstration that some quantity of useful groundwater is fairly widespread across the landscape. 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.

Table 4.2-7 provides summary data for municipal wells. Groundwater of adequate quality and quantity to meet municipal demands has been developed for the communities of LaGrange and Yoder, as indicated on Figure 4.2-14. In the former case, the town benefits from the productive LaGrange Aquifer and the abundant recharge from the surrounding irrigation operations. Two wells (one with an enlargement), 100 feet deep, with depths to water of less than 40 feet, produce a combined yield of 1,025 gpm.

The situation for Yoder has been more challenging, as discussed above. Six wells vary in depth from 85 to 420 feet; depths to water vary from 5 to 75 feet, and the combined permit capacity is only 150 gpm.

Figure 4.2-15 presents the distribution of the relative high-quantity demands of most irrigation systems. Table 4.2-8 summarizes construction and geologic formation data. As expected, irrigation wells are concentrated in the LaGrange area, where a broad valley and productive aquifer provide favorable conditions for groundwater irrigation. Wells depths, depths to water, and permit yields are clearly dramatically better in this aquifer than in other areas.

Many of the wells in the LaGrange area serve lands that also receive water under surface diversions. Historically, surface diversions have been made in this area outside the traditional irrigation season to ensure adequate groundwater recharge to support summer production from irrigation wells.

Table 4.2-7 - Municipal-Use Groundwater Permits - Horse Creek Watershed.

Name	Owner	Surface Formation	Depth (ft)	Depth to Water (ft)	Permit Yield (gpm)	Permit No.
LaGrange #1	Town of LaGrange	LaGrange Aquifer	100	35	450	P55678W
LaGrange #2	Town of LaGrange	LaGrange Aquifer	100	5	450	P55679W
ENL LaGrange #2	Town of LaGrange	LaGrange Aquifer	100	15	125	P74020W
Spirit of 76	Town of Yoder	Chadron	115	75	20	P33229W
Johnson Well	Town of Yoder	Chadron	90	10	18	P64677W
Tower Well	Town of Yoder	Chadron	85	55	16	P64678W
Yoder #8	Town of Yoder	Brule*	420	37	12	P64676W
Yoder #9	Town of Yoder	Chadron	100	37	70	P69496W
Yoder Water Station	Town of Yoder	Chadron	350	10	18	P69497W
Yoder #5	Town of Yoder	Fox Hills*	1,100	65	65	P201302W
Notes: *- the "Brule" and "Fox Hills" wells start in the Chadron, the listed formations reflects their completions at depth.						

The only high-production irrigation wells in the northeast portion of the watershed are those closely associated with the abundant recharge available right along Horse Creek or under areas of active irrigation. The farthest northeast well, for example, Permit U.W. 9831, is reported to yield 1125 gpm, but is only 95 feet deep. The log identifies "gravel" from 25 to 95 feet. The well is in an irrigated field approximately 800 feet from a major irrigation lateral.

The two irrigation permits out in the Lance Formation southwest of Yoder, in contrast, report yields of only 30 and 35 gpm.

Quoting from Hinckley and AMEC (2013), the Arikaree "is modestly productive of groundwater and has been developed for groundwater irrigation at scattered locations, i.e. the circles on the western portion of [the watershed]. In the Arikaree Fm., several irrigation wells are commonly combined to provide sufficient water to operate a center-pivot irrigation system. For example, in T20N, R64W, Sec. 1, five wells, yielding from 43 to 70 gpm, are combined to supply one small (48 ac) pivot."

Table 4.2-8 - Irrigation -Use Groundwater Permits - Horse Creek Watershed.

Surface Formation	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
	min	med	max	min	med	max	min	med	max
"LaGrange" (72)	15	90	200	3	14	74	75	850	2000
Arikaree (57)	90	200	400	6	72	280	25	225	4400
Brule, Chadron, Lance (71)	26	114	350	2	22	90	30	450	1750
other (3)	100	125	150	80	80	80	20	20	20
Notes: The 3 permits in the "other" category are all for a single well.									

There is only one groundwater permit for industrial use in the Horse Creek watershed (not including dual use with irrigation or a nominal "IND" well drilled for monitoring purposes). That well was constructed for dewatering at a limestone mine (Hartville Formation) in the Horse Creek headwaters (Permit U.W. 26756).

4.2.4.7 Groundwater Rights and Administration

As a tributary of the North Platte River, Horse Creek is associated with the interstate administration / regulation of the North Platte. Due to its special circumstances of both surface water and groundwater hydrology, however, that association is unlike other tributaries. Figure 4.2-16 provides location information for the following discussion.

The 2001 Modified North Platte Decree places no limitations, nor reporting requirements, on irrigated acreage or consumptive use in the Horse Creek watershed. It does require that the annual production volume of any irrigation wells with post-1945 priority permits in the watershed from 300 feet south of the Fort Laramie Canal to the Nebraska state line be reported each year and that for each active well, a "replacement" volume of 24.4 acre-ft will be provided as natural flow into the Whalen Diversion Dam to state line reach of the North Platter River. (The Whalen Diversion Dam is downstream from Guernsey.) For active irrigation wells in this area with post-2000 priority permits, an annual replacement volume of 80 acre-ft is required. So far, the State of Wyoming has provided the required replacement water each year, rather than the individual well owners.

Due to the unfavorable geology below the Fort Laramie Canal, there is currently only one irrigation well in the Horse Creek watershed subject to the Decree provisions (if it's active) - Permit U.W. 9831.

Subsequent to settlement of the Decree, Wyoming, Nebraska, Colorado, and the US completed agreement on the Platte River Recovery Implementation Program (PRRIP). Unlike the Decree, which only addresses irrigation, the PRRIP includes all sources of depletion in the North Platte River basin - irrigation,

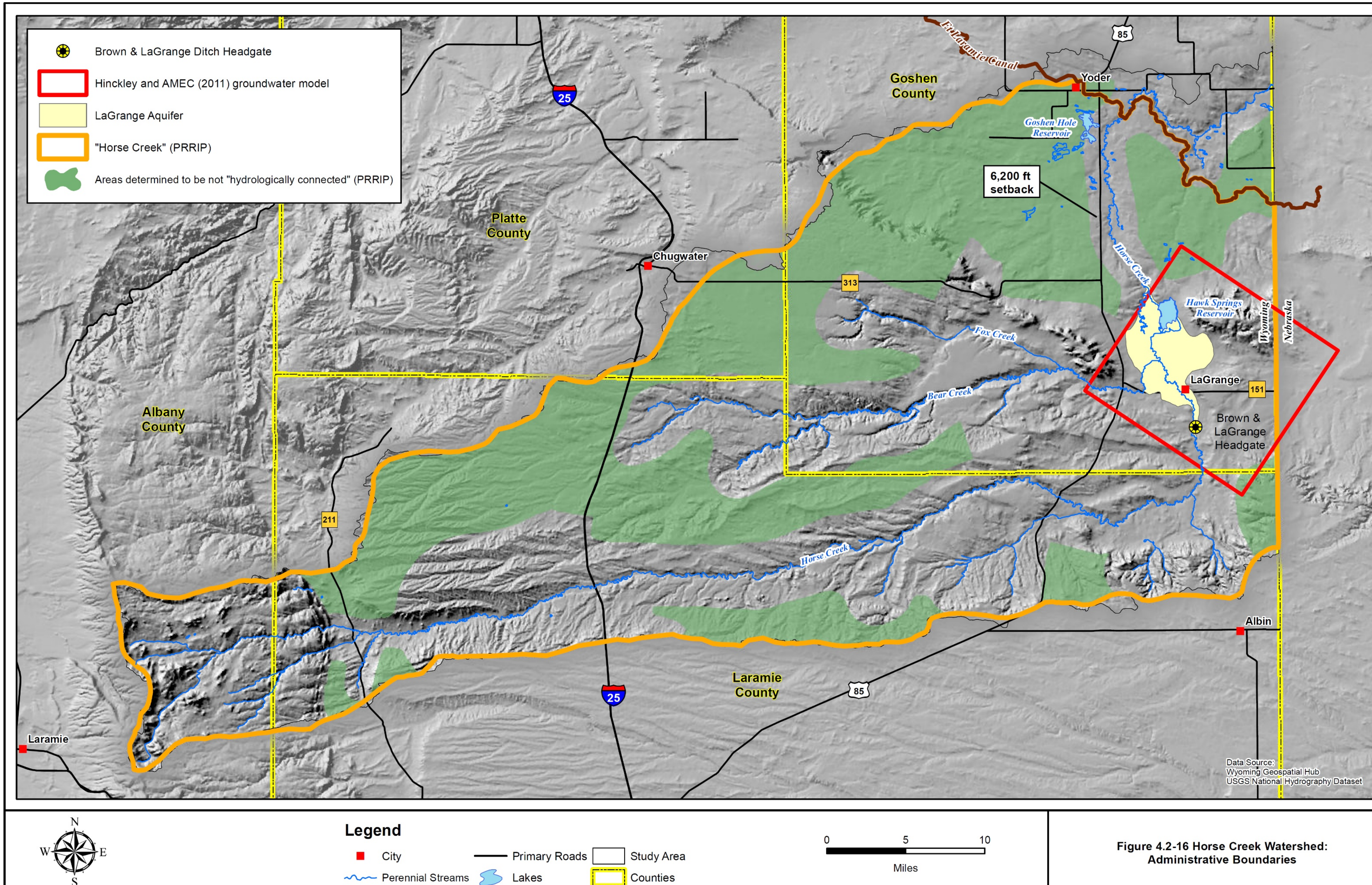


Figure 4.2-16 Horse Creek Watershed: Administrative Boundaries

municipal, industrial, etc. - with the objective of holding Wyoming to its 1997 level of depletion. Depletions are accounted for at the Wyoming Nebraska state line, so the special hydrologic conditions of the Horse Creek watershed play an important role. During the irrigation season (May 1 - Sept. 30) it is assumed that all Horse Creek flows above the Fort Laramie Canal are consumed “internally”, i.e. there is no contribution to the watershed below the canal, so no depletions of that contribution can occur. During the non-irrigation season, it is assumed that all Horse Creek flows above Hawk Springs Reservoir are impounded by the reservoir so, again, no depletion of downstream flows can occur.

As part of the Decree settlement, a criteria was developed for groundwater wells that are “not hydrologically connected”. These are wells 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 the total volume of pumping. An initial evaluation of “not hydrologically connected” areas of the Horse Creek watershed were developed in association with the settlement of the Nebraska v. Wyoming lawsuit that produced the 2001 Modified North Platte Decree. That evaluation is shown on Figure 4.2-16. 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.

Thus, the Decree requirements for replacement water <u>do</u> apply to the one well below the Fort Laramie Canal (and any future irrigation wells so located) because it does not fall in the “green” area.

The PRRIP adopted the same “hydrological connection” criteria as the Decree, and qualifying wells are also exempt from the provisions of the PRRIP. Because of the exclusion of depletions above the Fort Laramie Canal (irrigation season) or above Hawk Springs Reservoir (non-irrigation season), however, little of the Horse Creek watershed is subject to PRRIP regulation anyway. Only the depletive impact of groundwater wells within 6,200 feet of Horse Creek, below Hawk Springs Reservoir, in the non-irrigation season, are subject to potential mitigation requirements under that program.

Note that 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 those 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 4.2-16 remain fully subject to applicable Wyoming water law and priority administration. Thus, the distribution of the “green areas” of Figure 4.2-16 are largely irrelevant to groundwater development and administration in the Horse Creek watershed.

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.

A significant exception to the routine application of Wyoming water regulation is the LaGrange Aquifer. In that area, due to long-standing and complicated conflicts between surface and groundwater users, a groundwater model was developed to improve assessment of surface and groundwater connections - “Horse Creek Groundwater / Surface Water Connection Investigation Goshen and Laramie Counties, Wyoming”, prepared for the Wyoming State Engineer’s Office by Hinckley Consulting and AMEC Environment & Infrastructure, October 2011.

That study informed the subsequent 2013 Order by the Wyoming State Engineer that addressed the conjunctive use of surface water and groundwater in the Horse Creek watershed. As stated in that order, “The State Engineer finds that withdrawals and depletions by junior groundwater appropriators from the LaGrange Aquifer have a material and adverse effect on the supply available for and needed by senior surface water appropriators, including Hawk Springs Reservoir.” Based on these findings, for the area of the Hinckley and AMEC (2011) groundwater model and downstream of the Brown & LaGrange Ditch, the State Engineer ordered that:

- The area is closed to issuance of any new groundwater permits, except for domestic or stock use at rates of 25 gpm or less;
- Surface-water diversions under irrigation permits are limited to the quantities necessary for “saturating the holding capacity of local soils” (this eliminates diversions made for the purpose of groundwater recharge);
- Monthly groundwater use under irrigation, municipal, and miscellaneous permits must be measured and reported to the State Engineer;
- Groundwater irrigation volumes are limited to 36 inches during any 3-year period (i.e. 1 acre-ft per acre per year on average), not to exceed 15 inches in any one year; and
- Groundwater use will not otherwise be regulated in priority with surface water rights.

According to the order: "Beginning November 16, 2019 the State Engineer will review the effects of the three years of operation under this First Amended Order and determine, following a public hearing and comment period, whether or not the terms of this First Amended Order shall continue to apply or whether a new order should be issued. ... If no new order is issued by April 1, 2020, the terms of this First Amended Order will continue in force, for consecutive three-year periods, until a new order is issued."

4.2.5 Surface Water

4.2.5.1 Hydrography

The Horse Creek watershed originates in the Laramie Mountains about ten miles east of Laramie and flows generally eastward to its confluence with the North Platte River in Nebraska. The basin lies primarily on the Great Plains and consists of generally mild topography. The western headwaters lie in the eastern slope of the Laramie Mountains and are dissected by numerous canyons. Aside from the Laramie Range, the major topographic features include Bear Creek Mountain and Sixty Six Mountain.

The only major tributary to Horse Creek is Bear Creek which joins it near LaGrange, Wyoming. Numerous other minor tributaries contribute to Horse Creek; including Little Bear Creek, Little Horse Creek, Lone Tree Creek, Fourmile Creek, Fox Creek, and others.

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 water 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 watershed would be considered ephemeral in nature. There are perennial and intermittent reaches within it, however, for the most part, runoff occurs primarily in association with response to precipitation events. The USGS has classified the streams in the study area and indicates their assessment on their published topographic maps. Figure 4.2-17 displays perennial streams in the watershed, and all other streams are assumed to be intermittent or ephemeral. As is clearly indicated in this figure, there are few perennial stream segments. Those that are classified as perennial are typically spring fed or located in areas where the channel intersects groundwater tables.

4.2.5.2 Water Quality

WDEQ Horse Creek Arsenic Study

In 2019, WDEQ initiated an investigation including water quality monitoring for arsenic in Horse Creek and several reservoirs: Goshen Hole, Hawk Springs, and Bump-Sullivan. The following extract from WDEQ's Sampling and Analysis Plan: Evaluation of Arsenic in Horse Creek and Tributaries, Goshen and Laramie Counties, Wyoming (2019) provides study background and objectives:

"*During the summer of 2016, the WDEQ conducted a survey of 50 randomly selected sites in the North Platte River basin to identify perennial streams and rivers of high quality and those where designated use-support may be limited. Five of the 50 random monitoring sites were located in the Horse Creek watershed (four sites on Horse Creek and one site on its tributary Bear Creek). Elevated concentrations of dissolved arsenic were found at all five sites. Specifically, single-sample arsenic concentrations in Horse Creek and Bear Creek upstream of Hawk Springs Reservoir were 3-4 µg/L whereas concentrations in Horse Creek below the reservoir were 1112 µg/L – exceeding the state numeric human health criterion of 10 µg/L protective of fish consumption.*

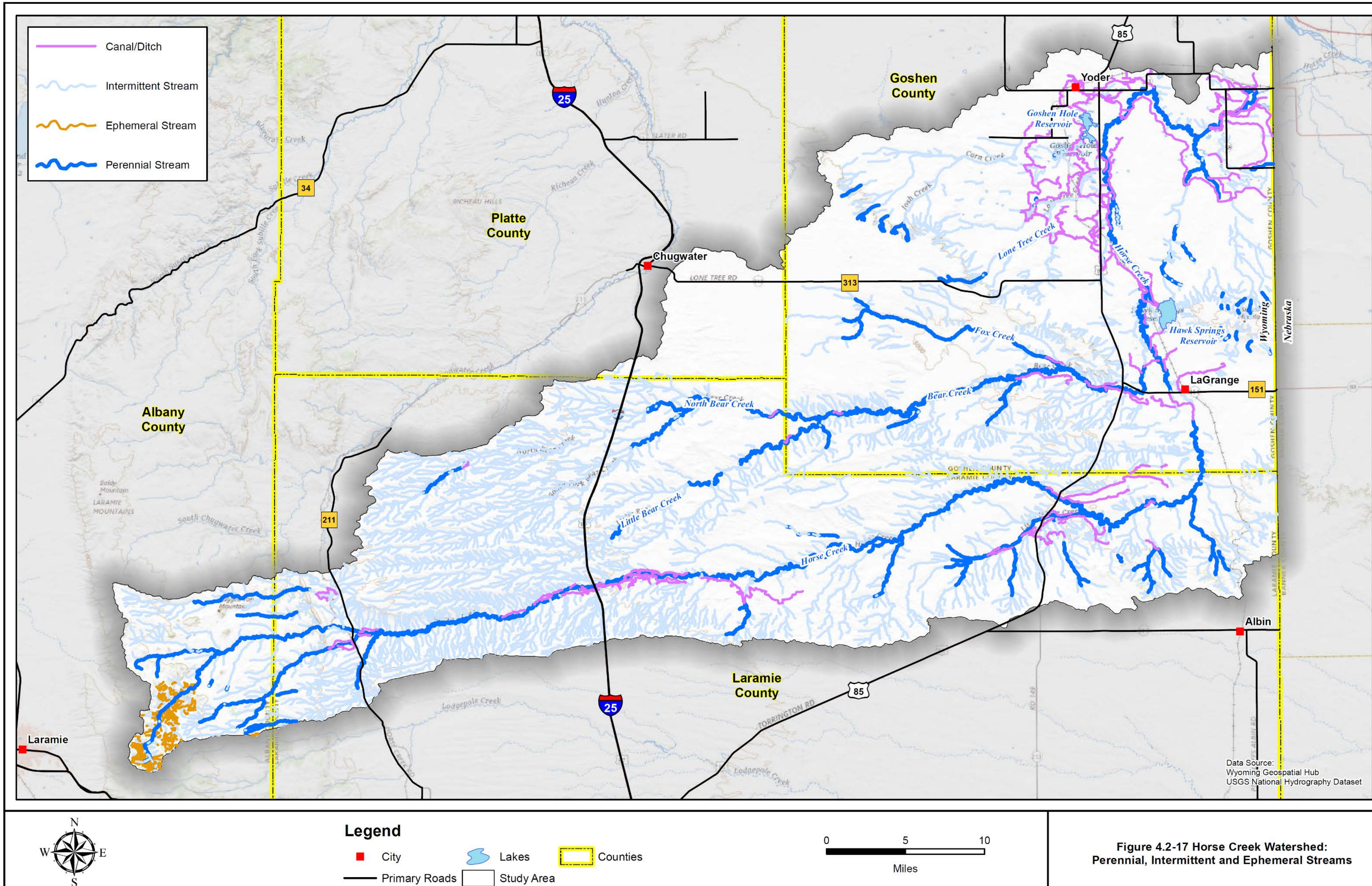


Figure 4.2-17 Horse Creek Watershed: Perennial, Intermittent and Ephemeral Streams

Considering the 2016 results and that Horse Creek is the primary source of water for the warm-water fisheries at Hawk Springs, Goshen Hole and Bump-Sullivan Reservoirs, WDEQ monitored the reservoirs in 2018 to evaluate arsenic concentrations with respect to the 10 µg/L dissolved arsenic numeric fish consumption criterion. Findings from this monitoring indicated dissolved arsenic concentrations were elevated in all three reservoirs with some concentrations approaching or exceeding the fish consumption criterion. Ranges of dissolved arsenic concentrations from three separate sampling events at each reservoir were 20-23 µg/L for Bump-Sullivan Reservoir, 9 µg/L in Goshen Hole Reservoir, and 6-7 µg/L for Hawk Springs Reservoir.

To our knowledge, the WDEQ 2016 and 2018 data represent the only available information on arsenic concentrations in surface waters of the Horse Creek watershed. Elevated concentrations of arsenic in Horse Creek may decrease the ability of Hawk Springs, Goshen Hole and Bump-Sullivan Reservoirs waters to support their fish consumption uses. Sources of arsenic in the Horse Creek watershed are presumed both natural and anthropogenic. Boughton (2014) found elevated concentrations of total arsenic >10 µg/L in groundwater of the White River Formation as well as alluvial aquifers that underlie streams in the Horse Creek watershed. Arsenic may also be released into streams as a result of human activities such as mining, and from its various uses in industry, in animal feed, as a wood preservative and in pesticides."

Objectives of the WDEQ effort were described as follows:

"A two-year targeted assessment of Horse Creek and its primary perennial tributaries is planned for the 2019 and 2020 field seasons. This duration may be extended depending on findings from two years of data collection. The objectives of this assessment are to conduct a detailed evaluation of arsenic concentrations in surface waters of the Horse Creek watershed that includes defining the geographic extent of elevated arsenic in Horse Creek and its major tributaries, identifying the geographic extent of attainment of the State's human health arsenic criterion protective of fish consumption and preliminarily identifying possible broad-scale source areas.

Data from this study will also help in determining whether elevated arsenic is natural and/or human related as well as better inform future monitoring efforts on the previously mentioned three publically-accessible reservoirs.

The two-year targeted assessment will be conducted at approximately 14 sites to best represent natural and anthropogenic influences in the Horse Creek watershed."

Stream Classifications

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 Horse Creek Watershed study area has 543 miles of streams classified in “Table A” and an additional 150 miles of streams classified in “Table B”. These streams are displayed in Figure 4.2-18. 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.

		Surface Water Classification												
		1	2AB	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B	4C
Designated Use	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
- Horse Creek (upstream of Stinking Water Creek)
- Bear Creek
- Fox Creek
- Little Bear Creek
- Bushnell Creek
- Little Horse Creek
- S Fork Horse Creek
- Mill Creek

Class 2ABWW (warm water fishery)
- Horse Creek (Downstream of Stinking Water Creek)
- Goshen Hole Reservoir
- Bump-Sullivan Reservoir
- Sinnard Reservoir
- Hawk Springs Reservoir

Class 2C
- Dry Creek

Class 3B
- Robb Draw
- Corn Creek
- Josh Creek
- Lone Tree Creek
- N Bear Creek
- S Bear Creek
- Four Mile Draw
- Springer Creek
- Carey Creek
- Spring Creek

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

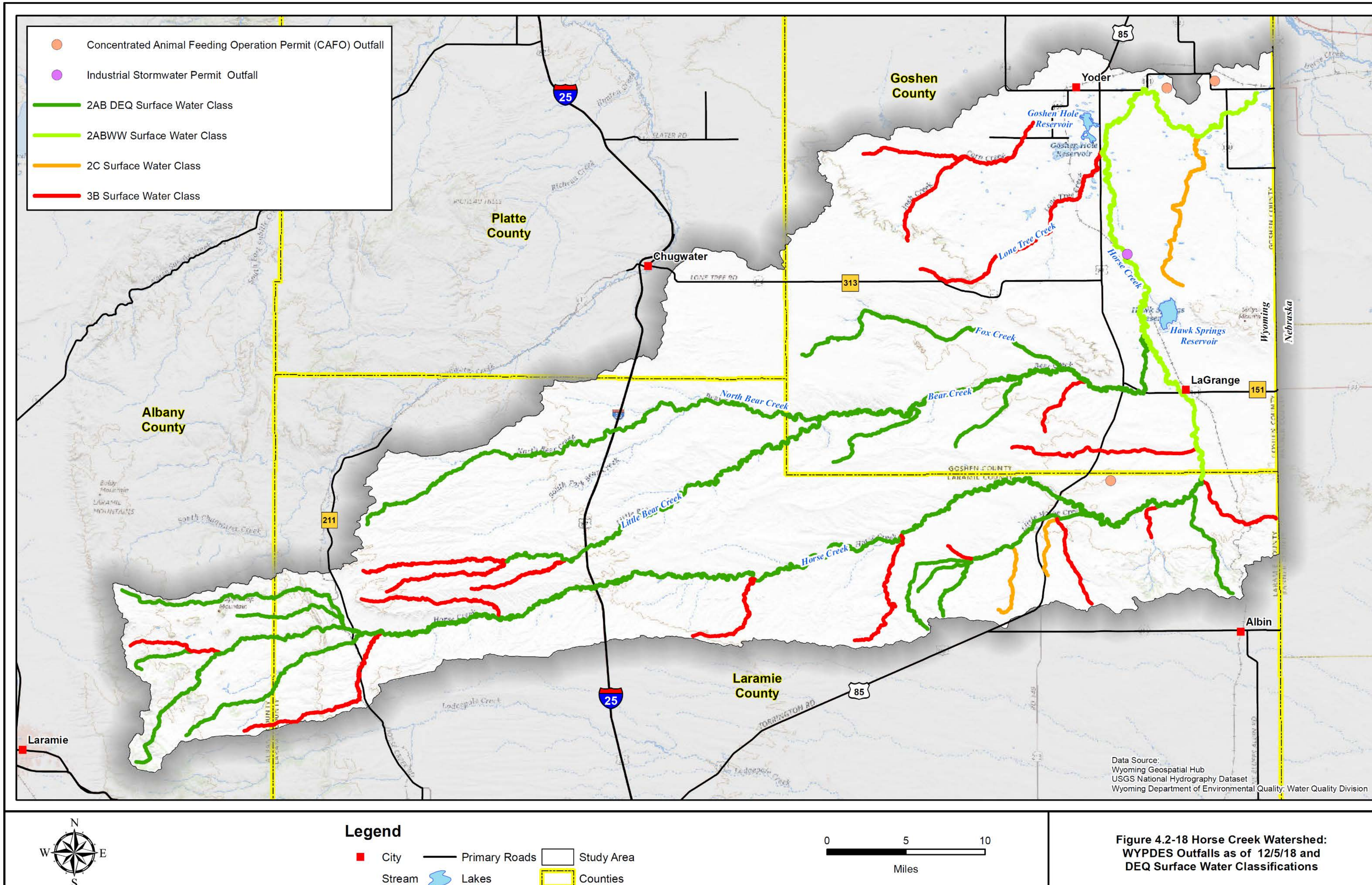


Figure 4.2-18 Horse Creek Watershed: WYPDES Outfalls as of 12/5/18 and DEQ Surface Water Classifications

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. At the time of this report, there were a total of 4 active (WYPDES) permitted discharges present within the study area. Table 4.2-10 summarizes pertinent information regarding the permits. The locations of these discharges are shown on Figure 4.2-18.

Table 4.2-10 Summary of Active WYPDES Permitted Discharge Locations.

WY Permit Number	Receiving Water	Permittee	PermitType	Facility Name
WY0095371	J Penn Drain (class 4A), tributary to Horse Creek (class 2AB), North Platte River basin.	Coxbill Farms, Inc.	CAFO	Coxbill Feedyard Containment System
WY0094935	Horse Creek (class 2AB), via unnamed ephemeral tributaries (class 3B), North Platte River basin.	Lippincott Feeding Inc.	CAFO	Lippincott Feeding Inc.
WY0035769	Horse Creek (2AB) via unnamed drainages (3B), North Platte River Basin	Petsch Farms, LLC	CAFO	Y6 Feeders
WY0053457	Horse Creek (2AB), North Platte River Basin	Portuguese Canyon Ranching Partners	Industrial	Lucky Gate Quarry #1

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.

In 1999, Upper Horse Creek and Bear Creek were monitored by the WDEQ. Results showed that cold water fish and aquatic life were supported in Horse Creek upstream of South Fork Horse Creek, and in Bear River upstream of Horse Creek; thus, the streams were placed in Category 2 in 2002.

With respect to Horse Creek, the 2016/2018 Integrated 305(b) and 303(d) Report states:

Results of the study indicated that the entire Horse Creek watershed upstream of the confluence with South Fork Horse Creek supported its cold water fish and aquatic life other than fish designated uses. As a result, the entire Horse Creek watershed upstream of South Fork Horse Creek was placed in Category 2 in 2002.

With respect to Bear Creek, it states:

There were no exceedances of numeric water quality criteria detected, however, elevated water temperatures were noted as a concern in the lower watershed. Macroinvertebrate data indicated that Wyoming's Draft 2016/2018 Integrated 305(b) and 303(d) Report Page 107 there was a decline in water quality in the middle reaches of the watershed, possibly due to sedimentation. Results of the study indicated that the Bear Creek watershed upstream of the confluence with Horse Creek support its cold water fish and aquatic life other than fish uses. As a result, the entire Bear Creek watershed upstream from the confluence with Horse Creek was placed in Category 2 in 2002.

4.2.6 Geomorphology

4.2.6.1 General

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.

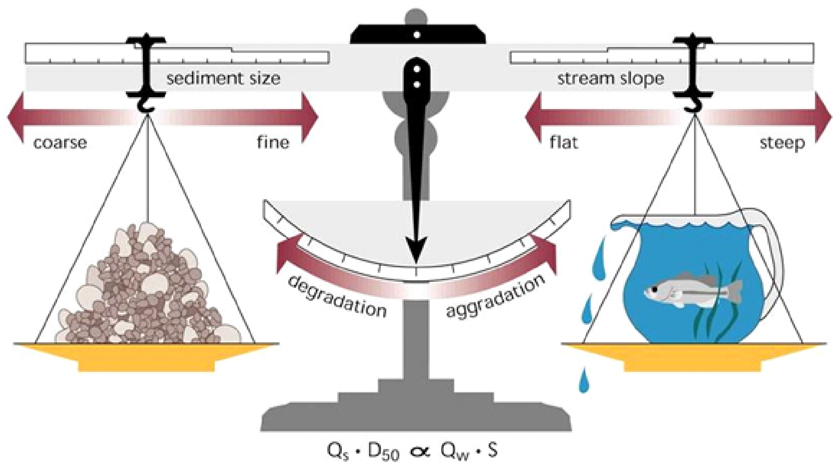


Figure 4.2-20 Lane's Balance.

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.

4.2.6.2 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 Horse Creek 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.

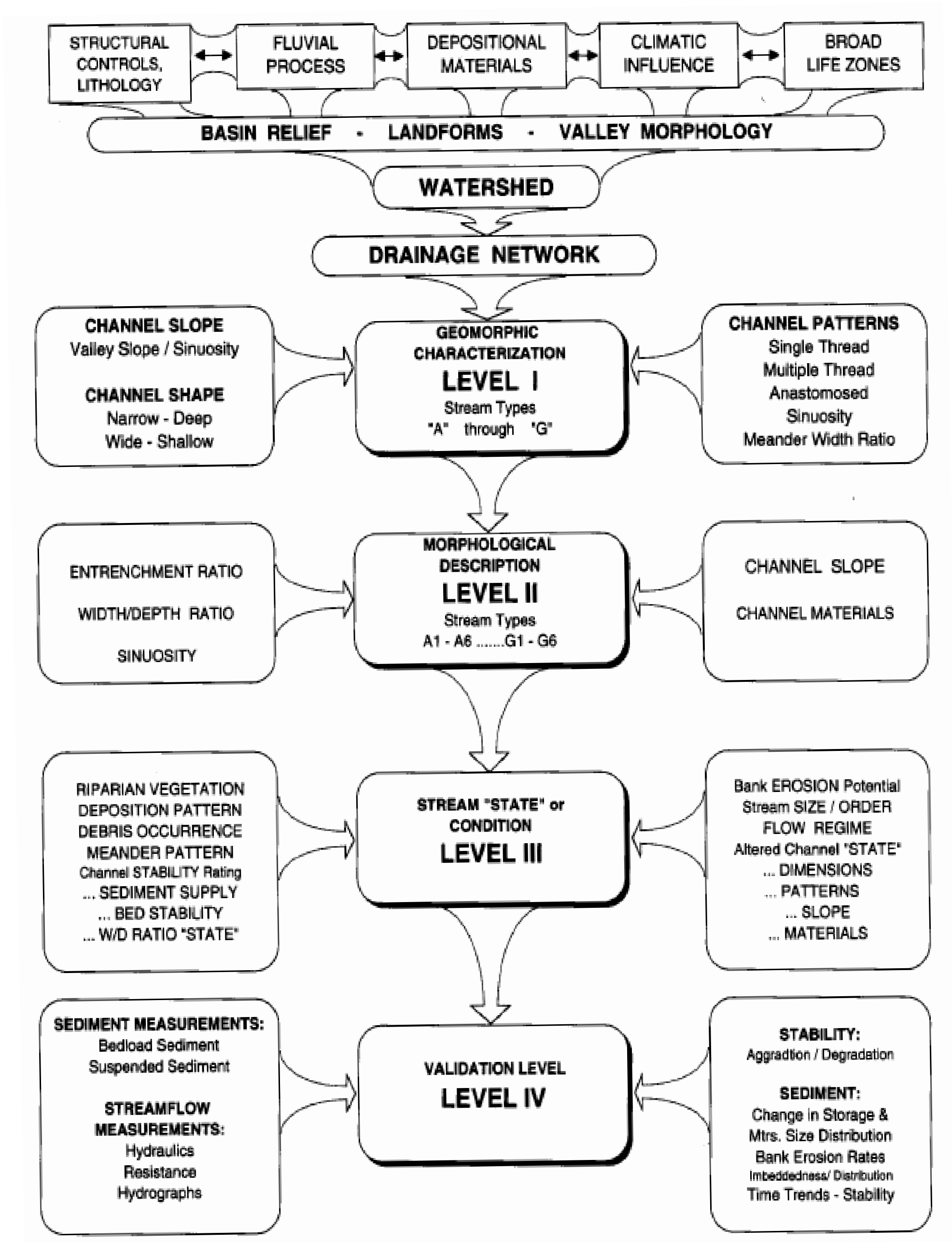


Figure 4.2-21 Hierarchy of the Rosgen Stream Classification System.

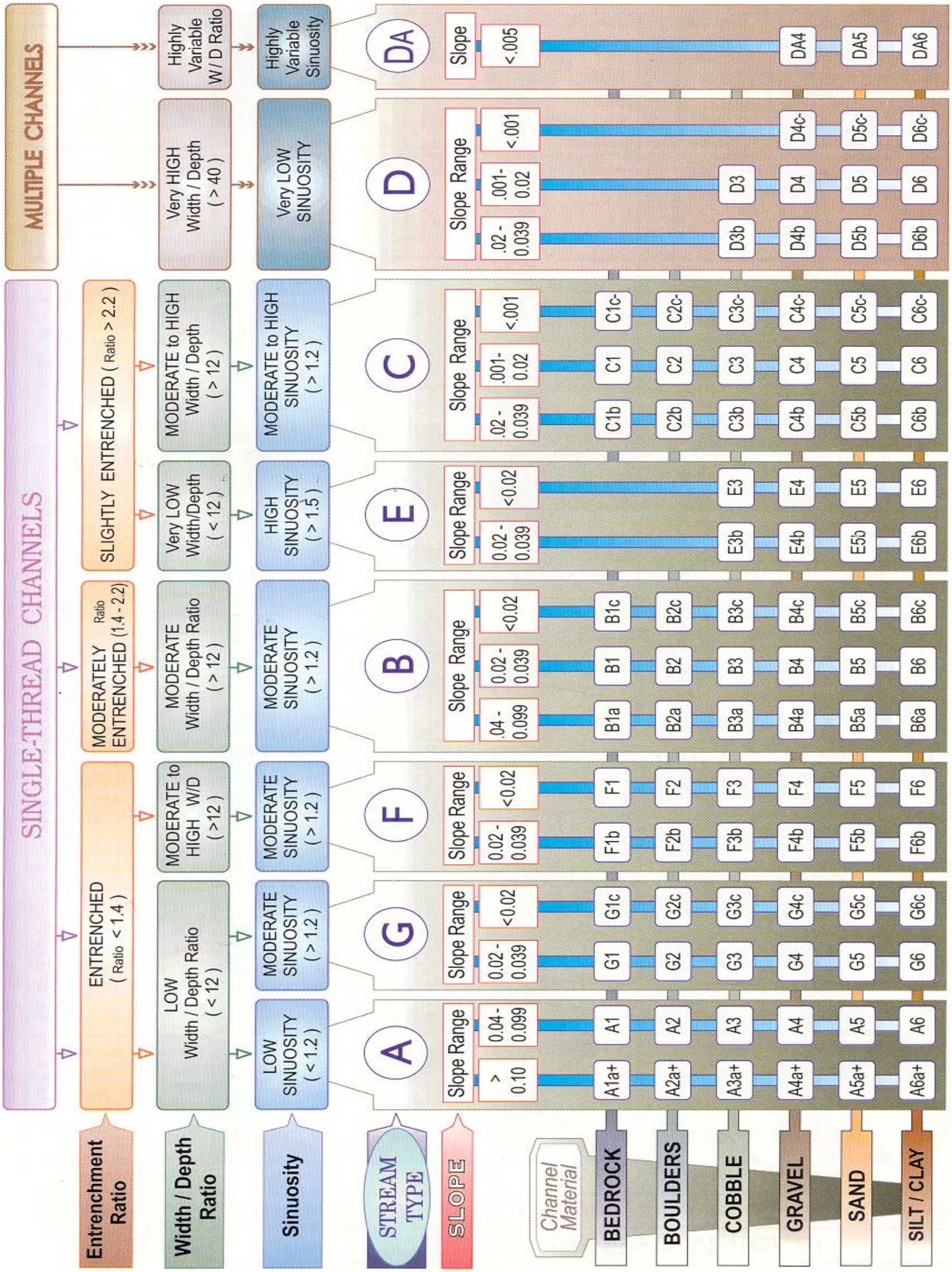


Figure 4.2-22 Rosgen Classification Matrix (Rosgen, 1996).

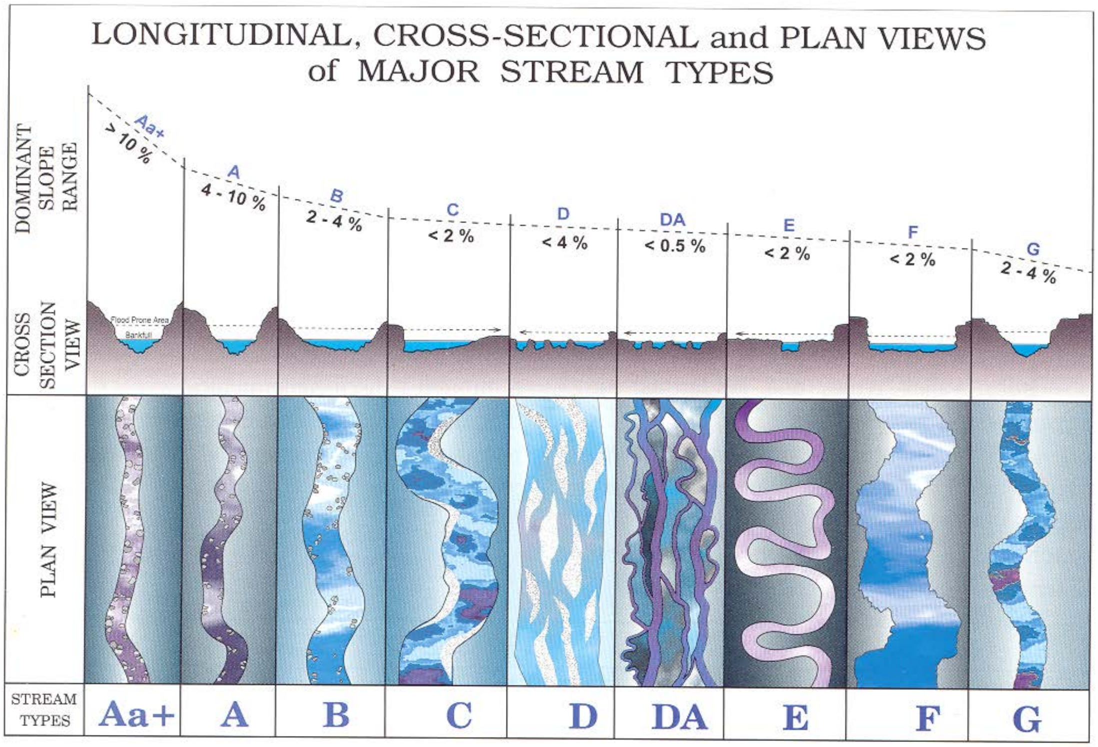


Figure 4.2-23 Major Stream Types within the Rosgen Classification System (Rosgen, 1996).

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 Upper Horse 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: Segment of Horse Creek, 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.

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 GIS environment 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 2017 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 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 4.2-26. 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 Horse Creek lie within the Laramie Range only a few miles east of Laramie, Wyoming. Although not specifically delineated, headwater streams are generally classified as A-type streams and characterized as having relatively steeper slopes and steeper valley margins; there are little to no floodplains in these areas.

As Horse Creek flows easterly and drops in altitude and slope, it transitions into a B-type channel east of I-25 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. The common stable stream type within these settings is the C channel type. Figure 4.2-27 displays a photo of a stable reach of Horse Creek.

Figure 4.2-27 Horse Creek: C-Type Channel.

Most of the mainstem streams in the study area (Horse Creek, Bear Creek, and their primary tributaries) 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 could actually be classified as

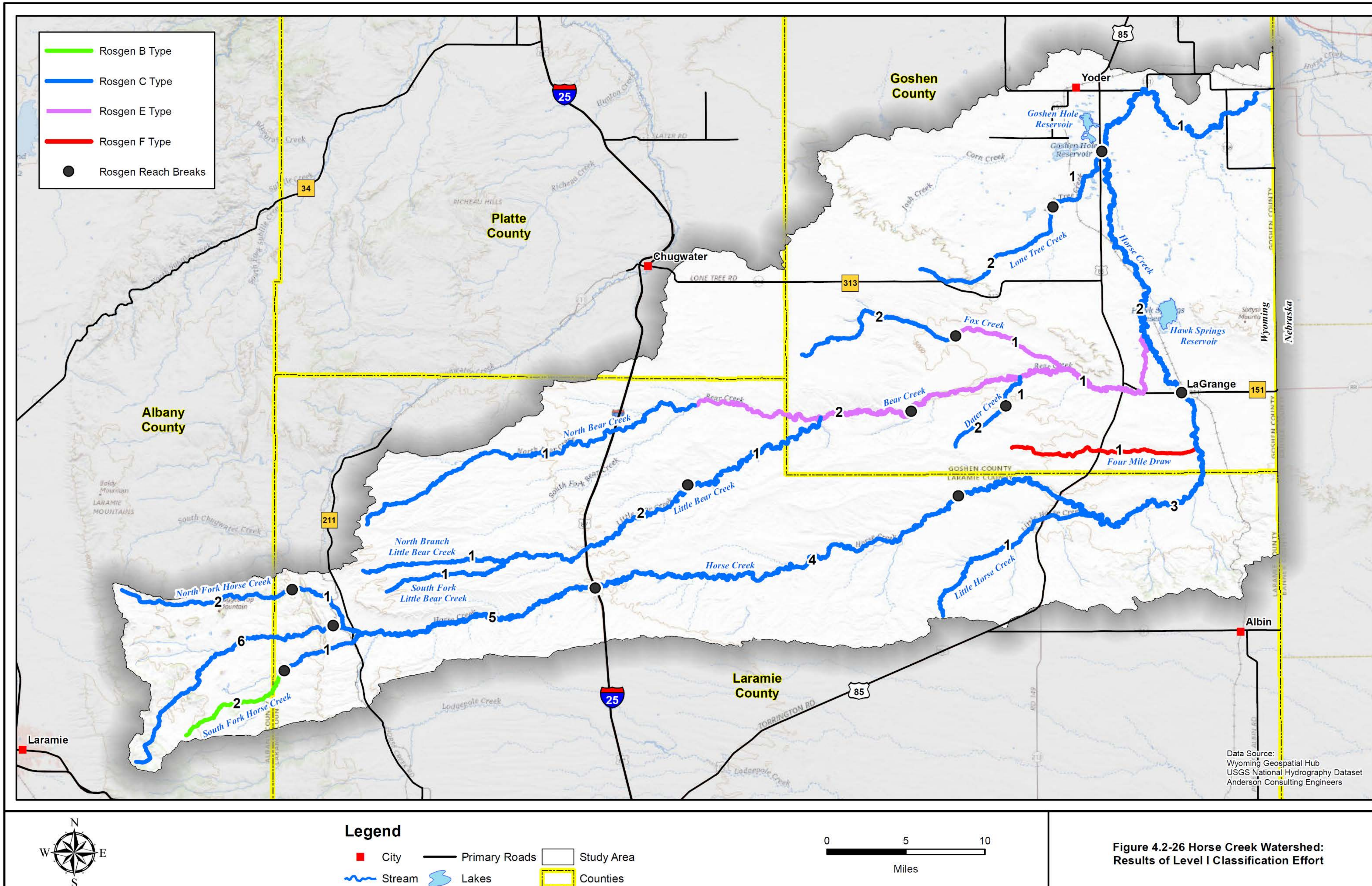


Figure 4.2-26 Horse Creek Watershed: Results of Level I Classification Effort

1

C/F type to denote this varying 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 4.2-28 displays a photo of a segment of Lower Horse Creek where the stream impinges upon the left bank causing a loss of pasture and irrigated acreage. This is a very typical condition encountered throughout the Horse Creek watershed and was visible on each of the streams classified in this effort. Based upon the observed extent of bank erosion coupled with the general lack of riparian vegetation, it is evident that erosional processes are a significant source of sediment to the Horse Creek system.

Figure 4.2-28 Bank Erosion on Lower Horse Creek.

Within the Bear Creek subwatershed, bank erosion is common in the mid to upper reaches of its basin. There were numerous locations where bare and erosive bank conditions were observed. Riparian vegetation is generally lacking throughout much of these reaches and grazing pressures exist. Sediment derived from unstable channel conditions is apparently contributing to downstream aggradation issues in the central portion of the basin. Channel aggradation has resulted in poorly defined channel conditions and sediment deposition has exacerbated irrigation infrastructure use and maintenance.

None of the primary streams or tributaries were classified as either Type F or Type G stream channels; however, as discussed above, there are reaches within each that would be categorized as entrenched and would therefore lend a F-type classification for limited reaches at least. 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. 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.

Although not pervasive, some of the first-order tributaries in the lower portions of the basin would 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.

4.2.6.3 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 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.

Table 4.3-1 National Land Cover Database Analysis for the Horse Creek Watershed.

Horse Creek 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.	857,873	82.49%
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.	86,691	8.34%
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.	55,682	5.35%
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.	13,658	1.31%
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.	9,580	0.92%
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.	6,745	0.65%
Open Water	Areas of open water, generally with less than 25% cover of vegetation or soil.	2,980	0.29%
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.	2,408	0.23%
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.	1,554	0.15%
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.	1,468	0.14%
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.	1,070	0.10%
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.	113	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.	75	0.01%
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.	38	0.004%
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.	6	0.001%
	Total	1,039,942	100.00%

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 81 different vegetation classes within the Horse Creek watershed.

Grassland dominates the watershed, covering about 67% of the watershed. The most common existing vegetation types are the Western Great Plains Shortgrass Prairie and Northwestern Great Plains Mixedgrass Prairie, covering 53% and 11% of the watershed, respectively.

The bar chart Figure 4.3-1 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, but areas of higher elevation (i.e. western headwaters) also have a high portion of shrubland such as Horse-Creek – Carey Creek, North Fork Horse Creek, and Upper Little Bear Creek. The subwatersheds with highest agricultural activity are Long-Canyon – Pumpkin Creek, Horse Creek – Packer Reservoir, and Upper Bull Canyon. The most developed subwatersheds are Dry Creek Drain and Goshen Hole Reservoir.

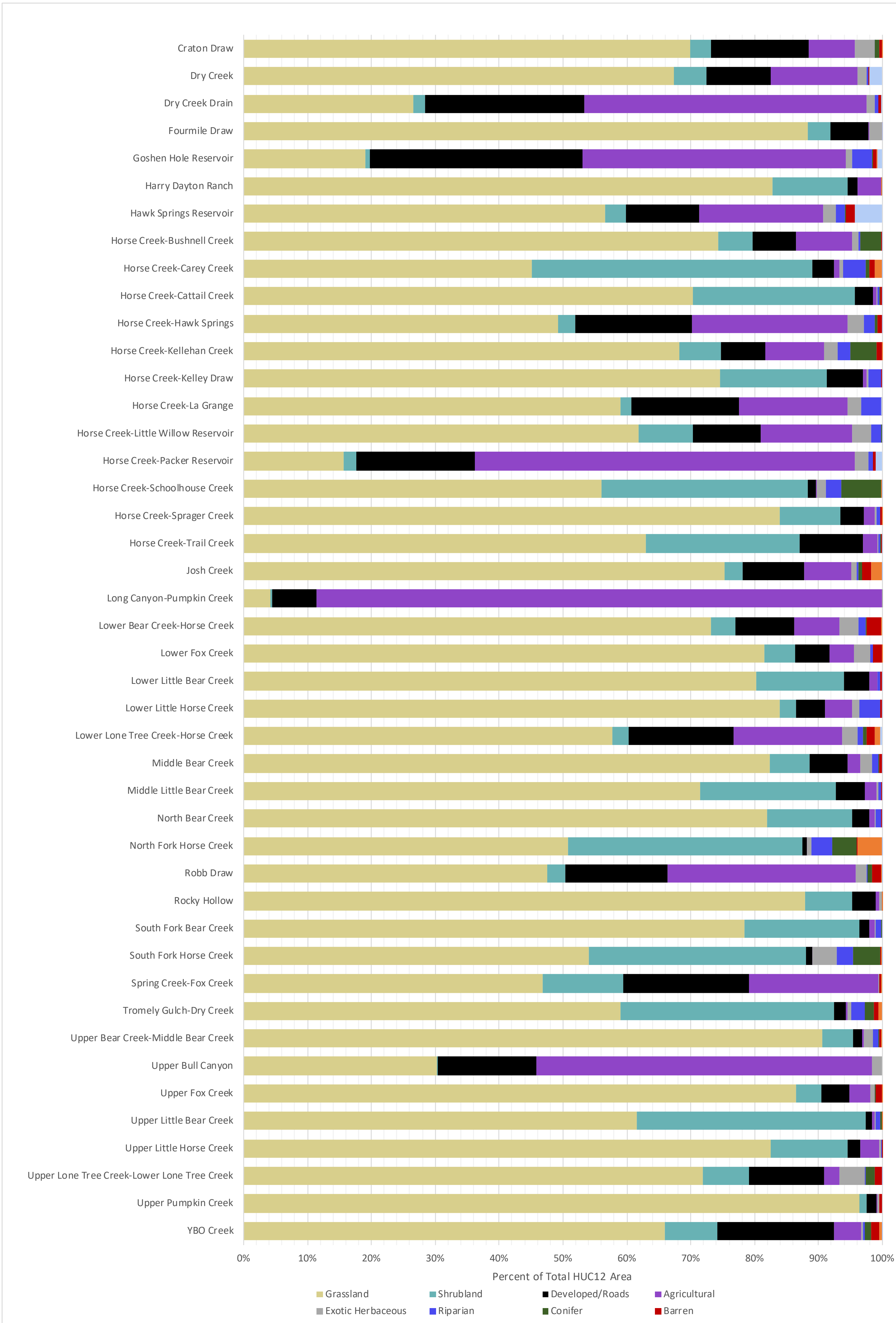


Figure 4.3-1 Horse Creek LANDFIRE Database Characterization.

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 SGCD 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 Horse Creek watershed. Figure 4.3-2 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 15 different GAP classifications present in the watershed, mixed grass prairie dominates the landscape, making up 59% of the study area. dry-land crops and irrigated crops are the next most abundant, making up 19% and 10% of the watershed, respectively.

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. Vegetation management goals, objectives and actions related to the study area are available in the Rawlins or Casper BLM Resource Management Plans located in the Digital Library delivered with this report.

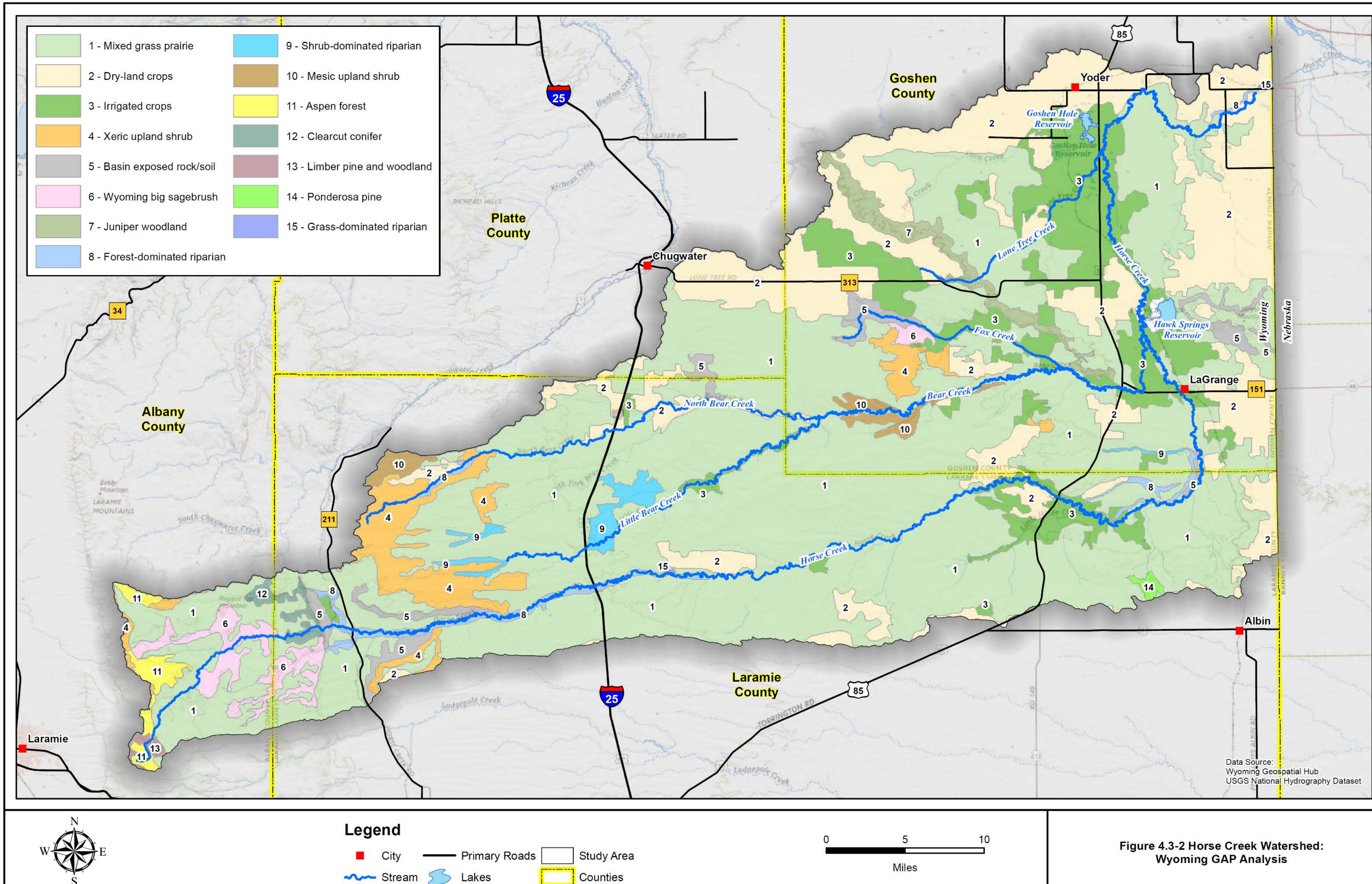


Figure 4.3-2 Horse Creek Watershed: Wyoming GAP Analysis

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 the dataset are presented in Table 4.3-2. There is a total of 11,386 acres designated Riparian in the LANDFIRE dataset. As this table clearly indicates, riparian areas in the study area are extremely limited in extent (1.09% of the watershed).

Table 4.3-2 LANDFIRE Riparian/Wetlands Classifications.

Horse Creek Watershed : LANDFIRE				
Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Acres	Percent of Watershed	Cumulative Percent
Western Great Plains Floodplain Herbaceous	Riparian	4300.6	0.41%	0.41%
Western Great Plains Floodplain Forest and Woodland	Riparian	2816.0	0.27%	0.68%
Rocky Mountain Montane Riparian Forest and Woodland	Riparian	2501.3	0.24%	0.92%
Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	670.8	0.06%	0.99%
Rocky Mountain Wetland-Herbaceous	Riparian	424.3	0.04%	1.03%
Rocky Mountain Montane Riparian Shrubland	Riparian	294.8	0.03%	1.06%
Western Great Plains Floodplain Shrubland	Riparian	193.5	0.02%	1.08%
Western Great Plains Depressional Wetland Systems	Riparian	157.2	0.02%	1.09%
Rocky Mountain Subalpine/Upper Montane Riparian Forest and Woodland	Riparian	26.0	0.00%	1.09%
Western Great Plains Wooded Draw and Ravine	Riparian	1.8	0.00%	1.09%

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 17,670 acres of wetlands exist within the watershed, which is only about 1.7% of the total study area.

Figure 4.3-3 presents a pie chart showing the relative distribution of the general wetland types. The major contiguous wetlands in the watershed are irrigation reservoirs such as Hawk Springs and those within in the Springer Wildlife Management Unit. Riverine wetlands

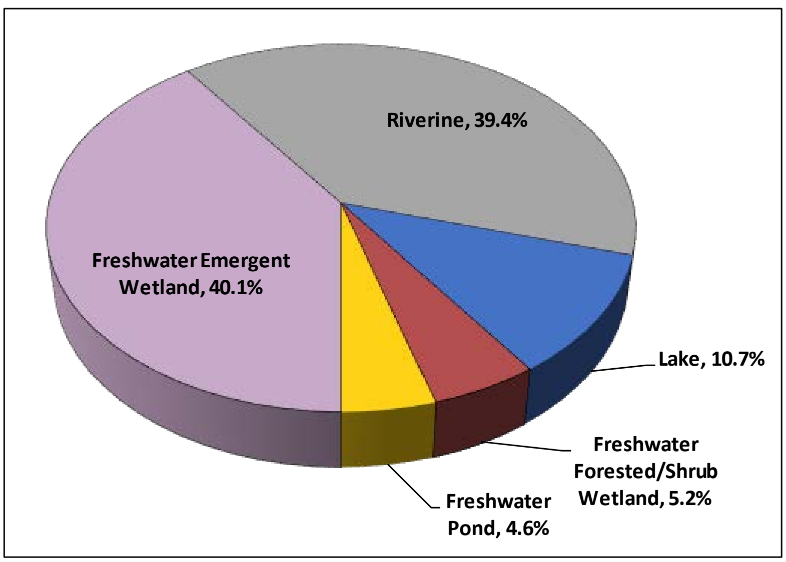


Figure 4.3-3 Percent of NWI Wetlands Types.

are also found throughout the study area, making up almost 40% 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:

> *"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 Goshen Hole Wetland Complex (GWC) and eleven unnamed complexes exist within the study area (Figure 4.3-4).

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.

In 2018, the Wyoming Game and Fish department published a conservation plan with numerous objectives and conservation strategies within the GWC (WGF, 2018) such as:

- Build partnerships within the local community area to support wetland conservation efforts while maintaining traditional agricultural uses of the land.
- Work with conservation districts to improve the efficiency of irrigation delivery systems while mitigating impacts to irrigation-dependent wetlands such as seepage areas along canals.
- Secure additional funding and match funding to support ongoing and future wetlands conservation and enhancement projects through DU, USFWS, NRCS, TNC, WWNRT, WGFD, and other partners.
- Strive for no net loss of existing wetlands within the GWC. Increase the wetland habitat base primarily through restoration of historically-drained and converted wetlands, and where sufficient water can be secured, through creation of additional wetlands.
- Negotiate additional conservation easements and other instruments to protect important wetlands and riparian areas potentially vulnerable to future development.

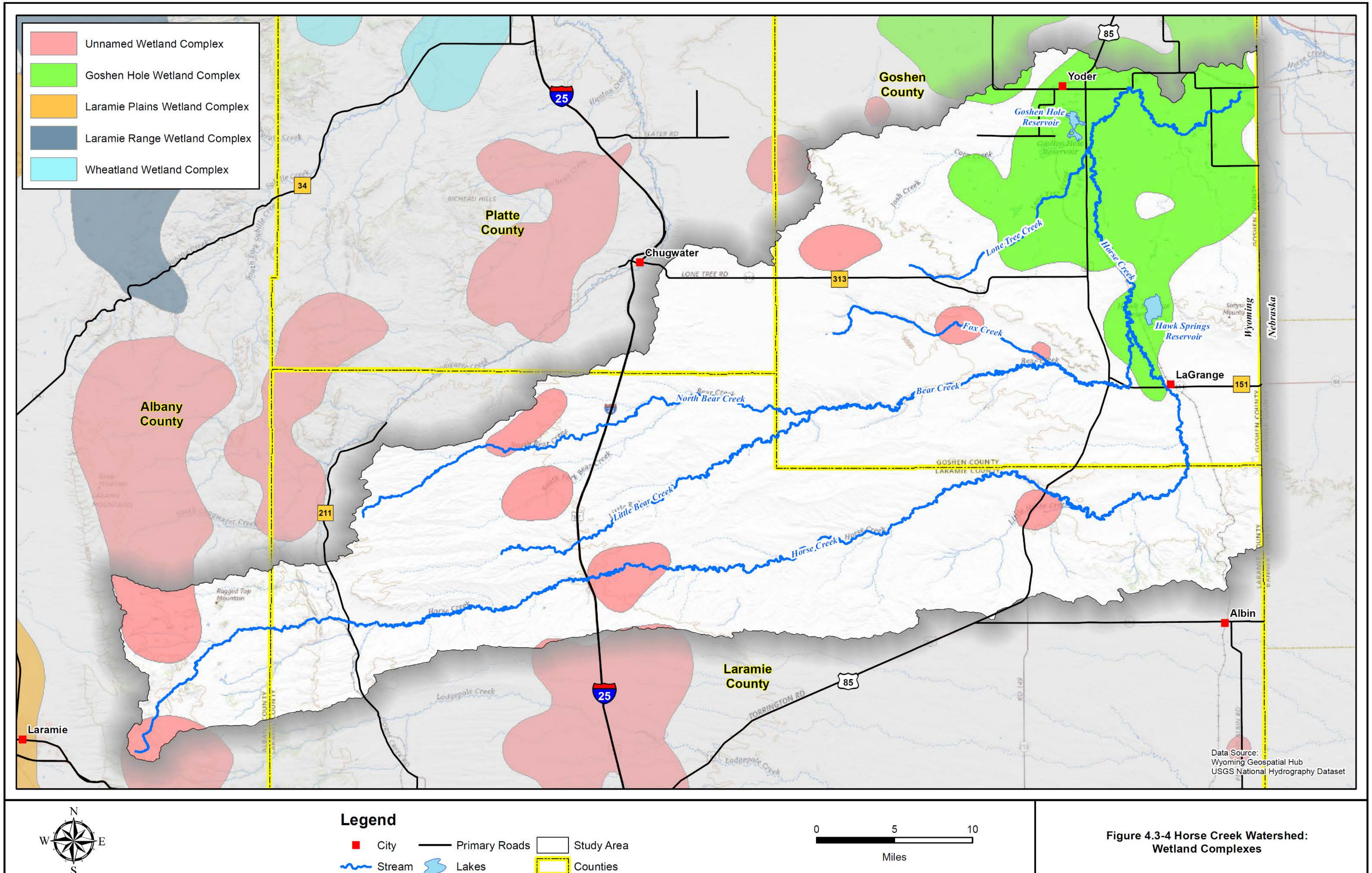


Figure 4.3-4 Horse Creek Watershed: Wetland Complexes

- Work with landowners to implement wetland and watershed “best management practices” that will improve water quality and sustain/enhance wetland functions and values throughout the GWC.
- Provide additional public access opportunities for wetland-dependent recreation such as waterfowl hunting, fishing, and wildlife viewing.

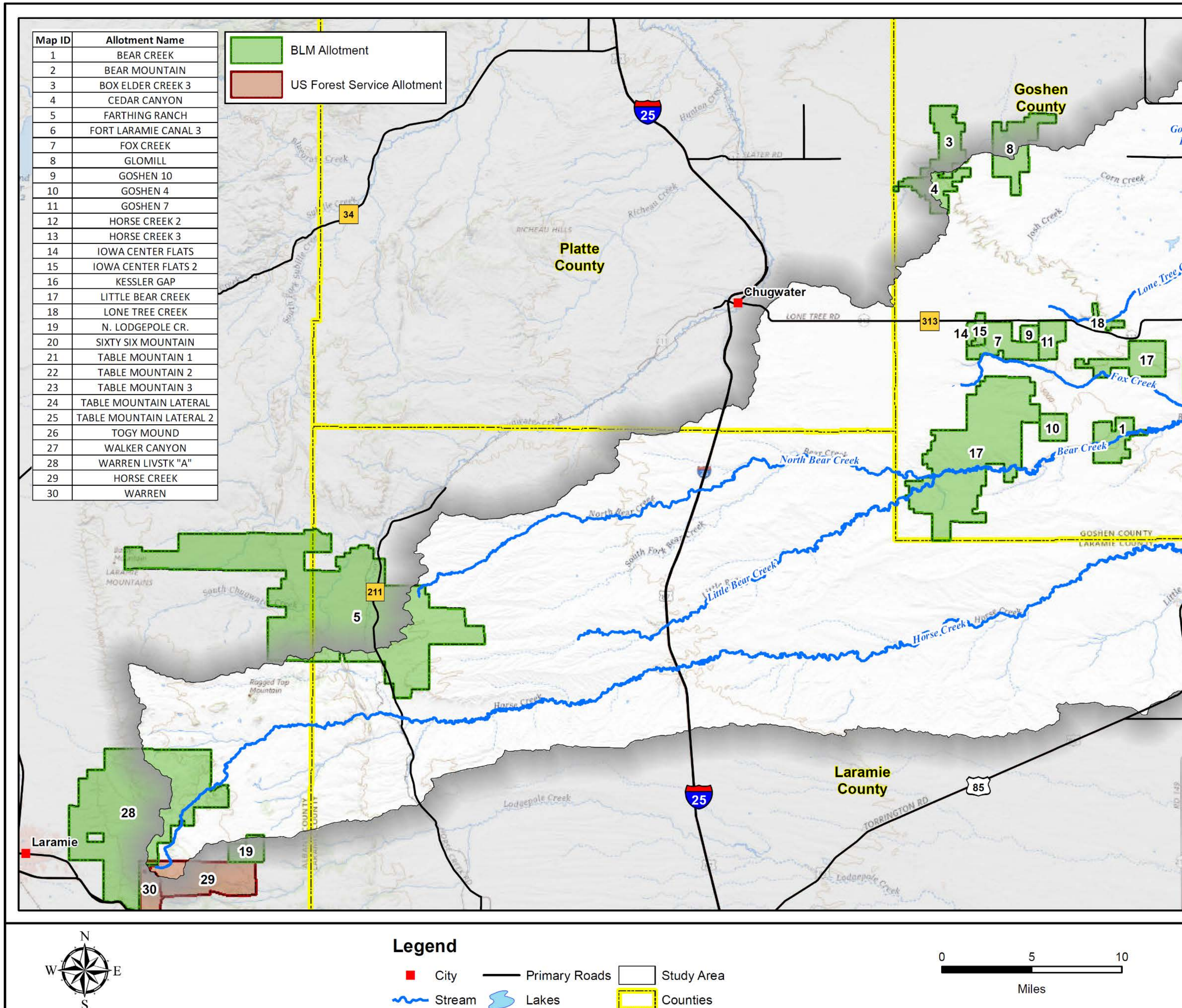
In 2016, the Nature Conservancy and the WGF published the results of an assessment of the Goshen Hole Wetland Complex (Tibbets et al., 2016). A summary of the assessment was extracted and is presented below:

- Overall, results indicated that approximately 77% of wetlands in the basin are moderately to significantly disturbed.
- Over 70% of the wetlands are privately owned, and 66% percent of the wetlands are freshwater-emergent wetlands, which include irrigated hayfields.
- Although irrigation and related agricultural activities are generally considered disturbance factors, the hydroperiod of many wetland basins is extended by nearby irrigation and other wetlands exist solely as a byproduct of irrigation runoff or seepage.
- Among wetland types, playas and saline depressions were the least disturbed, followed by riparian woodland and shrublands. Wet meadows were the most disturbed.
- The most widespread anthropogenic disturbances, or stressors, identified across all wetland types were presence of invasive plant species and grazing impacts such as soil compaction from both native and domestic herbivores.

4.3.1.5 Grazing Allotments Administration

Grazing resources within the Horse Creek Watershed Study area are influenced by land ownership. Land ownership in this study area is 90.0% privately owned, 9.2% State of Wyoming, 0.5% managed by the Bureau of Land Management with 0.3% United States Forest Service, Bureau of Reclamation, and Department of Defense.

Of the approximately 1,039,966 million acres within this study area, over 935,677 acres are privately owned, 98,023 acres are managed by the State, and 6,266 acres are under Federal management. Significant portions of this land base is 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 4.3-5. There are 28 BLM allotments and 2 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.



Map ID	Allotment Name
1	BEAR CREEK
2	BEAR MOUNTAIN
3	BOX ELDER CREEK 3
4	CEDAR CANYON
5	FARTHING RANCH
6	FORT LARAMIE CANAL 3
7	FOX CREEK
8	GLOMILL
9	GOSHEN 10
10	GOSHEN 4
11	GOSHEN 7
12	HORSE CREEK 2
13	HORSE CREEK 3
14	IOWA CENTER FLATS
15	IOWA CENTER FLATS 2
16	KESSLER GAP
17	LITTLE BEAR CREEK
18	LONE TREE CREEK
19	N. LODGEPOLE CR.
20	SIXTY SIX MOUNTAIN
21	TABLE MOUNTAIN 1
22	TABLE MOUNTAIN 2
23	TABLE MOUNTAIN 3
24	TABLE MOUNTAIN LATERAL
25	TABLE MOUNTAIN LATERAL 2
26	TOGY MOUND
27	WALKER CANYON
28	WARREN LIVSTK "A"
29	HORSE CREEK
30	WARREN

Figure 4.3-5 Horse Creek Watershed: BLM and US Forest Service Allotments

BLM 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

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.

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 48 plants as SOC or SOPC, which includes 1 coniferous species, and 47 flowering species. 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 4.3-6 shows the stream classifications within the Horse Creek Watershed. Trout are present in tributaries of Bear Creek and the upper portion of Horse Creek. North Fork Horse Creek, Little Horse Creek, and North Bear Creek are the only Yellow Ribbon streams in the watershed (50-299 pounds per mile). Little Bear Creek, South Fork Horse Creek, tributaries of Little Horse Creek, and Horse Creek upstream of Goshen County are all designated as Green Ribbon streams (<50 pounds per mile). Dry Creek and Horse Creek downstream of Laramie County are identified as cool/warm water streams with game fish present (no trout). All other streams are cold water streams with no trout present.

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 Horse Creek Watershed is home to several fish species designated as SGCN (Figure 4.3-7). 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 WYGFD has identified the suckermouth minnow (Phenacobius mirabilis) as an imperiled species due to greatly restricted distribution. Currently, they are found only in the Horse Creek drainage although they have historically been found in the Lower Laramie and North Platte River drainages. The State Wildlife Action Plan (2017) suggests conducting research on the historical distribution of suckermouth minnows as well as the impacts of diversion flows on Horse Creek, so that their preferred habitat can be protected, and their population could potentially be re-established in areas of historical distribution.

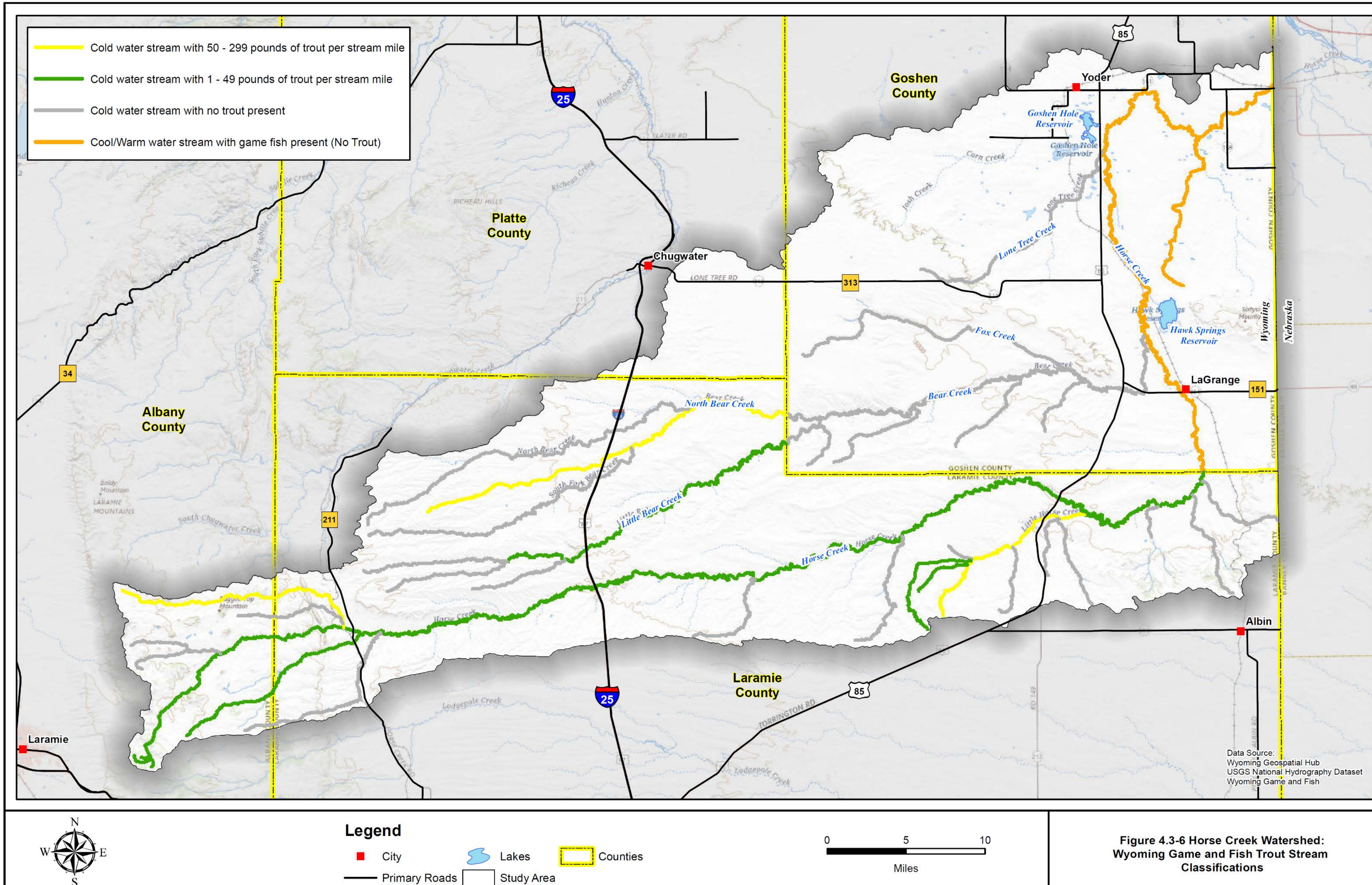


Figure 4.3-6 Horse Creek Watershed: Wyoming Game and Fish Trout Stream Classifications

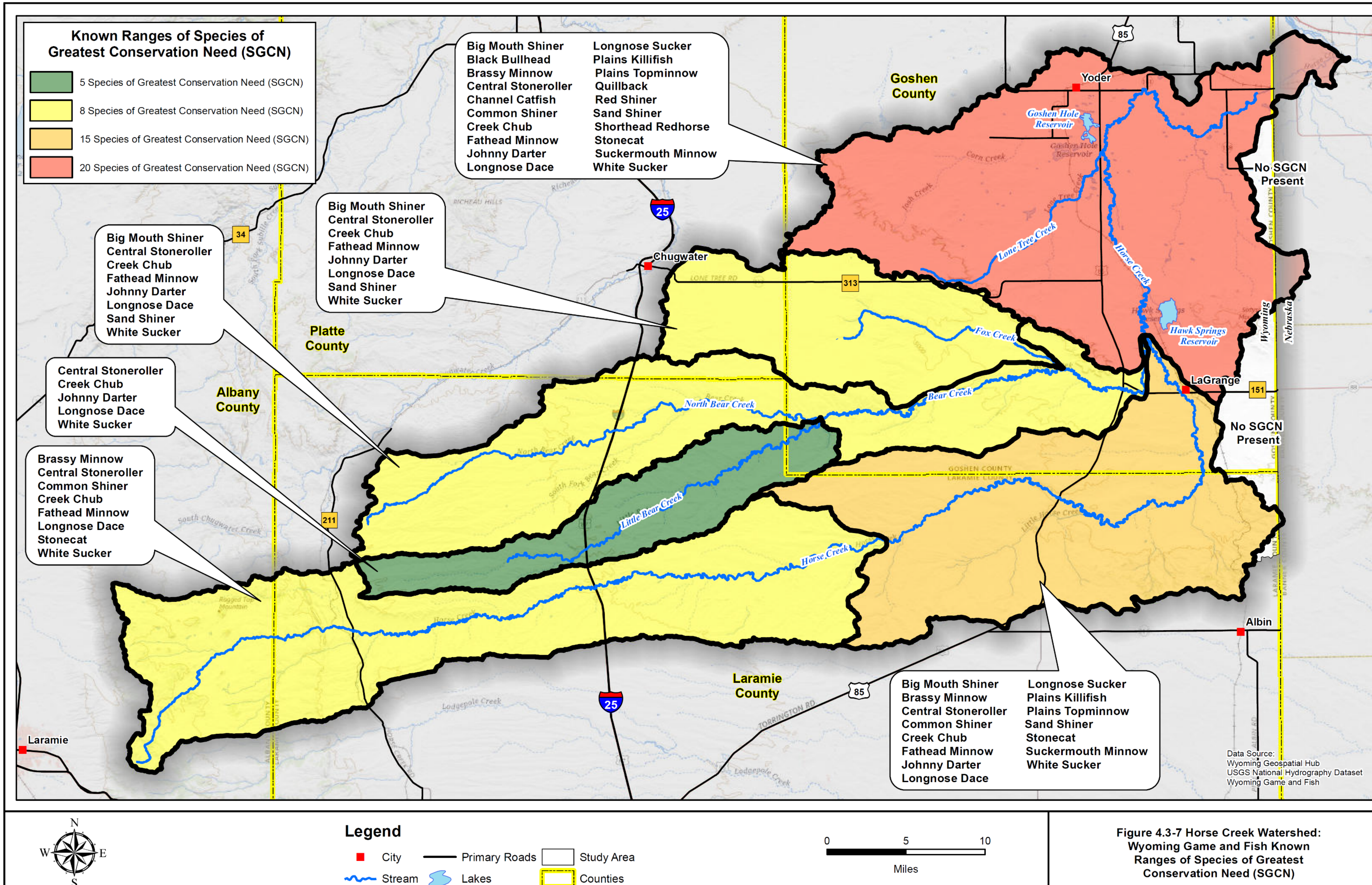


Figure 4.3-7 Horse Creek Watershed: Wyoming Game and Fish Known Ranges of Species of Greatest Conservation Need (SGCN)

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 Horse Creek watershed, the primary big game present are pronghorn antelope, bighorn sheep, elk, white tailed deer, and mule deer. Approximately 263,204 acres (roughly 25 percent of the study area) have been determined to be crucial habitat for one or more of antelope, elk, or mule deer. None of the big game species mapped by the WGFD have parturition areas within the watershed. According to the Game and Fish data provided, bighorn sheep may utilize a small western portion of the study area, but only as seasonal range. White-tailed deer use the entire study area as seasonal range, but don't have any crucial ranges in the study area.

The entire Horse Creek watershed is classified as seasonal range for the big game species. The watershed also has crucial ranges and migration routes for antelope, elk, and mule deer. The crucial range of these three primary species is generally concentrated in the headwaters of Horse Creek, Fox Creek, Lone Tree Creek, and Bear Creek. 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). Crucial ranges for these big game species can be accessed via the Suitewater geodatabase.

In an effort 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.

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 4.3-8). "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."*

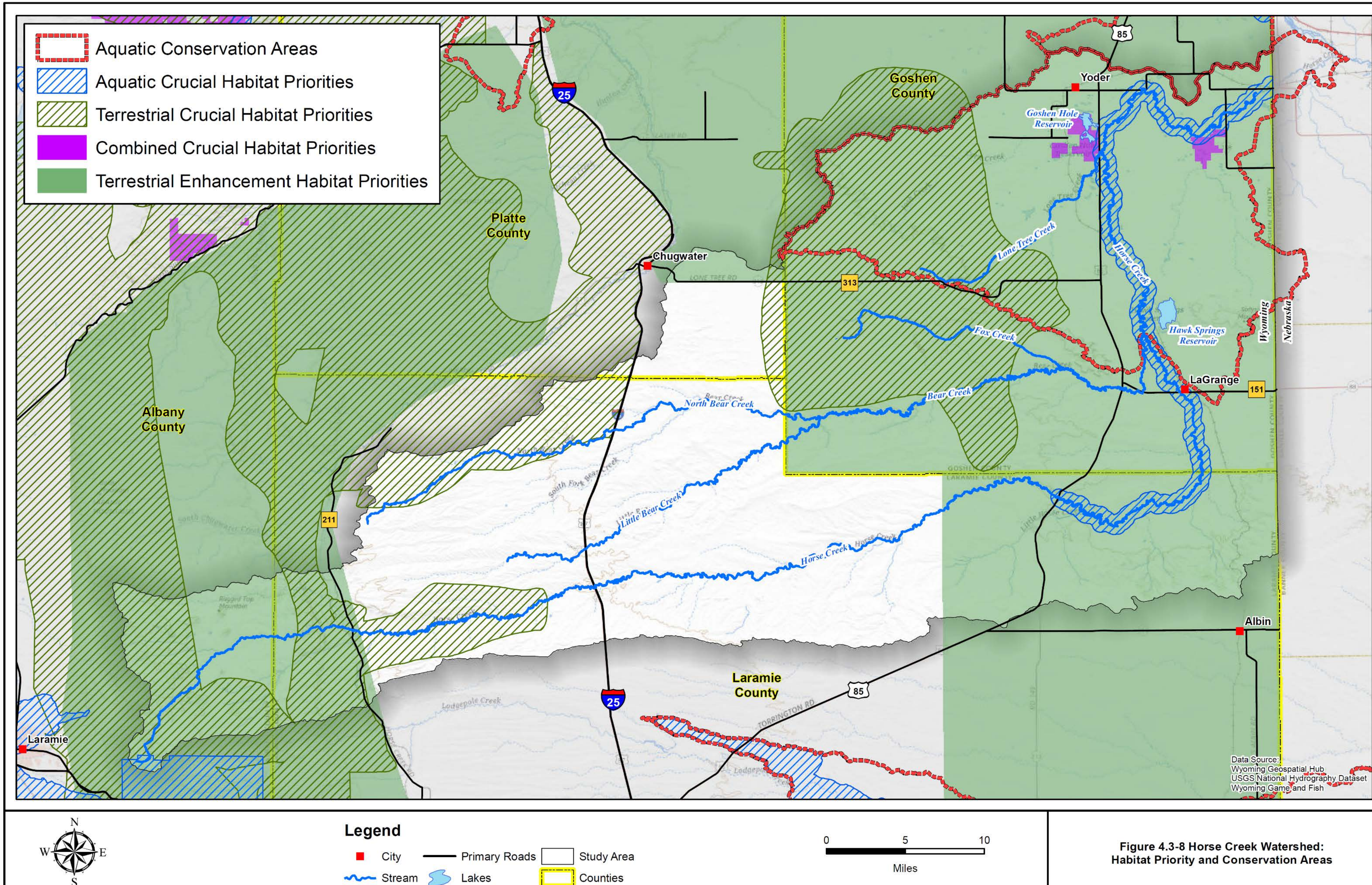


Figure 4.3-8 Horse Creek Watershed: Habitat Priority and Conservation Areas

"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/Laramie) 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 Horse Creek (Goal 1 Aquatic Crucial Area)

- **Habitat Value:**
  Functioning stream habitat to support native, non-game fish species and functioning riparian community
- **Reason Selected:**
  Dr. Timothy Patton in his 1997 PhD research found Horse Creek to have one of the highest densities of native fishes, and also some of the highest densities of 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 Lodgepole Creek drainage (Bear and Barrineau 2007, Moan et.al. 2011).
- **Primary species or assemblages of species:**
  Suckermouth minnow, plains topminnow, brassy minnow, common shiner, central stoneroller
- **Solutions or actions:**
  - Seek opportunities for conservation easements to provide protection for stream and riparian corridors.
  - 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 surveys 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.
  - Investigate and develop a better understanding of water availability and use in the drainage as it pertains to native fish habitat.
  - Promote and establish fish passage and screening solutions at irrigation diversions.

- Promote livestock grazing management practices to maintain or restore riparian habitat function.
- Apply active stream rehabilitation when necessary.

- **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

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:**
  - prescribed burning and/or natural fire planning in mixed shrub habitats;
  - brush mowing or other mechanical treatments of shrubs;

- herbicide application to control cheatgrass post-fire (wild or prescribed);
    - progressive livestock grazing management; and
    - riparian area enhancement through 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 abbreviated. 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. The Big Game Goal 1 Crucial Terrestrial Area, 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 two WHMAs in the Horse Creek watershed.

- **Springer / Bump Sullivan WHMA** - Various types of grasses, forbs, shrubs, and trees have been planted here to increase nesting, hiding, and feeding areas for wildlife. Current management priorities on the Springer area are focused on geese, ducks, and pheasants. Geese lay thousands of eggs each year in artificial nesting structures. During the spring and fall, large numbers of waterfowl use this area as a stopover point on their migration routes. Many species of ducks, Canada and snow geese, sandhill cranes and many shorebirds can also be seen. In addition, pheasants, cottontail rabbits, wild turkeys, mule deer, white-tailed deer, skunks, fox squirrels, and muskrats, songbirds, doves, and bald eagles use these lands.
- **Table Mountain** - 1,716 acres of Canada geese habitat managed in cooperation with the BLM. Many artificial goose-nesting structures have been installed, and thousands of ducks and geese pass through during the spring and fall migration. The WGF and the BLM have planted vegetation to increase nesting cover for pheasant and waterfowl species. American bitterns, great blue herons, marsh and Swainson's hawks, great horned owls, American white pelicans, western grebes, white-faced ibis, bald eagles, coyotes, foxes, and rabbits also use this area.

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 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.

According to WGFD, the overall goal of the Core Sage Grouse Population 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. ***None of the Sage Grouse Core areas are located within the Horse Creek watershed. However, according to the 2017 lek data received from WGFD, there is 1 occupied lek, and there are 4 unoccupied leks within the Horse Creek watershed study area, all of which are in the western portion of the watershed. The regulations related to these leks are explained in Attachment B of Executive Order 2015-4 (included in the digital library of this report).***

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 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.*
- *Irrigation (excluding the conversion of sagebrush habitats to new irrigated lands).*
- *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, crustaceans, fish, insects, 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 lists several endangered species as being sighted within the watershed. The WYNDD database is a historic accumulation of information related to sightings within the study area. The only recorded Whooping Crane sighting was in 1999. 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 these areas are less stringent than within areas containing “Listed Endangered” species. Species that are “Listed Endangered” in this watershed include the Least Tern and the Whooping Crane. The Piping Plover, Greenback Cutthroat Trout, Canada Lynx, and Preble’s Meadow Jumping Mouse are “Listed Threatened”.

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

Irrigation activities within the study area are primarily located in the northeastern portion of the watershed, as indicated on Figure 4.4-1. The irrigated acres are distributed along Horse Creek, Bear Creek, Fox Creek, and their tributaries. The total irrigated acreage within the study area is approximately 59,515 acres, less than 6% of the watershed. The Wyoming State Engineer's Office (WSEO) reports 189 points of diversion in the study area. Table 4.4-1 tabulates the irrigated acreage and points of diversion by subwatershed (HUC10). The Platte River Basin Plan (Trihydro, 2006) states that agricultural operations are the single largest consumer of water in Wyoming's Platte River Basin.

As presented in the Platte River Basin Plan in a discussion of irrigation practices in the Horse Creek watershed (Trihydro, 2006):

- *Alfalfa has typically been cultivated on an average of about 28 percent of* [Horse Creek] *subbasin irrigated acreage.*

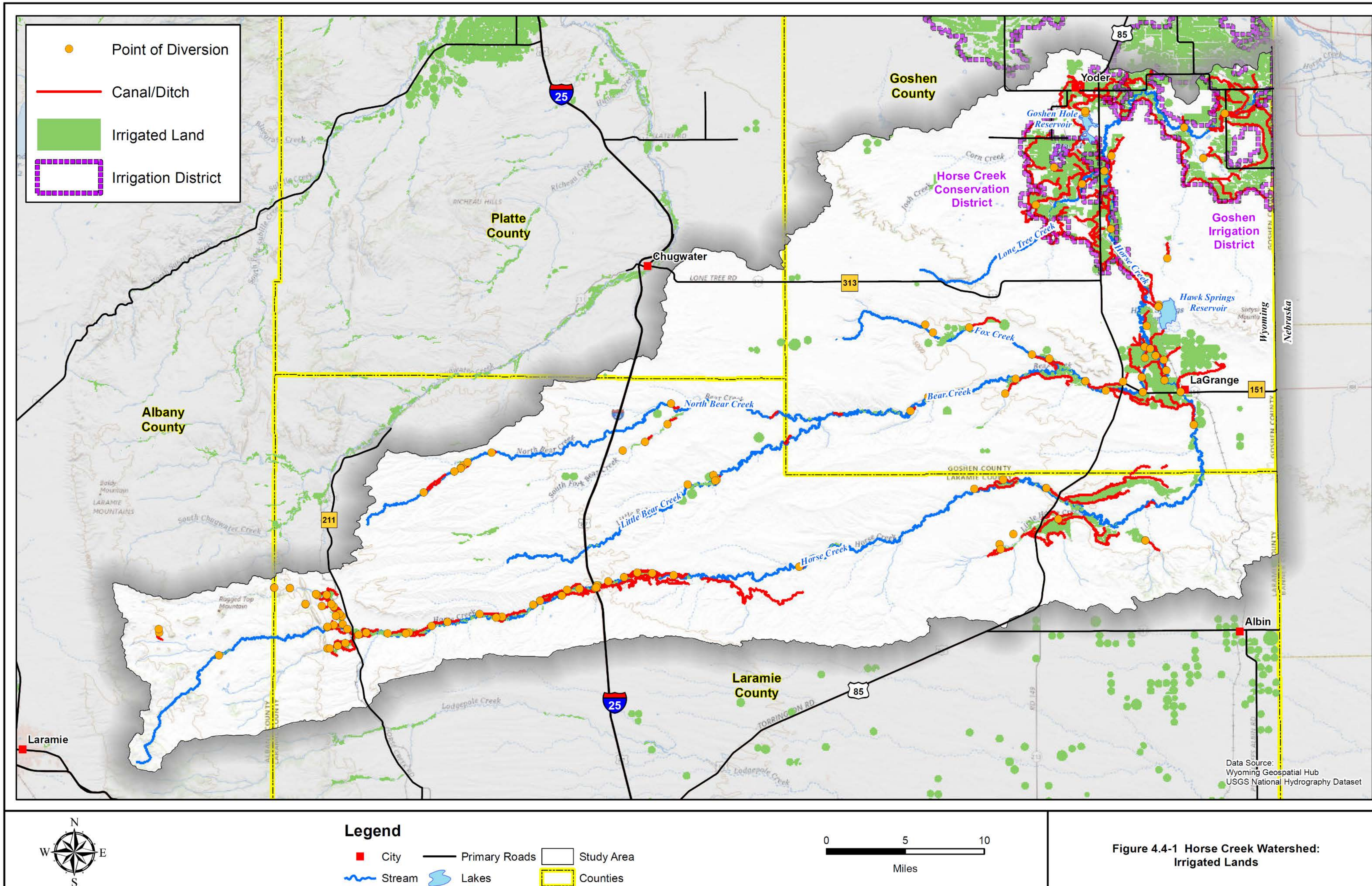


Figure 4.4-1 Horse Creek Watershed: Irrigated Lands

Table 4.4-1 Irrigated lands (2012) and Point of Diversion by Subwatershed.

HUC 10 Number	HUC 10 Name	Irrigated Acres 2012 Ground Condition	Additonal Irrigated Acres 2017 Ground Condition	Total Irrigated Acres (2012, 2017)
1018001203	Bear Creek	1341	2332	3672
1018001205	Fox Creek	1538	160	1698
1018001207	Kiowa Creek	1910	51	1960
1018001204	Little Bear Creek	724	482	1206
1018001206	Lower Horse Creek	28381	3417	31799
1018001202	Middle Horse Creek	4264	2621	6885
1018001301	Pumpkin Creek	120	0	120
1018001201	Upper Horse Creek	2256	1952	4208

- *Both grass hay and irrigated pasture have each typically covered about 15 percent of* [Horse Creek] *subbasin irrigated acreage.*
- *Corn has covered an average of about 19 percent of* [Horse Creek] *subbasin irrigated acreage.*
- *Sugar beets have been cultivated on an average of about 9 percent of* [Horse Creek] *subbasin irrigated acreage*
- *Dry beans have been cultivated on an average of about 7 percent of* [Horse Creek] *subbasin irrigated acreage.*
- *Other crops, particularly winter wheat and barley, have been cultivated in smaller average portions of the Horse Creek subbasin."*

4.4.1.2 Irrigated Systems

According to the 2015 Wyoming Irrigation Systems Report provided by the Wyoming Water Development Commission (WWDC), there are three irrigation systems within the study area (Table 4.4-2). The Horse Creek Conservation District irrigates approximately 10,544 acres and has 62 individual operators/water users. The district has approximately 6 miles of conveyance (via ditches) and can store up to 16,735 acre-ft in Hawk Springs Reservoir and 1,369 acre-ft in Sinnard Reservoir.

Table 4.4-2 Irrigation Systems in the Horse Creek Watershed.

Subbasin: Horse Creek	Surface Source	Irrigated Acres	Number of Users	Storage (ac-ft)	Storage Reservoirs
Horse Creek Conservation District	Hawk Springs Reservoir	10,544	62	18,104	Hawk Springs and Sinnard Reservoirs
Goshen Hole Water Users Association	Horse Creek	2,516	5	2,516	Springer Reservoir (i.e. Goshen Hole Reservoir)
Goshen Mutual Reservoir and Ditch Co.	Horse Creek	2,500	9	1,929	Bump-Sullivan Reservoir (i.e. Goshen No. 1 and No. 2 Reservoirs)

Goshen Hole Water Users Association irrigates 2,516 acres, serving 5 individual operators/users, and diverts up to 250 cfs from Horse Creek. The Association can store 2,516 acre-ft in Springer Reservoir (i.e. Goshen Hole Reservoir).

Goshen Mutual Reservoir and Ditch Co. can divert up to 50 cfs from Horse Creek, serving 9 individual operators/users and 641 irrigated acres. The Company has 4 miles of conveyance and can store 1,929 acre-ft in Bump-Sullivan Reservoir (i.e. Goshen No. 1 and No. 2 Reservoirs).

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.

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. Of course, there typically is enough water in the river to supply all the diversions. When the water supply is insufficient, water right priorities restrict diversions for junior priority ditches.

Somewhat unique to the Horse Creek watershed is the need of many irrigators to apply water during winter non-growing months. The following paragraphs are quoted from the Hinckley and AMEC, 2011 report, "Horse Creek Groundwater / Surface Water Connection Investigation - Goshen and Laramie Counties, Wyoming".

> *"Irrigation from Horse Creek and its tributaries began well before Wyoming became a state in 1890. The earliest water right in the study area has an 1874 priority. It diverts from the headwaters of Horse Creek, 70 miles upstream of LaGrange.*
>
> *The ratio of demand to supply for surface irrigation water in the Horse Creek Basin is as high as anywhere in the state. Because of the scarcity of stream flow, relatively junior priorities – which can mean junior to the mid-1880s – commonly have no opportunity to divert during the main growing season and must rely on "winter" diversions to fill the soil moisture profile to support spring crop growth. Such diversions are common in the basin, constrained only by weather conditions that preclude diversion, e.g. sustained periods of ice build-up in ditches.*
>
> *Thus, the "irrigation season" is not well-defined in this area. Only the most senior-priority diversions enjoy the opportunity to irrigate on an as-needed basis, in response to contemporaneous crop-water demands during the growing season. "Main" vs. "winter" irrigation season is distinguished more by which appropriations are diverting than by whether diversions are taking place at all. Both Horse and Bear Creeks are routinely under 12-month priority administration, the most consistent and continuous regulation in the state of Wyoming.*
>
> *Fortunately, weather conditions along Horse Creek allow for year-round diversion in most cases. A typical entry in the annual Hydrographer's Report for Division 2 (including Goshen County) has been, "Priority administration remained in effect all winter as mild temperatures and dry*

conditions allowed junior priorities to divert" (e.g. 2004, 2005, 2006, 2007, 2008, and 2009). "Juniors with rights later than the 1910s did not have a priority early enough to divert due to limited supplies. ... Many ditches [on Bear Creek] were not able to divert any water the entire year for the fifth consecutive year" (e.g. 2005)."

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 recycled. 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.

Management Implications:

Within the watershed study area, the majority of irrigated lands are located within an existing irrigation district: Goshen Irrigation District or the Horse Creek Conservation District. These entities are eligible to apply and receive financial assistance through the WWDC's conventional programs. Those irrigators with lands outside of the irrigation districts can receive funding for certain irrigation infrastructure projects through the WWDC's Small Water Project Program (SWPP). Chapter 8 of this report contains detailed information regarding the SWPP.

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 Horse Creek watershed is described in the Platte River Basin Plan as follows (Trihydro, 2006):

Two small municipal public water supply systems are operated in the Horse Creek subbasin by the Towns of Yoder and LaGrange. Both communities rely on groundwater as a source of supply. Two non-community public water systems within the Horse Creek subbasin utilize groundwater to provide water for about 200 people. Estimated domestic water usage from these two systems is 15,000 gpd. The total number of permitted rural domestic wells in the Horse Creek subbasin is estimated to be approximately 694, serving about 1,698 people.

In October 2011, a groundwater Level II study was conducted for the Town of Yoder by Wyoming Groundwater LLC. According to the study, the town of Yoder obtains its water supply from the Chadron Formation via four wells. However, one of the wells has been offline since 2008 because its water exceeded EPA drinking standards for arsenic, gross alpha, and uranium. Another well has temporarily exceeded the EPA standards for gross alpha, and thus is only used when necessary. The other two wells provide a combined production capacity of approximately 80 gpm. Historically, the average daily demand of the Yoder water system is 21 gpm, and the maximum daily demand is 57 gpm. The Level II study was completed to explore groundwater resources near Yoder, to improve the redundancy and resiliency of the current system, while preparing for future growth. It was recommended that a fifth production well be installed in the Fox Hills Aquifer with a design pumping rate of 60 gpm.

According to the 2016 Wyoming Public Water System Survey Report provided by the Wyoming Water Development Commission (WWDC), the town of Yoder has a total system capacity of 216,000 gpd and a raw water storage capacity of 125,000 gallons. The water is treated by chlorination and disinfection, serving 151 people. The Yoder system uses of 8 million gallons annually with a peak day water use of 115,200 gallons.

The town of LaGrange has two wells with a total system capacity of 62,704 gpd and total raw water storage of 300,000 gallons. The LaGrange system serves 448 people, with a total annual use of 45,897,600 gallons and a peak day use of 324,000 gallons (WWDC, 2016).

4.4.2.2 Industrial and Mining

Industrial water use is relatively small in the Horse Creek basin, only making up 5.6 percent of the Wyoming Platte River Basin industrial water use. There are no use permits for mining and mine reclamation, road and bridge construction, or power generation in the Horse Creek subbasin. Groundwater composes 98% of the industrial permitted water use. The largest industrial water use category is “miscellaneous” but there is some limited use for oil exploration and aggregate production.

John E. Jacobs holds a groundwater permit for 100 gpm which is to be used for oil well drilling. Pete Lien and Sons perform aggregate production and hold a groundwater permit for 120 gallons per minute, although their total consumptive use is only 25 gallons per minute. Earl K. Parsons and Robert Coxbill hold miscellaneous industrial water permits for 4,400 gpm and 100 gpm, respectively (Trihydro, 2006).

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 for 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.

Below are descriptions of major reservoirs in the Horse Creek watershed. Some of the information was extracted directly from the Platte River Basin Plan Technical Memorandum 2.6 (Trihydro, 2006).

Table 4.4-3 Major Reservoirs in the Horse Creek Watershed.

Structure Number	Permit Number	Reservoir Name	Priority Date	Year Completed	Use	Applicant Name	Source	Active Capacity (acre-ft)	Size of Reservoir (acre-ft)
1	P1307R	Hawk Springs Reservoir	5/25/1908	1921	Domestic, Irrigation, Recreation, Stock	Horse Creek Conservation District	Hawk Springs, Horse Creek, Bear Creek	15,718	16,735
	P2568R	Hawk Springs Reservoir, Enlargement	10/13/1913	1925	Irrigation, Recreation, Stock			1,017	
2	P349R	Goshen Hole Reservoir	11/5/1902	1907	Domestic, Irrigation	Henry M. Springer	Horse Creek	3,327	4,961
	P4425R	Goshen Hole Reservoir, Enlargement	6/7/1930	ca. 1939	Irrigation			1,634	
3	P2140R	Goshen Reservoir (Goshen Reservoir No. 1)	5/22/1911	1916	Irrigation	Goshen Ditch Co.	Horse Creek	765	1,928
	P2716R	Goshen No. 2 Reservoir	7/16/1914	1921	Irrigation			876	
	P3517R	Goshen Nos. 1 and 2 Reservoir, Enlargement	1/8/1919	1925	Irrigation, Domestic, Stock			287	
4	P3605R	Sinnard Reservoir	2/11/1920	1935	Domestic, Irrigation	Horse Creek Conservation District	Sinnard Draw	1,358	1,358

Hawk Springs Reservoir

Hawk Springs Reservoir is the primary storage reservoir for the Horse Creek Conservation District. Located in Goshen County, southeast of the town of Hawk Springs, storage water is released from Hawk Springs Reservoir into the Hawk Springs Canal and travels approximately 13 miles to the Sinnard Reservoir. In 1985, improvements were made to the Hawk Springs Reservoir and canal. The Hawk Springs Reservoir consists of one main earthfill dam and three small dikes, and has a permitted capacity of 16,735 acre-ft. The reservoir is an off-stream reservoir with a drainage area of approximately 15 square miles. The Hawk Springs Reservoir does not have a spillway. The main dam contains two separate outlet works. One outlet has a discharge capacity of 210 cubic feet per second and releases to the Hawk Springs Ditch for distribution throughout the irrigation district, and the second outlet has a capacity of 8.57 cubic feet per second and is a water right held by Lincoln Land Company (Trihydro, 2006).

Goshen Hole Reservoir

Permitted for irrigation purposes, Goshen Hole Reservoir, which is also known as Springer Reservoir, has a permitted capacity of 4,961.19 acre-feet. Heavy rock riprap and hay bales protect the upstream face of

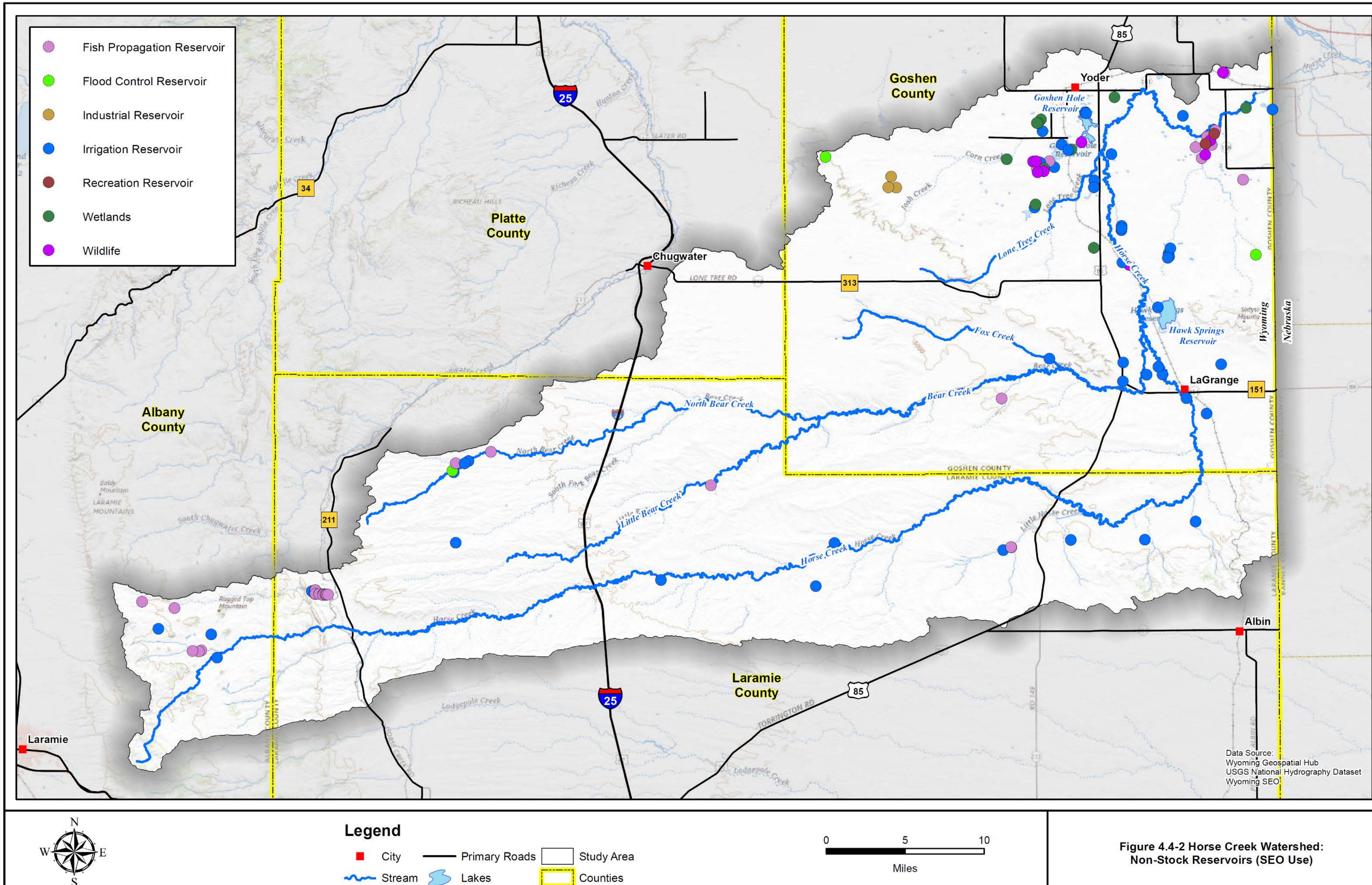


Figure 4.4-2 Horse Creek Watershed: Non-Stock Reservoirs (SEO Use)

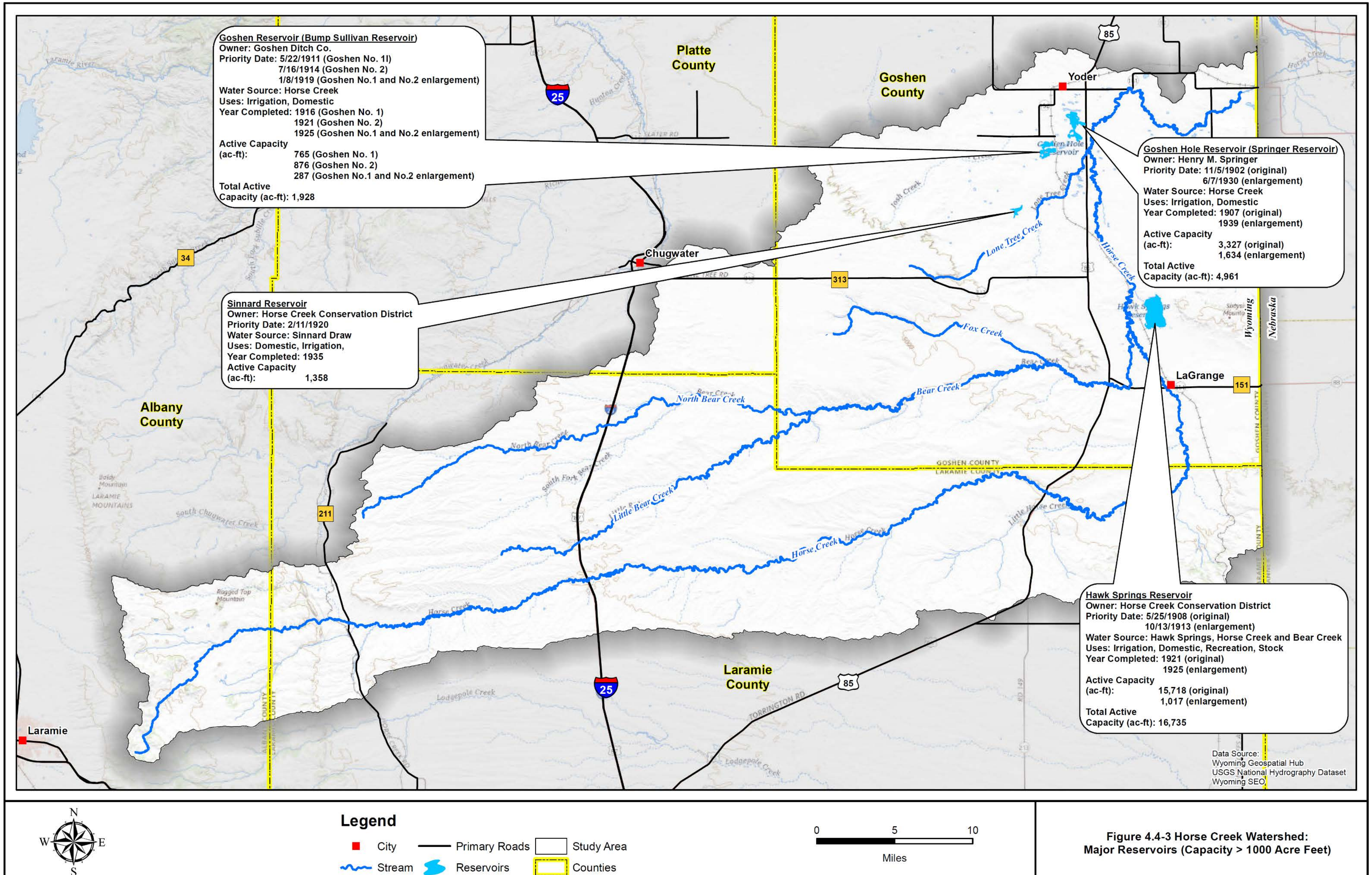


Figure 4.4-3 Horse Creek Watershed: Major Reservoirs (Capacity > 1000 Acre Feet)

the dam from erosion. The reservoir is filled through the Enlargement of the Goshen Hole Supply Canal (Trihydro, 2006).

Goshen No. 1 and No. 2 Reservoir

Also known as Bump-Sullivan Reservoir, Goshen No. 1 and No. 2 Reservoirs are two earthfill dams with a drainage area of approximately six square miles. The reservoirs are filled via the Goshen Ditch, which has a discharge capacity of 50 cubic feet per second. The reservoirs have a permitted capacity of 1,929 acre-feet. Permitted uses for the reservoir include irrigation, stock, and domestic uses. Goshen Reservoir No. 1 (i.e. Goshen Reservoir) was completed in 1911 for irrigation use. Goshen No. 2 was completed a few years later in 1921 and is filled from Goshen Reservoir No. 1 by means of a cut connection (10 ft wide bottom with a slope of 1 on 2). A grassed fuse-type emergency spillway approximately 30 feet wide is located between the two dams. In 1925 the reservoirs were enlarged by raising the earthen dam elevation by three feet. The dam outlet is a 24-inch diameter iron pipe which a discharge capacity of 10 cubic feet per second, and discharges water into the Bump-Sullivan Ditch. The reservoir also has a natural spillway, which is 100 feet wide (Trihydro, 2006).

Sinnard Reservoir

Constructed in the 1920's and located on Sinnard Draw tributary Horse Creek, Sinnard Reservoir is located roughly 7.6 miles upstream of the confluence of Sinnard Draw and Horse Creek. The reservoir is located in Goshen County and is approximately one mile north and four miles west of the town of Hawk Springs. The Horse Creek Conservation District (HCCD) both owns and operates the reservoir and dam. Sinnard Reservoir is considered an off-channel reservoir since the Hawk Springs Canal is the main source of reservoir water supply (Banner, 1993). Sinnard Dam is an earthfill structure with a drainage area of approximately eight square miles. The dam has a crest width of 12 feet and a crest length of 1,350 feet. An open channel emergency spillway approximately 300 feet wide is located around the left abutment of the dam. Hawk Springs Reservoir provides a major portion of the storage inflow to Sinnard Reservoir. The permitted capacity of Sinnard Reservoir is 1,358.31 acre-feet. Sinnard Reservoir's primary use is as a re-regulation facility. During times when irrigation demand is very high, the Hawk Springs Canal does not have enough capacity to support irrigation demand. Sinnard Reservoir stores water and then releases the water to "satisfy the shortfall from the Canal" (Banner, 1993). Lands within the HCCD along the north side of Lone Tree Creek are served by water released from Sinnard Reservoir into Sinnard Ditch (Trihydro, 2006). Throughout most of the irrigation season, "Sinnard Reservoir provides a buffer in the HCCD canal system which allows relatively constant releases to be maintained from Hawk Springs Reservoir" (Banner, 1993).

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.

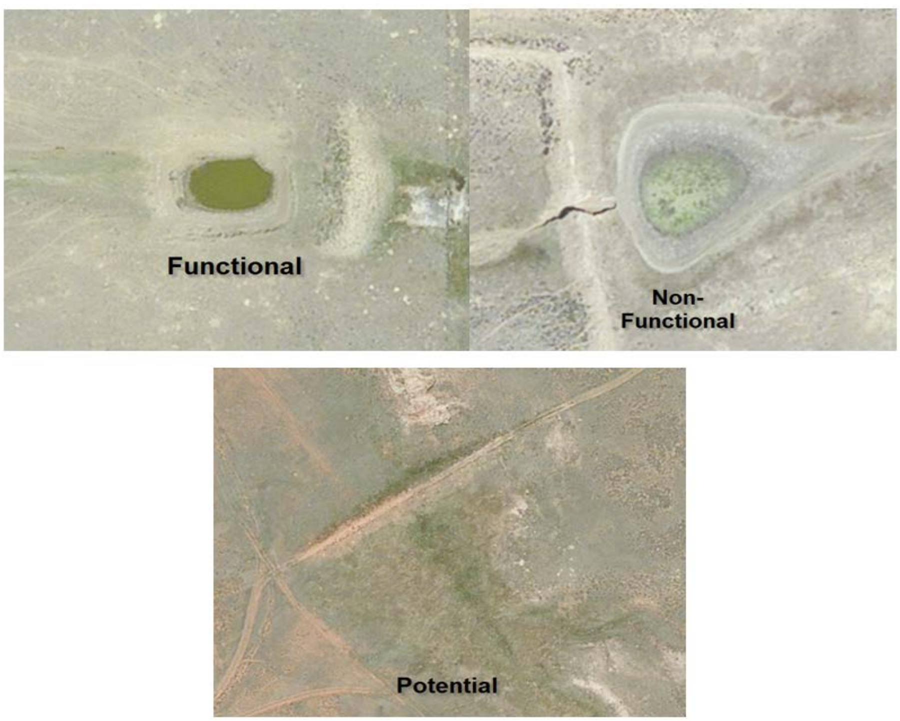


Figure 4.4-4 Evaluation of Stock Reservoirs within the GIS Environment.

The results of this effort indicated that:

- There is an estimated total of 477 stock reservoirs/ponds in the watershed.
- A minimum of 317 reservoirs appear to be "functional" water sources,
- There are 119 "potential" water sources (functionality could not be determined), and

- A minimum of 41 reservoirs are “nonfunctional” water sources. These reservoirs displayed physical breaches or other failures.

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 Management

4.4.4.1 Land Use

Mine Permits

At the time of this report, there were nine 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 (8 permits). There is also one limestone mine currently active within the study area.

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

Permit Number	Company Name	Mine Name	Mine Type	Mineral	Acres	Status
ET1473	LUCKY GATE RANCH LLC	LUCKY GATE RANCH	Limited Mine Operation (ET)	Sand & Gravel	10	Active
ET1543	MCMURRY READY MIX CO	YNOTT PIT	Limited Mine Operation (ET)	Sand & Gravel	10	Active
ET1325	DOMSON INC	NIMMO RANCH	Limited Mine Operation (ET)	Sand & Gravel	10	Active
PT0221	PETE LIEN & SONS INC	HORSE CREEK QUARRY	Large Mine (PT)	Limestone	37.1	Active
ET1579	WILLITS CO., INC	THALER PIT	Limited Mine Operation (ET)	Sand & Gravel	8.9	Active
SP0288	GOSHEN IRRIGATION DIST	Table Mountain	Small Mine (SP)	Sand & Gravel	N/A	Active
PT0318	GOSHEN COUNTY OF	#2 - Broken Box	Permit	Sand & Gravel	N/A	Active
PT0318	GOSHEN COUNTY OF	#3 - Chamberlain	Permit	Sand & Gravel	N/A	Active
PT0318	GOSHEN COUNTY OF	Arnold Pit	Permit	Sand & Gravel	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/

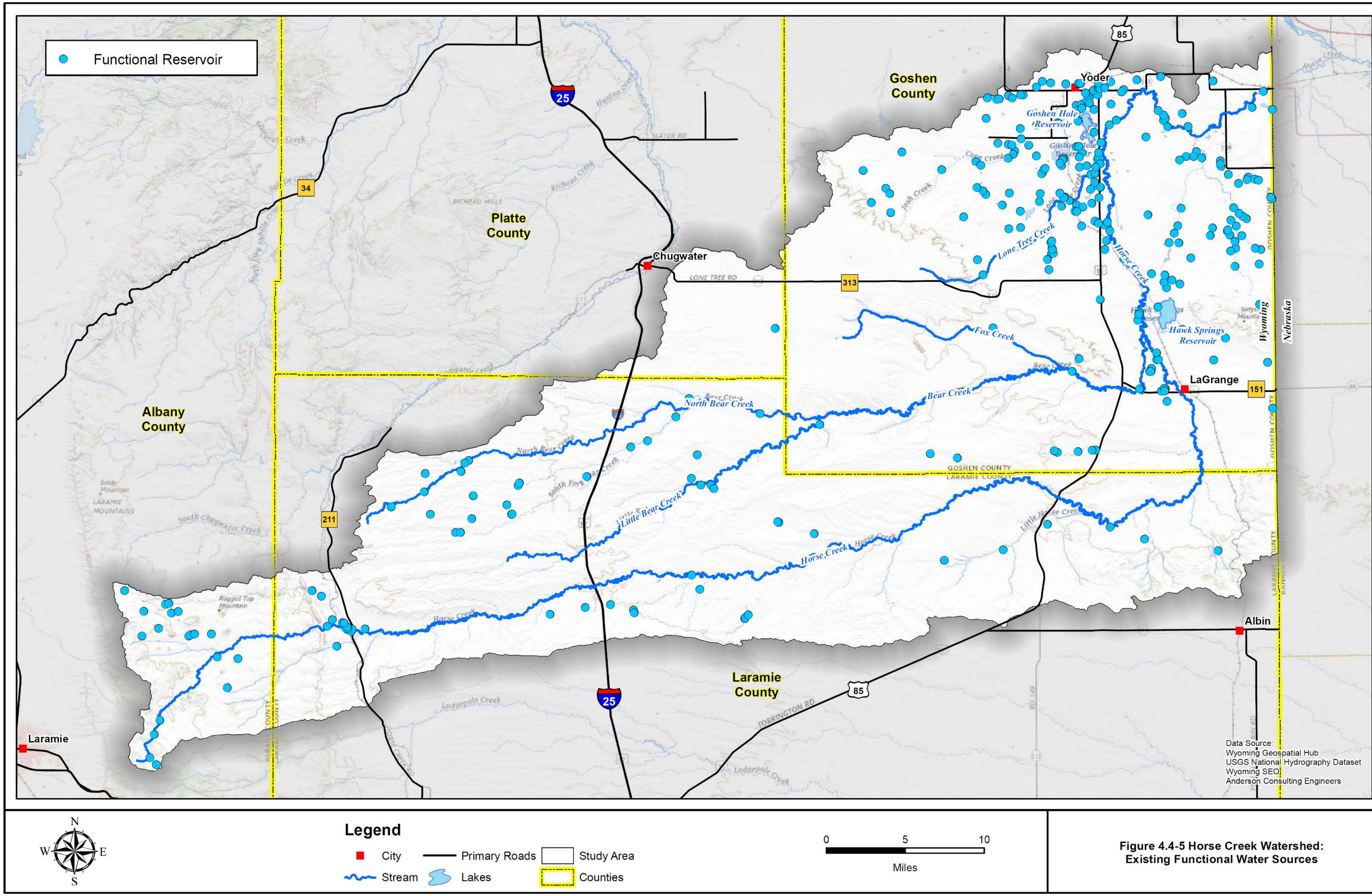


Figure 4.4-5 Horse Creek Watershed: Existing Functional Water Sources

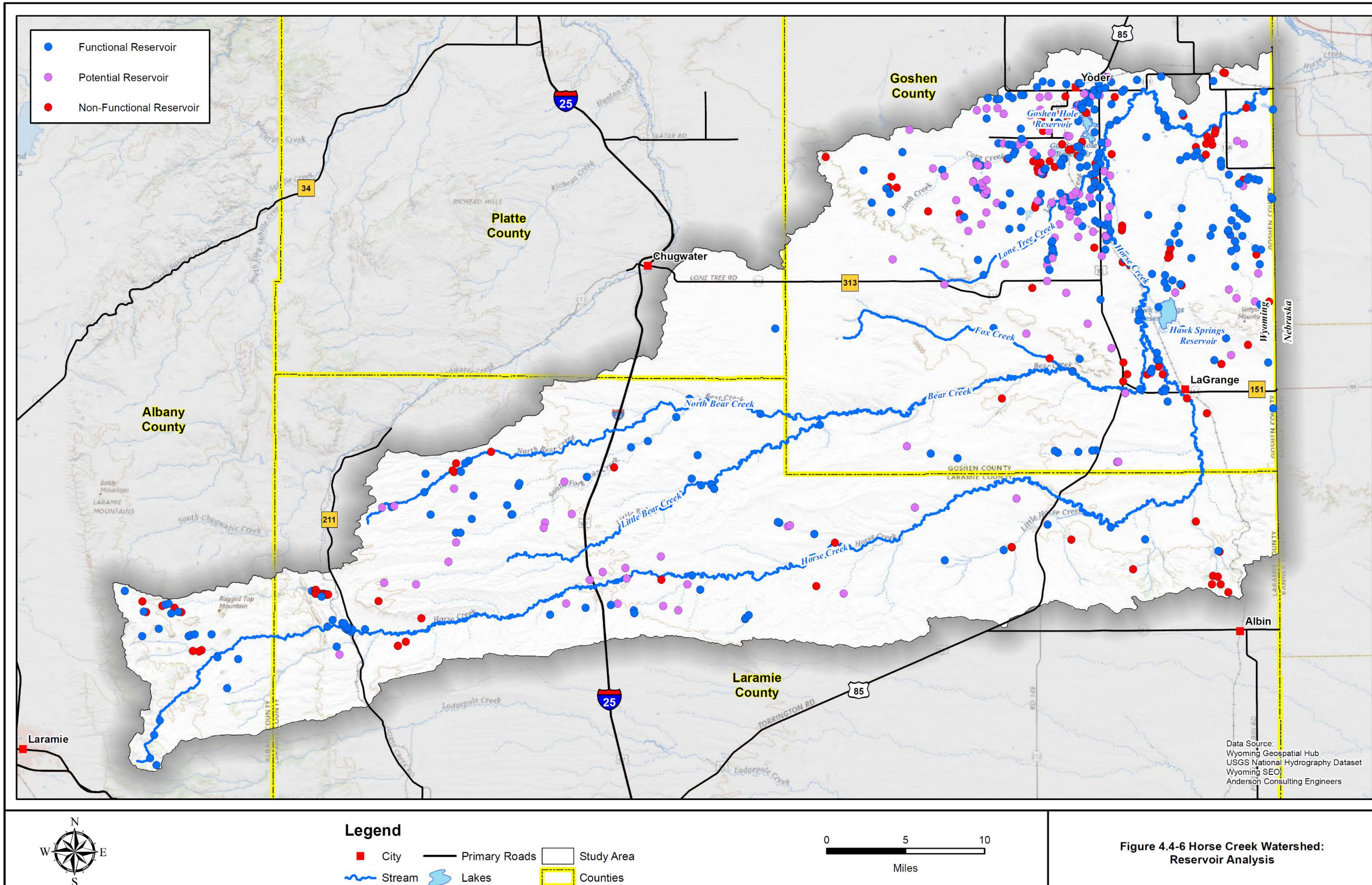


Figure 4.4-6 Horse Creek Watershed: Reservoir Analysis

Transportation, Energy and Communications Infrastructure

The Horse Creek watershed is sparsely populated, and thus Interstate 25 (I-25) intersects the west upper portion of the watershed, running north to south. US-85 travels along the eastern portion of the watershed from north to south. Wyoming State Route 313 runs east from the town of Chugwater, Wyoming State Route 151 travels from the east to west through the town of LaGrange, and Wyoming State Route 211 crosses the headwaters of Horse Creek.

The main active railroad line in the watershed is the Burlington Northern Railroad that runs along WY-211. There is also a Union Pacific railroad which runs north-south through the towns of LaGrange and Yoder.

Communication towers are located throughout the watershed; however, they are clustered around main transportation routes, and near LaGrange and Yoder, which are the major population centers within the study area.

There are no power generation facilities within the study area. Several electric transmission corridors are located within the study area, primarily located in the eastern portion of the watershed.

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 4.4-7, many of the pipelines are located along the main transportation route I-25. These include multiple crude oil pipelines and natural gas liquid (NGL) 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 NGL pipeline which runs north-south through Goshen County.

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 4.4-8. Most of the wells are in the southern portion of the watershed, and 484 wells are still active.

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 1,039,966 acres (1,625 square miles). Figure 4.4-9 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 4.4-10, Laramie County comprises 46.1 percent (749 square miles) of the study area, Goshen County comprises 44.6 percent (725 square miles), Albany County comprises 5.5 percent (89 square miles), while Platte County comprises the remaining 3.8 percent (62 square miles).

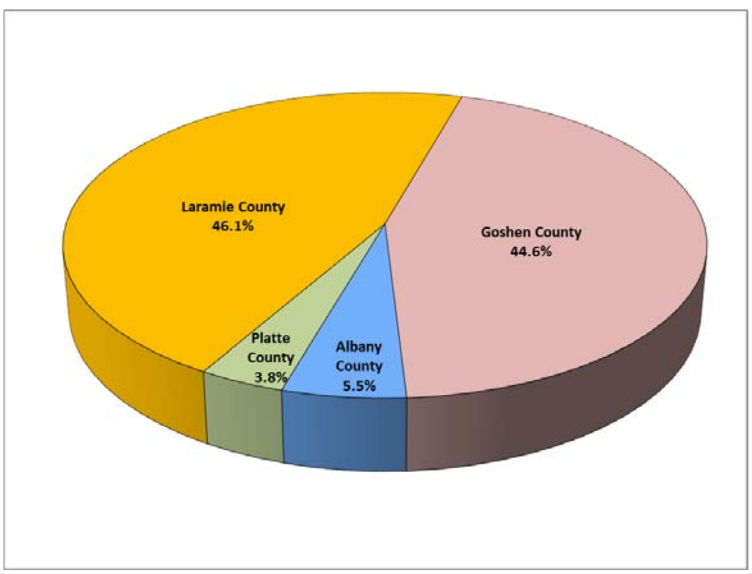


Figure 4.4-10 Distribution of Ownership Among Counties.

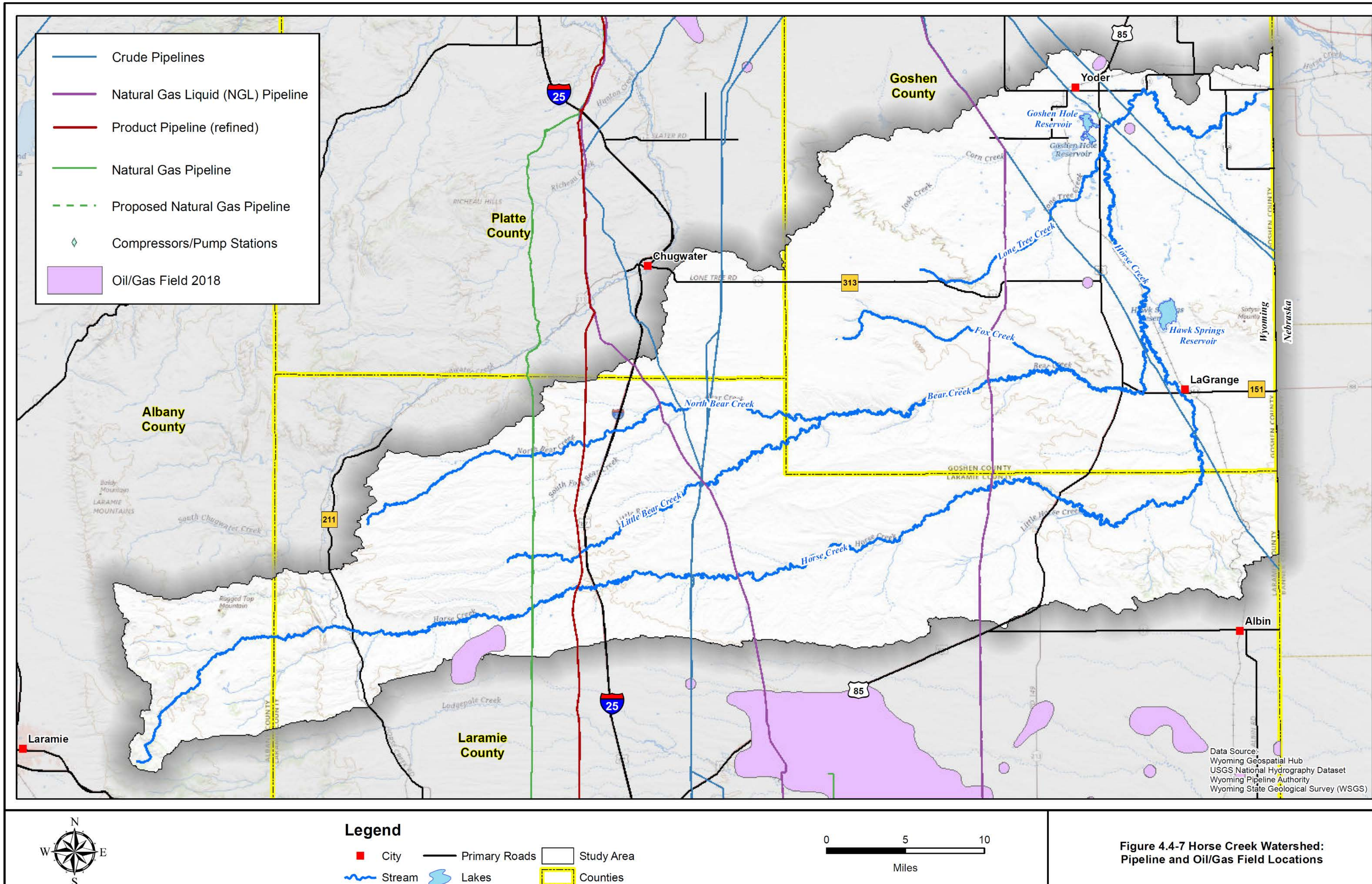


Figure 4.4-7 Horse Creek Watershed: Pipeline and Oil/Gas Field Locations

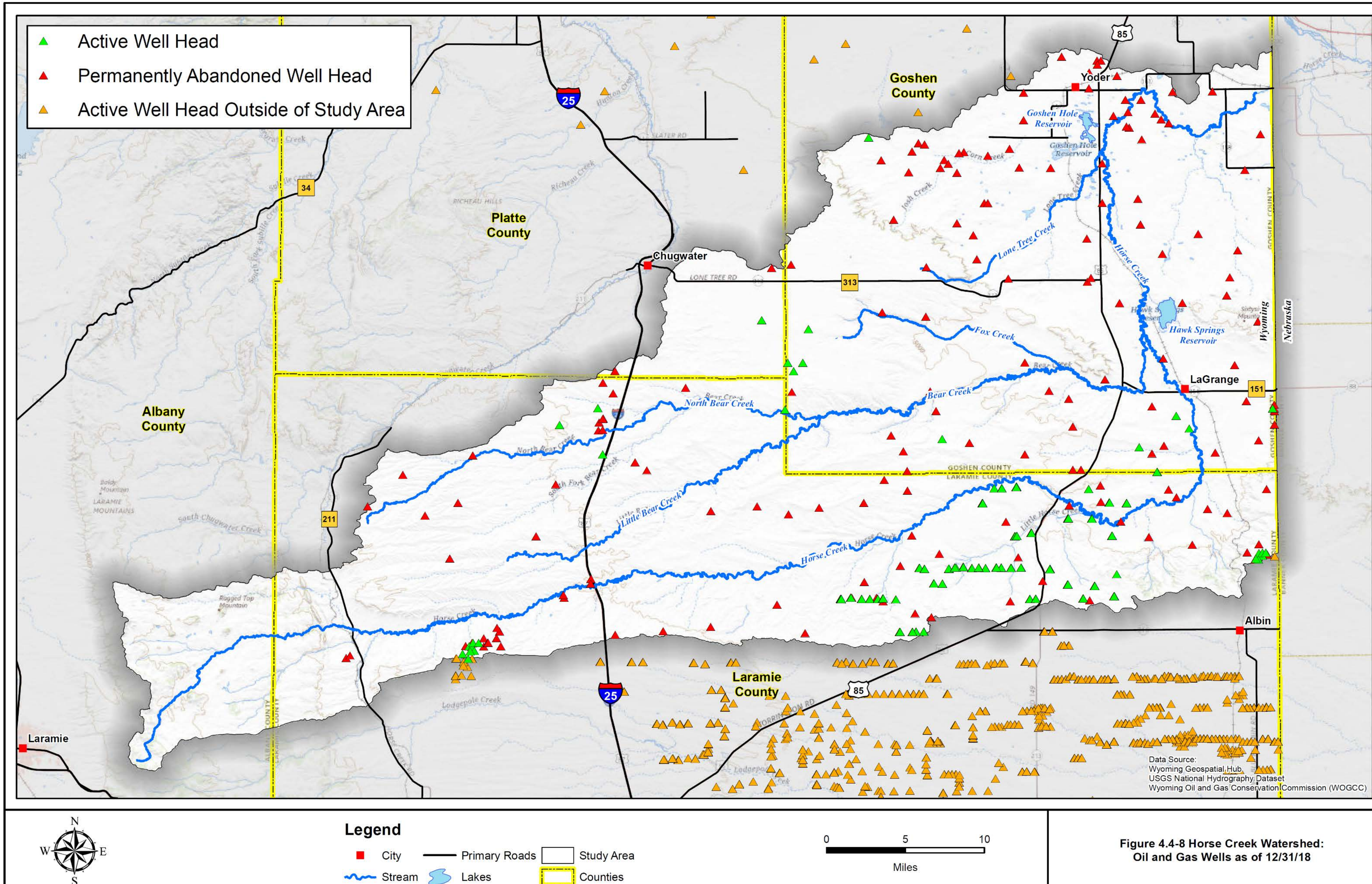


Figure 4.4-8 Horse Creek Watershed: Oil and Gas Wells as of 12/31/18

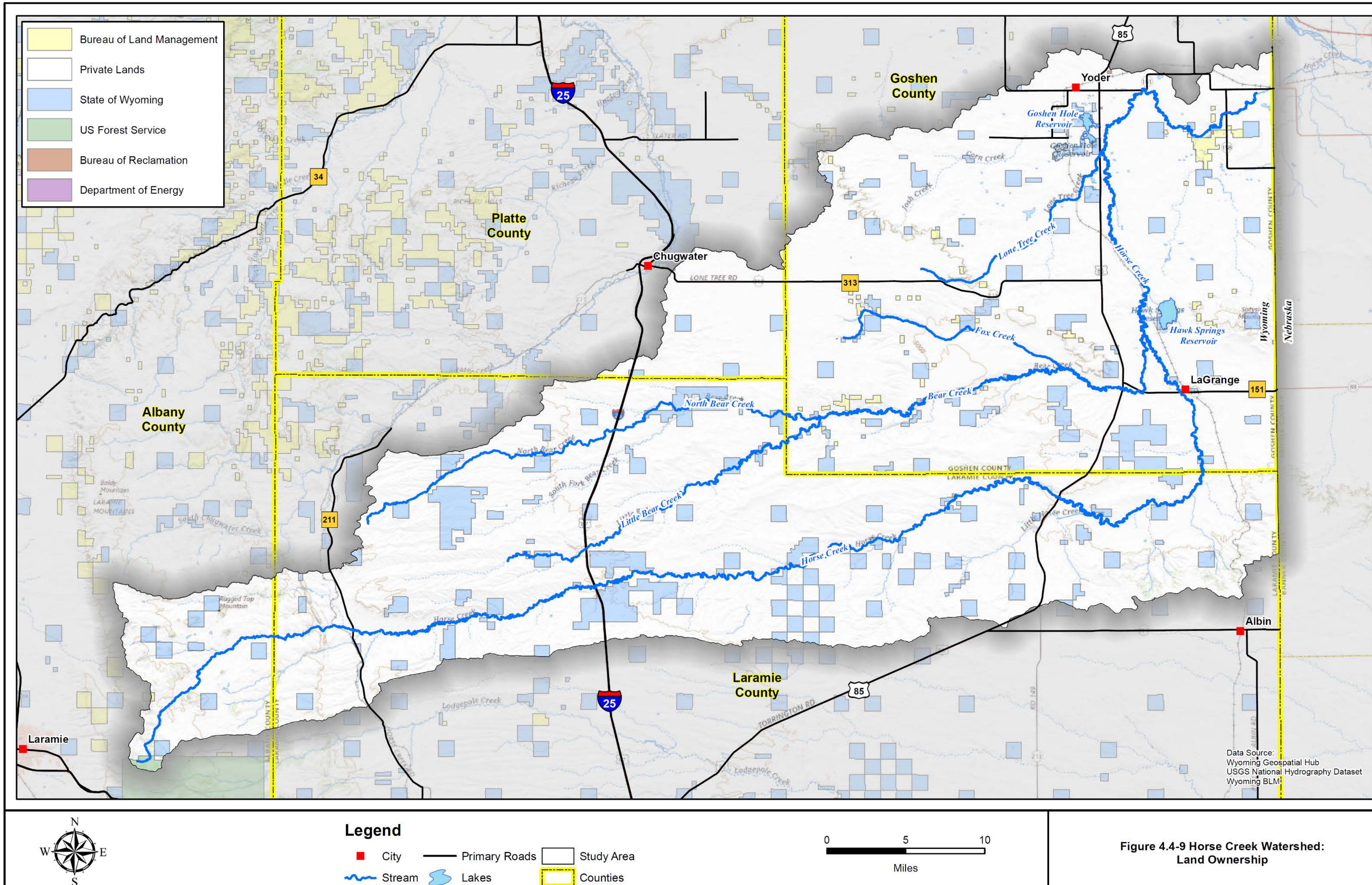


Figure 4.4-9 Horse Creek Watershed: Land Ownership

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 4.4-11):

- Private Lands: 1,462 square miles (90.0 percent of the study area),
- State of Wyoming: 150 square miles (9.2 percent of the study area),
- Bureau of Land Management: 8.2 square miles (0.5 percent of the study area),
- Water bodies: 3 square miles (0.2 percent of the study area),
- United States Forest Service: 1.5 square miles (<0.1 percent of the study area),
- Bureau of Reclamation: 0.1 square miles (<0.1 percent of the study area),
- Department of Energy: 0.01 square miles (<0.1 percent of the study area).

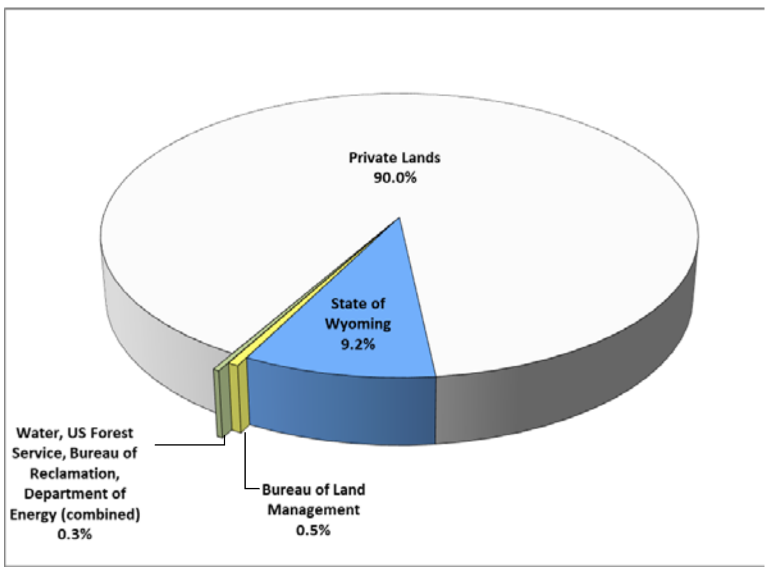


Figure 4.4-11 Distribution of Land Ownership within the Horse Creek Study Area.

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 (90 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 1,039,966 million acres within this study area, over 935,677 acres are privately owned, 98,023 acres are managed by the State, and 6,266 acres are under Federal management. Significant portions of this land base is 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 4.3-5. Federal land grazing is managed under the Federal Land Policy and Management Act of 1976 and the Taylor Grazing Act of 1934.

There are 28 BLM grazing allotments in the study area. 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 2 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.

Ecological Site Descriptions

The concept of "Ecological Sites" is described by the NRCS as follows:

> *"A distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation, and in its ability to respond similarly to management actions and natural disturbances."*

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); and
- 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 site. 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.

ESD reports are available from the NRCS that describe the following for each Ecological Site:

- Site Characteristics: Identifies the site and describes the physiographic, climate, soil, and water features associated with the site.
- Plant Communities: Describes the ecological dynamics and the common plant communities comprising the various vegetation states of the site. The disturbances that cause a shift from one state to another are also described.
- Site Interpretations: Interpretive information pertinent to the use and management of the site and its related resources.
- Supporting Information: Provides information on sources of information and data utilized in developing the site description and the relationship of the site to other ecological sites (NRCS, 2009).

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 4.4-12 displays the ecological precipitation zones found in the watershed.

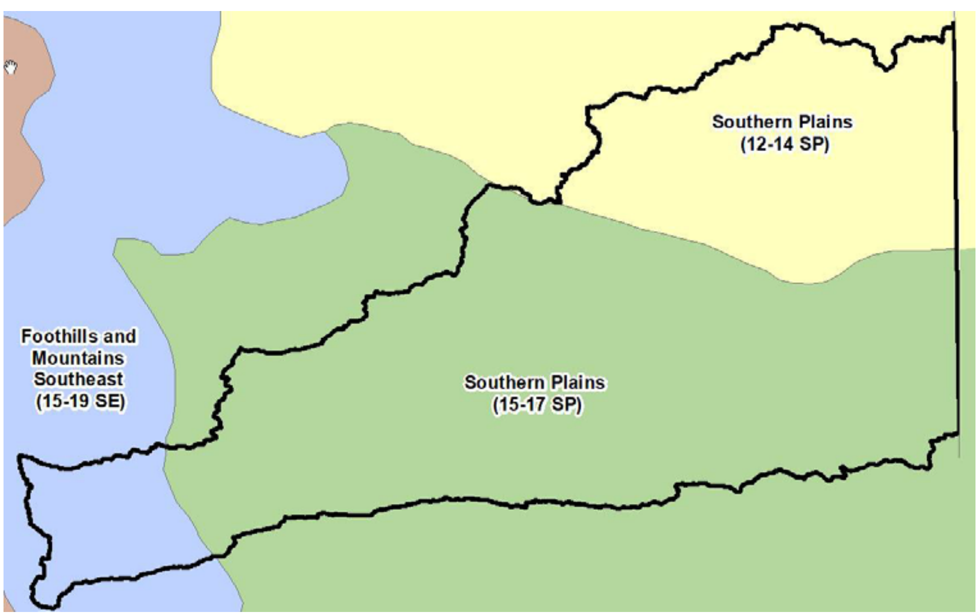


Figure 4.4-12 Ecological Precipitation Zones.

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. Figure 4.4-13 displays the locations of the major ecological sites where the 1:24,000 soils mapping was available.

Table 4.4-5 Ecological Site Descriptions within the Horse Creek Watershed.

Ecological Site ID	Ecological Site Name	Acres	Percent of Watershed
R067AY150WY	SANDY (12-17SP)	237,067	22.80%
R067AY122WY	LOAMY (12-17SP)	142,809	13.73%
R067AY250WY	SANDY (15-17SP)	137,510	13.22%
R067AY222WY	LOAMY (15-17SP)	131,111	12.61%
N/A	No ESD Available	59,584	5.73%
R067AY266WY	SHALLOW SANDY (15-17SP)	52,801	5.08%
R049XA160WY	SHALLOW IGNEOUS (15-19SE)	40,141	3.86%
R067AY234WY	ROCKY HILLS (15-17SP)	32,428	3.12%
R067AY262WY	SHALLOW LOAMY (15-17SP)	24,243	2.33%
R067AY142WY	SALINE SUBIRRIGATED (12-17SP)	19,939	1.92%
R067AY276WY	VERY SHALLOW (15-17SP)	19,768	1.90%
R067AY246WY	SANDS (15-17SP)	19,387	1.86%
R049XA122WY	LOAMY (15-19SE)	15,683	1.51%
R067AY146WY	SANDS (12-17SP)	15,571	1.50%
R067AY120WY	LIMY UPLAND (12-17SP)	14,519	1.40%
R072XY111KS	SANDY PLAINS	11,445	1.10%
R067AY112WY	GRAVELLY (12-17SP)	8,846	0.85%
R067AY162WY	SHALLOW LOAMY (12-17SP)	8,559	0.82%
R067AY104WY	CLAYEY (12-17SP)	6,437	0.62%
R067AY274WY	SUBIRRIGATED (15-17SP)	5,021	0.48%
R067AY144WY	SALINE UPLAND (12-17SP)	4,389	0.42%
R067AY228WY	LOWLAND (15-17SP)	3,707	0.36%
R049XA174WY	SUBIRRIGATED (15-19SE)	3,667	0.35%
R067AY126WY	LOAMY OVERFLOW (12-17SP)	2,996	0.29%
R067AY204WY	CLAYEY (15-17SP)	2,995	0.29%
R067AY152WY	SANDY LOWLAND (12-17SP)	2,967	0.29%
R067AY166WY	SHALLOW SANDY (12-17SP)	2,634	0.25%
R049XA116WY	IGNEOUS (15-19SE)	2,544	0.24%
R067AY102WY	CHOPPY SANDS (12-17SP)	2,534	0.24%
R072XY100KS	LOAMY TABLELAND	2,214	0.21%
R067AY242WY	SALINE SUBIRRIGATED (15-17SP)	2,057	0.20%
R049XA162WY	SHALLOW LOAMY (15-19SE)	1,599	0.15%
R067AY212WY	GRAVELLY (15-17SP)	1,148	0.11%
R049XA108WY	COARSE UPLAND (15-19SE)	479	0.05%
R067AY124WY	LOAMY LOWLAND (12-17SP)	464	0.04%
R058BY150WY	SANDY (10-14 NP)	370	0.04%
R067AY176WY	VERY SHALLOW (12-17SP)	207	0.02%
R034AY334WY	ROCKY HILLS (10-14SE)	98	0.01%
R034AY322WY	LOAMY (10-14SE)	12	0.001%

Four predominant ESDs cover approximately 62 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 237,000 acres (22.8%) of the study area.

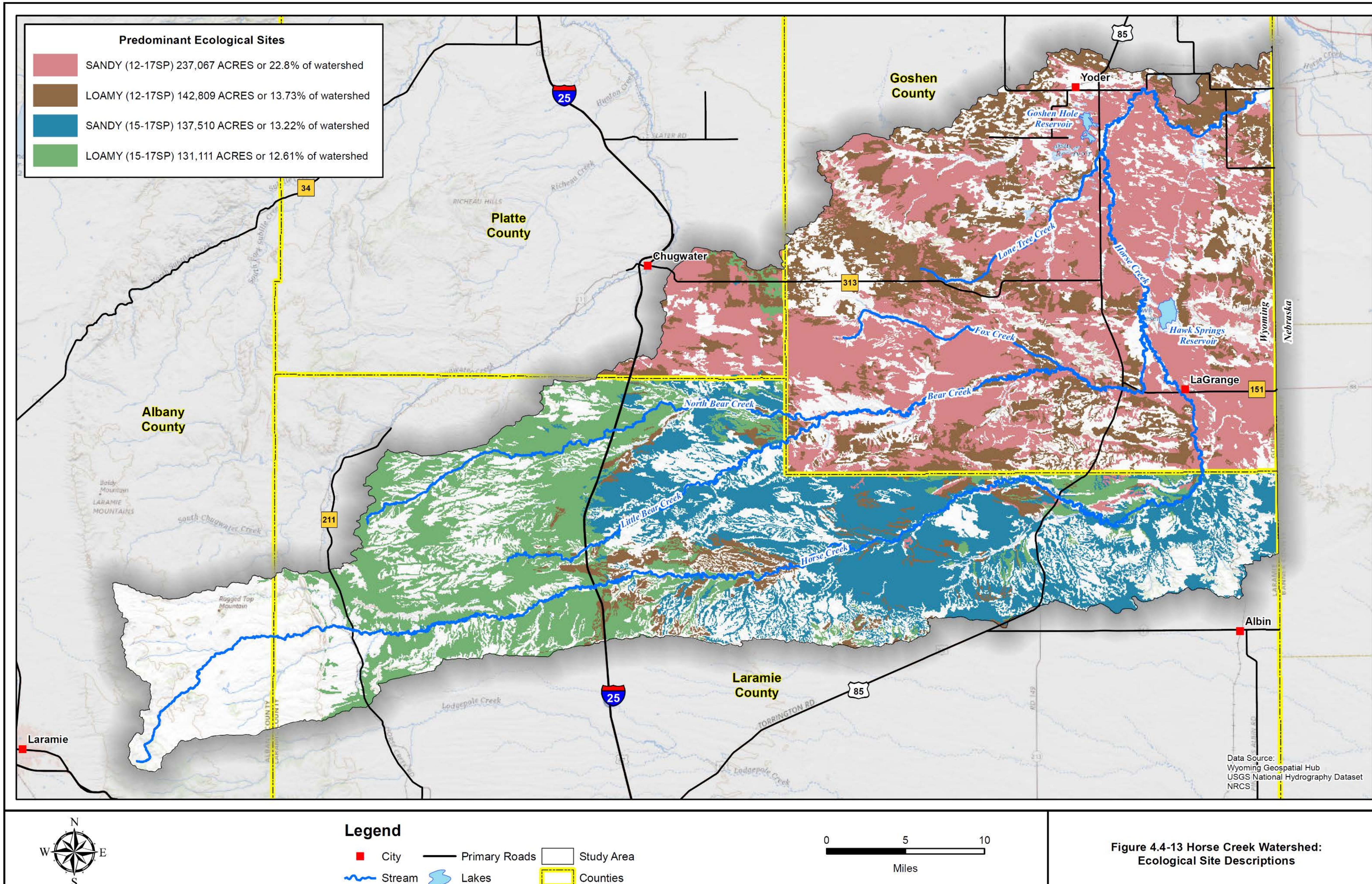


Figure 4.4-13 Horse Creek Watershed: Ecological Site Descriptions

2. **Loamy (Ly) 12 – 17-inch Central High Plains**, **Northern Part** (R067AY122WY) covers approximately 143,000 acres (13.7%) of the study area.

3. **Sandy (Sy) 15 – 17-inch Central High Plains**, **Northern Part** (R067AY250WY) covers approximately 138,000 acres (13.2%) of the study area.

4. **Loamy (Ly) 15 – 17-inch Central High Plains**, **Northern Part** (R067AY222WY) covers approximately 131,000 acres (12.6%) of the study area.

Appendix 4G contains the plant community descriptions that were available for 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.

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, only 1 site within the study area has been included in the National Register. The Dereemer Ranch Historic District (Reference Number: 83004290) is located near the headwaters of Horse Creek. A full description of this site is available from the National Park Service website located at: *http://npgallery.nps.gov/nrhp/*.

The BLM has mapped the historic trails in Wyoming. The Cheyenne-Deadwood State Road runs along the western portion of the watershed, roughly parallel with present-day I-25. The Texas Trail passes through the eastern portion of the watershed, roughly parallel with present-day US-85.

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/

V. TASK 4: SURFACE HYDROLOGY

5.1 Overview

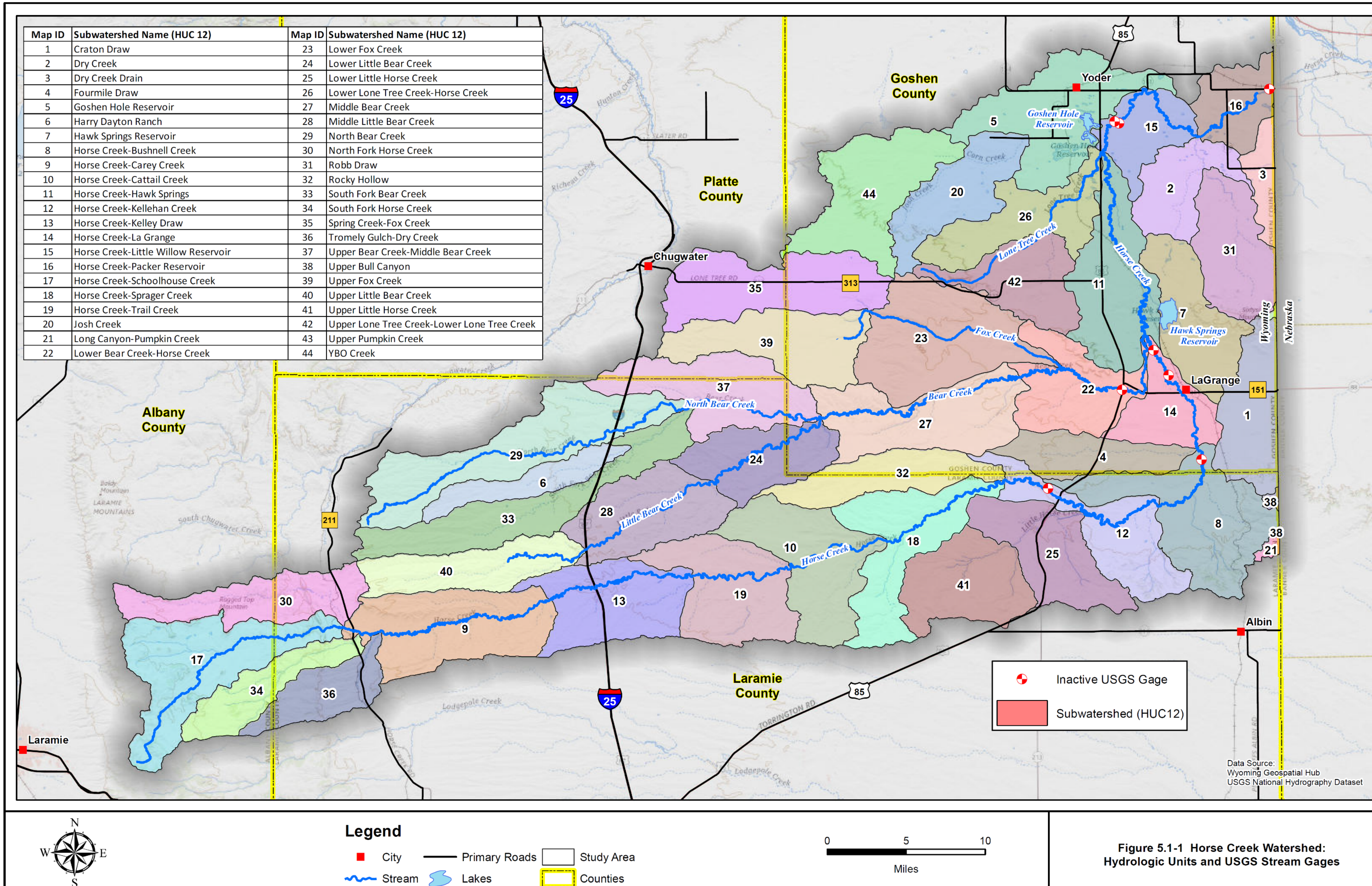
The USGS has assigned watersheds in the United States with numeric identifiers called Hydrologic Unit Codes, or HUCs. According to the USGS, "The United States is divided and sub divided into successively smaller hydrologic units which are classified into four levels: regions, sub-regions, accounting 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 Horse Creek tributaries: Josh Creek.

Region:	10 Missouri	(Second order HUC)
Subregion:	1018 North Platte	(Fourth Order HUC)
Accounting Unit:	101800 North Platte	(Sixth Order HUC)
Cataloging Unit:	10180012 Horse Creek	(Eighth Order HUC)
Sub-basin:	1018001206 Lower Horse Creek	(Tenth Order HUC)
Sub-basin:	101800120605 Josh Creek	(Twelfth Order HUC)

The Horse Creek watershed study area was defined primarily by the eighth order HUC, 10180012 Horse Creek, while the southwest portion of the study area is in 10180013 Pumpkin Creek. 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.



Map ID	Subwatershed Name (HUC 12)	Map ID	Subwatershed Name (HUC 12)
1	Craton Draw	23	Lower Fox Creek
2	Dry Creek	24	Lower Little Bear Creek
3	Dry Creek Drain	25	Lower Little Horse Creek
4	Fourmile Draw	26	Lower Lone Tree Creek-Horse Creek
5	Goshen Hole Reservoir	27	Middle Bear Creek
6	Harry Dayton Ranch	28	Middle Little Bear Creek
7	Hawk Springs Reservoir	29	North Bear Creek
8	Horse Creek-Bushnell Creek	30	North Fork Horse Creek
9	Horse Creek-Carey Creek	31	Robb Draw
10	Horse Creek-Cattail Creek	32	Rocky Hollow
11	Horse Creek-Hawk Springs	33	South Fork Bear Creek
12	Horse Creek-Kellehan Creek	34	South Fork Horse Creek
13	Horse Creek-Kelley Draw	35	Spring Creek-Fox Creek
14	Horse Creek-La Grange	36	Tromely Gulch-Dry Creek
15	Horse Creek-Little Willow Reservoir	37	Upper Bear Creek-Middle Bear Creek
16	Horse Creek-Packer Reservoir	38	Upper Bull Canyon
17	Horse Creek-Schoolhouse Creek	39	Upper Fox Creek
18	Horse Creek-Sprager Creek	40	Upper Little Bear Creek
19	Horse Creek-Trail Creek	41	Upper Little Horse Creek
20	Josh Creek	42	Upper Lone Tree Creek-Lower Lone Tree Creek
21	Long Canyon-Pumpkin Creek	43	Upper Pumpkin Creek
22	Lower Bear Creek-Horse Creek	44	YBO Creek

Figure 5.1-1 Horse Creek Watershed: Hydrologic Units and USGS Stream Gages

Table 5.1-1 Horse Creek Watershed Study: Hydrologic Unit Code Breakdown.

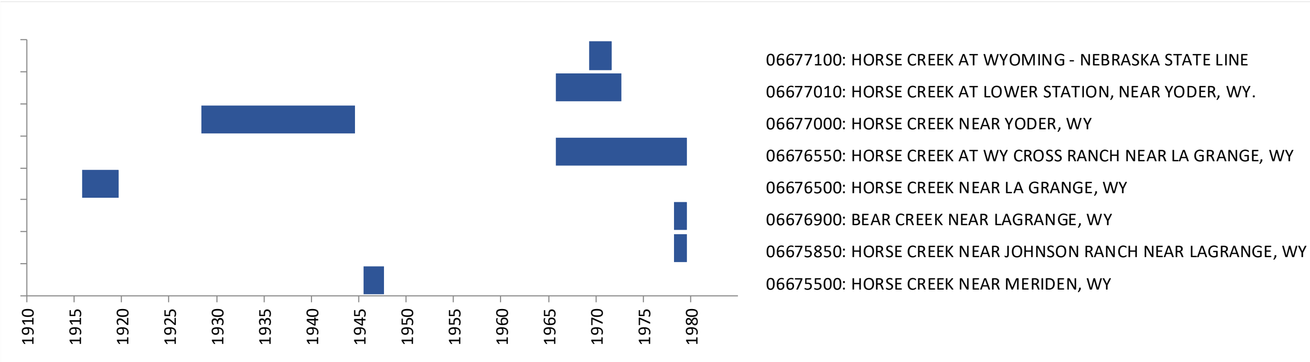
HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10		HUC 12	
				Number	Name	Number	Name
Region 10: Missouri	Subregion 1018: North Platte	Accounting Unit 101800: North Platte	Cataloging Unit 10180012: Horse	1018001201	Upper Horse Creek	101800120101	Horse Creek-Schoolhouse Creek
						101800120102	North Fork Horse Creek
						101800120103	Horse Creek-Carey Creek
						101800120104	South Fork Horse Creek
						101800120105	Tromely Gulch-Dry Creek
						101800120106	Horse Creek-Kelley Draw
						101800120107	Horse Creek-Trail Creek
						101800120108	Horse Creek-Cattail Creek
				1018001202	Middle Horse Creek	101800120201	Horse Creek-Sprager Creek
						101800120202	Rocky Hollow
						101800120203	Horse Creek-Kellehan Creek
						101800120204	Upper Little Horse Creek
						101800120205	Lower Little Horse Creek
						101800120206	Horse Creek-Bushnell Creek
						101800120207	Fourmile Draw
						101800120208	Horse Creek-La Grange
				1018001203	Bear Creek	101800120301	South Fork Bear Creek
						101800120302	Harry Dayton Ranch
						101800120303	North Bear Creek
						101800120304	Upper Bear Creek-Middle Bear Creek
						101800120305	Middle Bear Creek
						101800120306	Lower Bear Creek-Horse Creek
				1018001204	Little Bear Creek	101800120401	Upper Little Bear Creek
						101800120402	Middle Little Bear Creek
						101800120403	Lower Little Bear Creek
				1018001205	Fox Creek	101800120501	Upper Fox Creek
						101800120502	Spring Creek-Fox Creek
						101800120503	Lower Fox Creek
				1018001206	Lower Horse Creek	101800120601	Horse Creek-Hawk Springs
						101800120602	Upper Lone Tree Creek-Lower Lone Tree Creek
						101800120603	Lower Lone Tree Creek-Horse Creek
						101800120604	Horse Creek-Little Willow Reservoir
						101800120605	Josh Creek
						101800120606	YBO Creek
						101800120607	Goshen Hole Reservoir
						101800120608	Hawk Springs Reservoir
						101800120609	Dry Creek
						101800120610	Robb Draw
						101800120611	Horse Creek-Packer Reservoir
				1018001207	Kiowa Creek	101800120703	Dry Creek Drain
			Cataloging Unit 10180013: Pumpkin	1018001301	Pumpkin Creek	101800130101	Craton Draw
						101800130102	Upper Pumpkin Creek
						101800130103	Upper Bull Canyon
						101800130104	Long Canyon-Pumpkin Creek

5.2 Surface Hydrology

5.2.1 Summary of Existing Data

There are currently no active USGS stream gaging stations within the watershed (Figure 5.1-1). As indicated in Figure 5.2-1, historically, eight gages have been active. However, all of the gages have been discontinued by the USGS (the last one being discontinued in 1979). 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.

Mean monthly discharges were computed using the available data from two inactive gages in the Horse Creek watershed (USGS Gages 06677000 and 06676550) and are presented in Table 5.2-2. The mean annual hydrographs for Horse Creek shown in Figure 5.2-2 show evidence of heavy irrigation during the growing season, with streamflows dropping below 10 cfs from July to September. Recorded streamflows were generally higher for the La Grange station, since many diversions exist between La Grange and Yoder.



Site Number	Site Name	Site Status	Beginning	End	Drainage Area (sq. miles)	Gauge Elevation (ft, NGVD29)
06677100	HORSE CREEK AT WYOMING - NEBRASKA STATE LINE	Inactive	5/1/1969	9/30/1971	1530	1490
06677010	HORSE CREEK AT LOWER STATION, NEAR YODER, WY.	Inactive	10/1/1965	10/13/1972	1320	4230
06677000	HORSE CREEK NEAR YODER, WY	Inactive	5/1/1928	9/30/1944	1347	4235
06676550	HORSE CREEK AT WY CROSS RANCH NEAR LA GRANGE, WY	Inactive	10/1/1965	9/30/1979	680	4490
06676500	HORSE CREEK NEAR LA GRANGE, WY	Inactive	10/1/1915	9/30/1919	645	4500
06676900	BEAR CREEK NEAR LAGRANGE, WY	Inactive	3/13/1978	9/30/1979	N/A	4600
06675850	HORSE CREEK NEAR JOHNSON RANCH NEAR LAGRANGE, WY	Inactive	3/13/1978	9/30/1979	N/A	4650
06675500	HORSE CREEK NEAR MERIDEN, WY	Inactive	7/1/1945	9/30/1947	425	N/A

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
0102HRCK	Horse Creek at Goshen-Laramie CO. Line	Division 1 / District 02	11/20/2013
0102HC1D	Horse Creek #1 Ditch	Division 1 / District 02	12/29/1899
010266RS	66 Reservoir Supply Ditch	Division 1 / District 02	12/29/1899
0102HS1N	Hawk Springs Reservoir Supply Ditch	Division 1 / District 02	12/29/1899
0102HSPR	Hawksprings Reservoir	Division 1 / District 02	8/1/2011
0102HSPO	Hawksprings Reservoir Outflow	Division 1 / District 02	8/1/2011
0102HUGH	Hughes Ditch	Division 1 / District 02	12/29/1899
0102GOSH	Goshen Reservoir Supply Ditch	Division 1 / District 02	12/29/1899
0102HRES	Hughes Reservoir Supply Ditch	Division 1 / District 02	12/29/1899
0102SPIN	Goshen Hole Reservoir Supply Ditch	Division 1 / District 02	12/29/1899
0102BOUT	Goshen Reservoir Outlet	Division 1 / District 02	12/29/1899

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

USGS Gage	HORSE CREEK NEAR YODER, WY	HORSE CREEK AT WY CROSS RANCH NEAR LA GRANGE, WY
USGS ID	06677000	06676550
Calculation Period	5/1/1928 to 9/3/1944	10/1/1965 to 9/3/1979
Month	**Mean Stream Discharge (cfs)**	
Jan	24	34
Feb	27	40
Mar	29	36
Apr	22	37
May	16	38
Jun	12	33
Jul	1.2	9.6
Aug	4.8	5.4
Sep	6.6	8.4
Oct	9.4	12
Nov	28	19
Dec	32	29

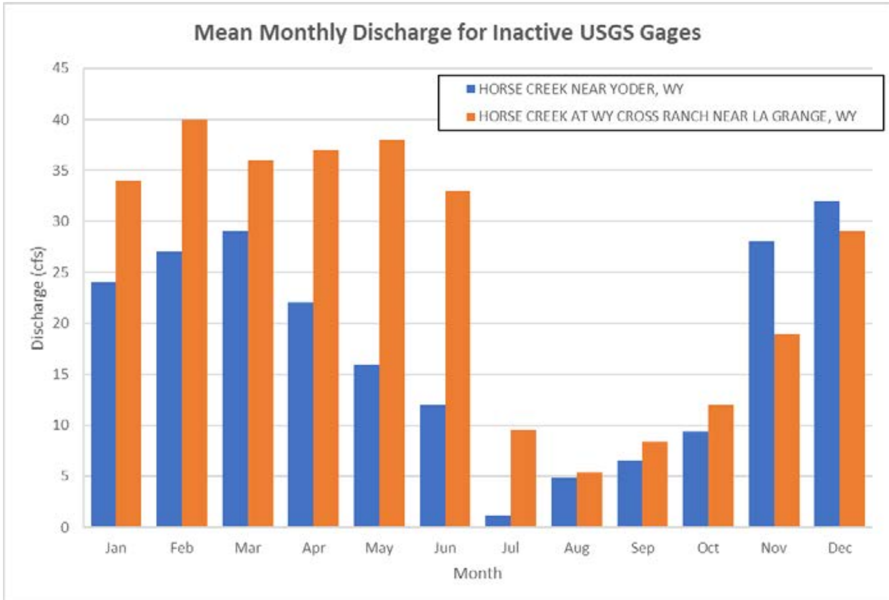


Figure 5.2-2 Mean Monthly Discharge at USGS Stream Gages in Horse Creek Watershed.

Horse Creek was not originally included in the North Platte Decree, because it enters the North Platte below the Tri-State Dam where canals are "well supplied from return flows and other local sources" (Doherty, 1943). The report, "Water Rights, Streamflow, and Hydrogeology of the Horse Creek Basin, Wyoming" (Hinkley, 1998) was prepared for the Attorney General's Office to investigate the contribution of Horse Creek to the flows of the North Platte River. It was determined that the "Ft. Laramie Canal effectively divides the basin into largely disconnected upper and lower basins", and that "Horse Creek flows at Lyman are dominated by irrigation return flows from below the Ft. Laramie Canal and do not reflect the hydrology of the 'Horse Creek basin'" (Hinkley, 1998). It was also found that "very little, if any, water passes the siphon at the Ft. Laramie Canal," and thus, "the Horse Creek basin above the Fort Laramie Canal makes no substantial contribution to the flow of the North Platte River" (Hinkley, 1998). Other conclusions from this 1998 report include:

- *"The Horse Creek streamflows at Lyman have been increasing since entry of the 1945 North Platte Decree.*
- *There is no evidence in the streamflows at Lyman of the flow depletions alleged by Nebraska.*
- *The Horse Creek streamflows at Lyman are not strongly correlated with precipitation, contrary to what would be expected if the upper Horse Creek basin runoff were a large contribution to lower basin flows.*
- *Main canal waste from Goshen Irrigation District has been increasing since 1945.*
- *There is, and has been historically, little contribution from upper Horse Creek (above the Ft. Laramie Canal siphon) to lower Horse Creek."*

5.2.2 Mean Annual Discharge Estimation

Mean annual discharge was also computed for each of the 44 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 Phillips, La Grange, and Yoder climate stations, the annual precipitation recorded within the last 40 years was sorted and divided into "wet" (top 20%), "dry" (bottom 20%), and "normal" (middle 60%) years. Figures 5.2-4 through 5.2-6 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.

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 44 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. 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 to complete the analysis (10 years). 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 5.2-7 displays the results of the analysis for the USGS Gage 06676550 Horse Creek at WY Cross Ranch near LaGrange, WY. Figure 5.2-8 displays the results of the analysis for the USGS Gage 06677000 Horse Creek Near Yoder, WY. Appendix 5C contains all of the results.

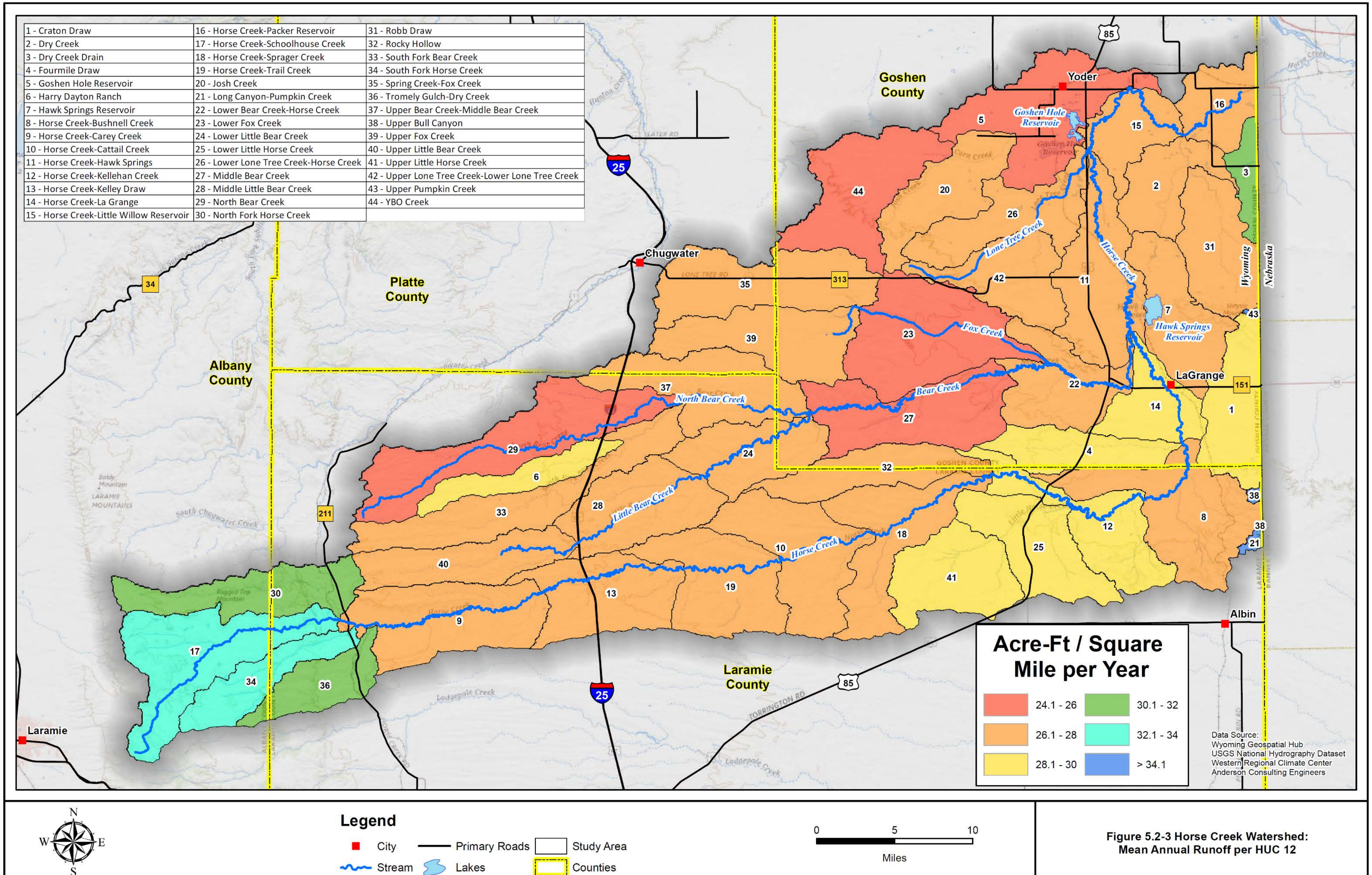


Figure 5.2-3 Horse Creek Watershed: Mean Annual Runoff per HUC 12

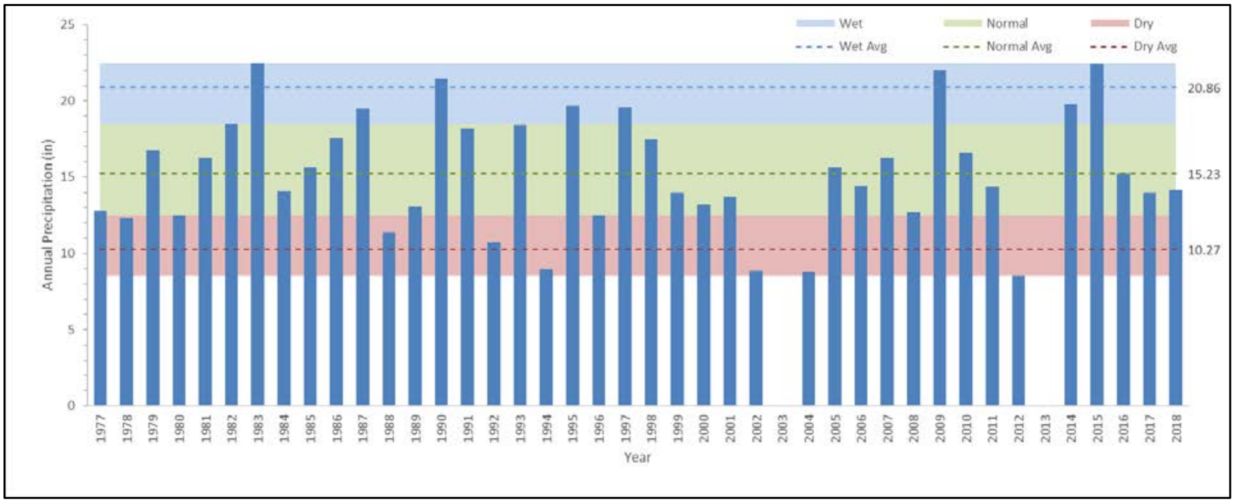


Figure 5.2-4 Phillips, WY Station (1977-2018) – Wet/Dry Classification.

Figure 5.2-5 La Grange, WY Station (1970-2009) – Wet/Dry Classification.

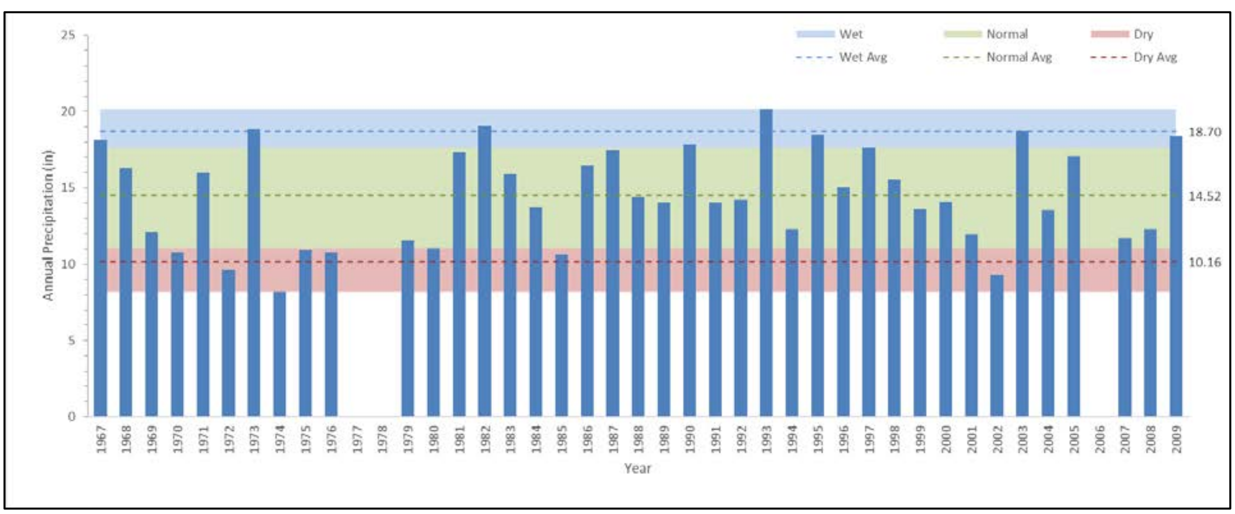
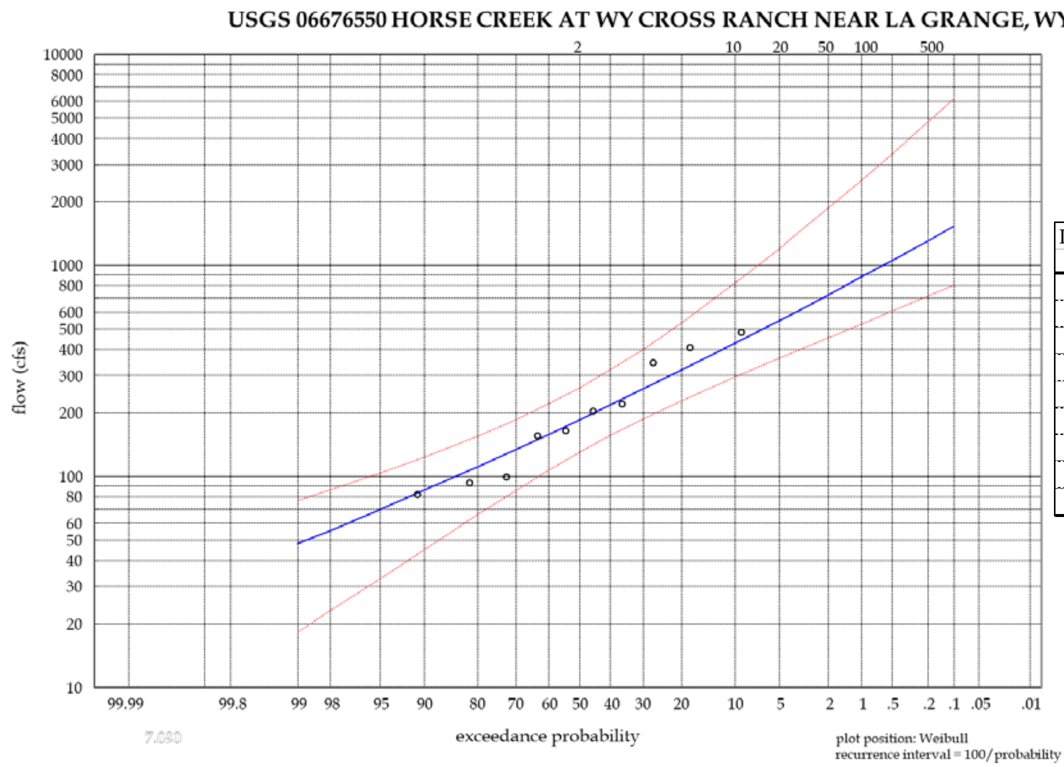
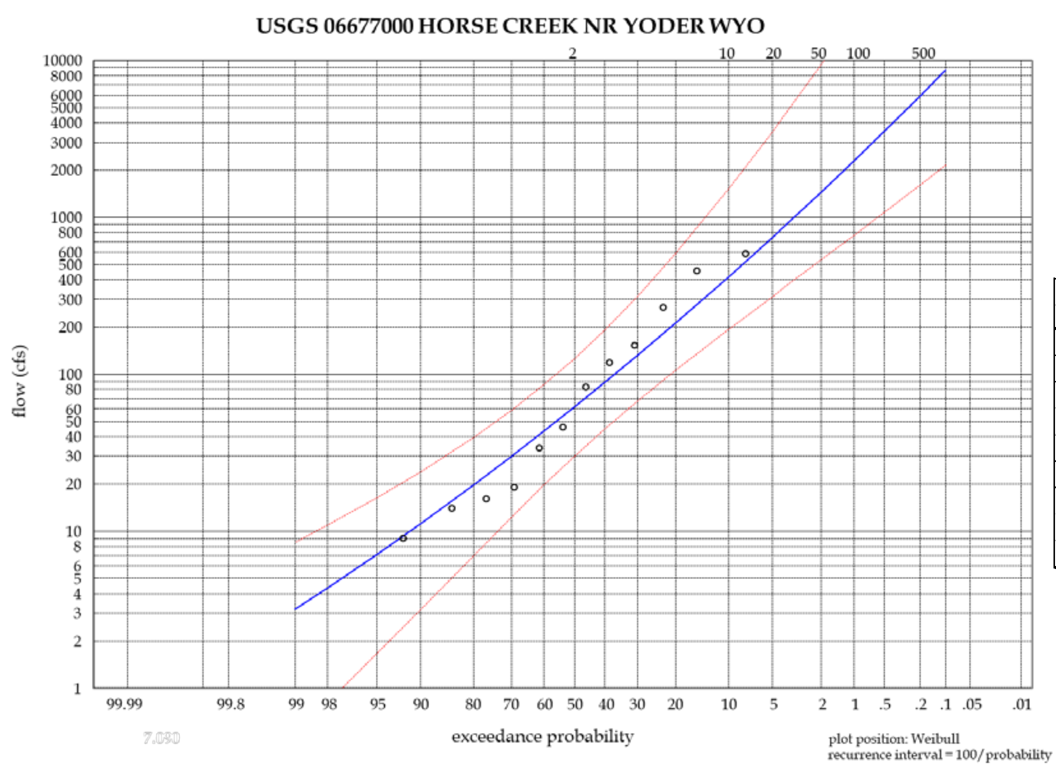


Figure 5.2-6 Yoder 4 SW, WY Station (1967-2009) – Wet/Dry Classification.



Recurrence (years)	Q (cfs)
500	1,317
200	1,056
100	882
50	727
25	589
20	547
10	427
5	319
2	186

Figure 5.2-7 Flood Frequency Analysis: USGS Gage 06676550.



Recurrence (years)	Q (cfs)
500	5,959
200	3,514
100	2,293
50	1,451
25	882
20	743
10	417
5	212
2	62

Figure 5.2-8 Flood Frequency Analysis: USGS Gage 06677000.

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.

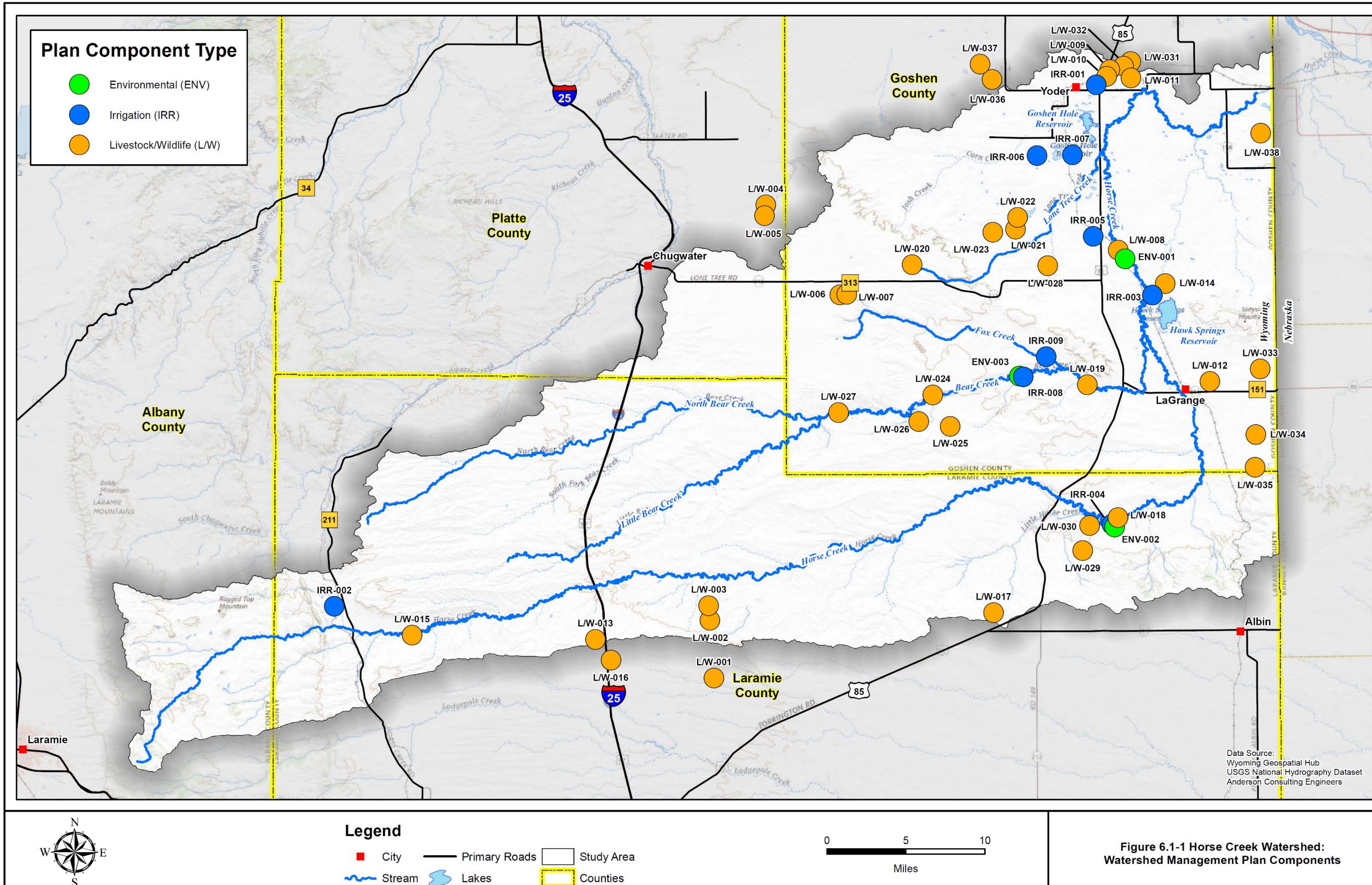


Figure 6.1-1 Horse Creek Watershed: Watershed Management Plan Components

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, Horse Creek 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 to varying degree:

- Modified North Platte Decree (2001)
- 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:

- 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.
- Permits for stock and domestic wells (<25 gpm) are generally obtained without difficulty, require no mitigation by the applicant under the PRRIP, and only come under PRRIP jurisdiction at all below the Fort Laramie Canal and in a narrow band along Horse Creek between Hawk Springs Reservoir to the Fort Laramie Canal.
- New permits in the LaGrange Aquifer for anything other than stock and domestic use are precluded by the Horse Creek Order.
- 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 seasonality of use.
- Questions about how to obtain a new water right or to make significant changes to an existing water right should be directed to the Wyoming Board of Control - Division 1 in Torrington, and for water rights potentially associated with the North Platte Decree of the PRRIP, 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.

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 Horse Creek Watershed Plan: Irrigation Components.

Horse Creek Watershed Management Plan			
Watershed Management Plan Component	**Watershed Management Plan Component**	**County**	**Project Name**
Irrigation Components			
IRR-001	Alps-001	Goshen	Alps Ditch Conversion Project
IRR-002	Christofferson-001	Laramie	Christofferson Ditch Diversion Reconstruction
IRR-003	Davis-002	Goshen	Davis Pipeline Project
IRR 004	Frank-001	Goshen	Scoon Ditch Diversion Rehabilitation Project
IRR-005	Hanlon-001	Goshen	Schwab Ditch Conversion Project
IRR-006	Sipola-001	Goshen	Sipola Ditch Conversion Project
IRR-007	Tomayer-001	Goshen	Tomayer Pipeline Project
IRR-008	Thaler-002	Goshen	Bear Creek Ditch Measurement Device
IRR-009	Thaler-001	Goshen	Fox Creek Diversion Structure

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.

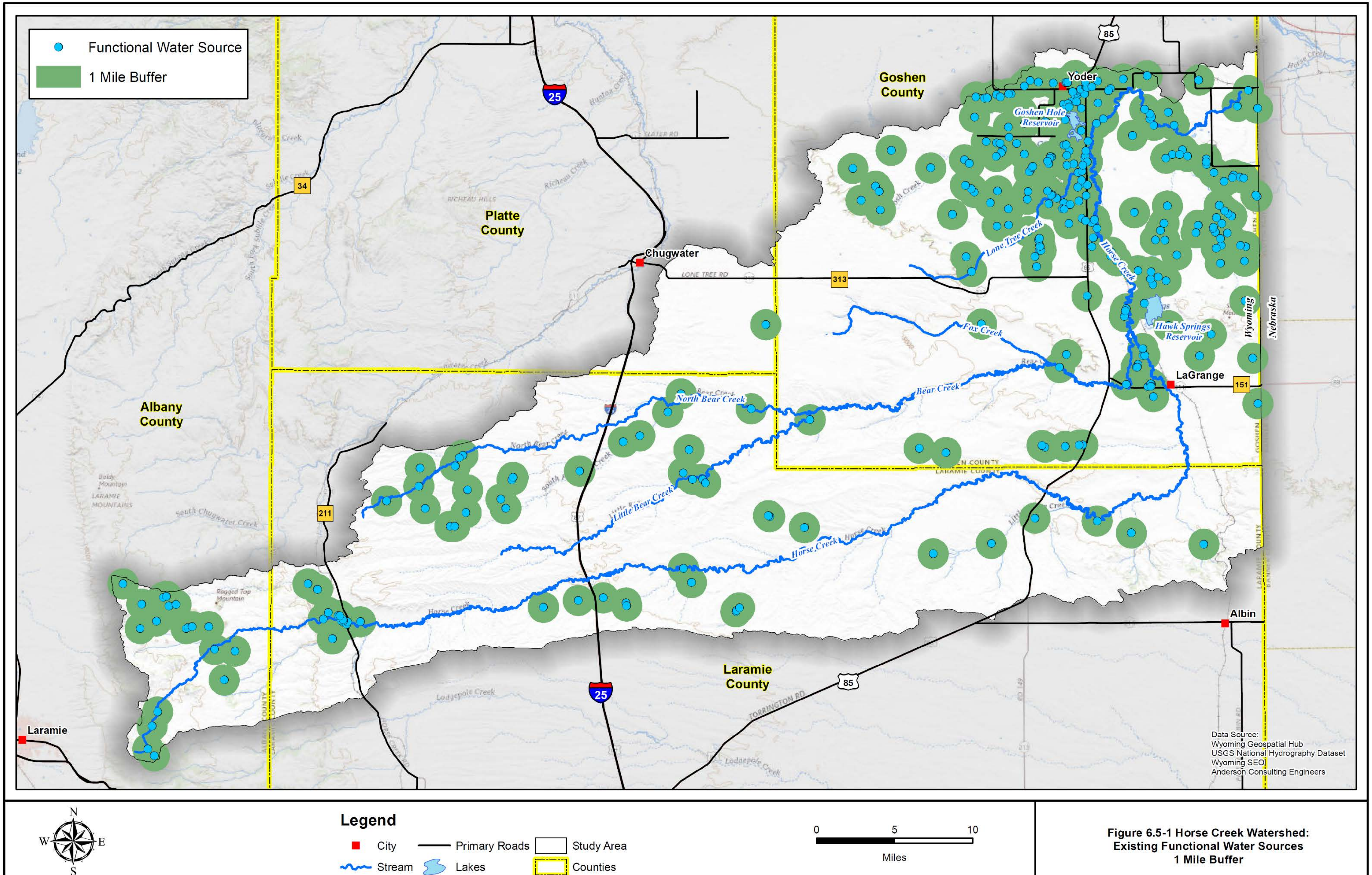


Figure 6.5-1 Horse Creek Watershed: Existing Functional Water Sources 1 Mile Buffer

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 Horse Creek 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 Horse Creek Watershed Plan: Livestock/Wildlife Water Supply Components.

Horse Creek Watershed Management Plan			
Watershed Management Plan Component	Watershed Management Plan Component	County	Project Name
HC ENV-001	Buchaults-002	Goshen	Buchaults Check Structure - Horse Creek
HC ENV-002	Frank-002	Goshen	Horse Creek Bank Stabilization Project
HC ENV-003	Kessler-001	Goshen	Bear Creek Sedimentation Project
Irrigation Components			
IRR-001	Alps-001	Goshen	Alps Ditch Conversion Project
IRR-002	Christofferson-001	Laramie	Christofferson Ditch Diversion Reconstruction
IRR-003	Davis-002	Goshen	Davis Pipeline Project
IRR 004	Frank-001	Goshen	Scoon Ditch Diversion Rehabilitation Project
IRR-005	Hanlon-001	Goshen	Schwab Ditch Conversion Project
IRR-006	Sipola-001	Goshen	Sipola Ditch Conversion Project
IRR-007	Tomayer-001	Goshen	Tomayer Pipeline Project
IRR-008	Thaler-002	Goshen	Bear Creek Ditch Measurement Device
IRR-009	Thaler-001	Goshen	Fox Creek Diversion Structure
Livestock / Wildlife Water Supply Projects			
L/W-001	Berry 001	Laramie	Berry Well Construction Project No. 1
L/W-002	Berry 002	Laramie	Berry Well Construction Project No. 2
L/W-003	Berry 003	Laramie	Berry Well Rehabilitation Project
L/W-004	Borchardt-001	Laramie	Borchardt Solar Platform Instatllation
L/W-005	Borchardt-002	Laramie	Borchardt Pipeline Extension Project
L/W-006	Borchardt-003	Laramie	Borchardt Stock Tank Project
L/W-007	Borchardt-004	Laramie	Borchardt Spring Development Project
L/W-008	Buchaults-001	Goshen	Buchaults Pipeline Project
L/W-009	Cecil-001	Goshen	Cecil Well Construction Project
L/W-010	Cecil-002	Goshen	Cecil Pipeline Project No. 1
L/W-011	Cecil-003	Goshen	Cecil Pipeline Project No. 2
L/W-012	Chamberlain-001	Goshen	Chamberlain Pipeline Project
L/W-013	Clark-001	Laramie	Clark Well Construction
L/W-014	Davis-001	Goshen	Davis Stock Reservoir Rehabilitation
L/W-015	Dereemer-001	Laramie	Dereemer Pipeline Project
L/W-016	Drake-001	Laramie	Drake Well Construction Project
L/W-017	Eklund-001	Laramie	Eklund Solar Platform / Pipeline Project
L/W-018	Frank-003	Goshen	Frank Pipeline Project
L/W-019	Grandstaff-001	Goshen	Grandstaff Pipeline Project
L/W-020	Jackson-001	Goshen	Jackson Pipeline Project
L/W-021	Ruiz-001	Goshen	Ruiz Solar Platform Project
L/W-022	Ruiz-002	Goshen	Ruiz Pipeline Project No. 1
L/W-023	Ruiz-003	Goshen	Ruiz Pipeline Project No. 2
L/W-024	ScheerD-001	Goshen	Scheer D. Well Construction Project
L/W-025	ScheerD-002	Goshen	Scheer D. Solar Platform Project
L/W-026	ScheerJ-001	Goshen	Scheer J. Pipeline Project
L/W-027	ScheerJ-002	Goshen	Scheer J. Irrigation Pipeline Project
L/W-028	Shimic-001	Goshen	Shimic Stock Reservoir Project
L/W-029	Shoun-001	Goshen	Shoun Well Construction Project No. 1
L/W-030	Shoun-002	Goshen	Shoun Well Construction Project No. 2
L/W-031	Tomayer-002	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 1
L/W-032	Tomayer-003	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 2
L/W-033	Tremain-001	Goshen	Tremain Solar Platform Project No. 1
L/W-034	Tremain-002	Goshen	Tremain Solar Platform Project No. 2
L/W-035	Tremain-003	Goshen	Tremain Solar Platform Project No. 3
L/W-036	Yeik-001	Goshen	Yeik Pipeline Project No. 1
L/W-037	Yeik-002	Goshen	Yeik Pipeline Project No. 2
L/W-038	Zimmerer-001	Goshen	Zimmerer Spring Development

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

- The most productive aquifer in the Horse Creek watershed is created by the alluvial deposits combined with especially permeable zones of the underlying Brule Formation in the vicinity of LaGrange. This combination has come to be called "the LaGrange Aquifer" and is only present beneath approximately 25 square miles. However, this area is only open to future groundwater development under domestic and stock permits.
- Where alluvial deposits are sufficiently thick and saturated, successful development of substantial quantities of groundwater is possible. These deposits are confined to narrow bands along the perennial streams of the watershed.
- Over the wider area of the watershed, the highest groundwater potential is in the Arikaree Formation and Ogalalla Formations. In many areas of Ogalalla however, the outcrop formation may be at too high an elevation and too thin to be saturated, requiring well completion in the underlying Arikaree Formation.
- In the northeast portion of the watershed, groundwater development is likely restricted to relatively low-capacity wells and groundwater quality can be challenging. Best opportunities are in areas with active and nearby recharge from surface irrigation facilities and Horse Creek itself.
- Opportunities for development of small supplies of groundwater for uses without strong water-quality restrictions are widely available across the watershed, but cannot be specifically evaluated without site-specific data.
- Groundwater rights, active regulation, and user conflicts are a key consideration in the heavily-used LaGrange Aquifer, but are unlikely to significantly impact small-quantity uses developed across the wider Horse Creek landscape.
- Groundwater levels (and depth-to-water) in the Horse Creek watershed can be expected to fluctuate with long-term climate conditions, with the seasonal cycles of recharge, and in response to pumping, both of a well itself and of any neighboring wells. Well construction should take this into consideration and allow sufficient margin of drawdown to accommodate.

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 SGCD 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:

- Groundwater quality limitations vary widely depending on the intended use; groundwater unsuitable for one use may be perfectly 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. 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 4.2-10 (refer to Section 4.2 of this report) 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 4.2-10 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. (See the references section of this report, for example.)
- Throughout the Horse Creek watershed, younger strata are underlain by older strata (i.e. in the order listed in Appendix A, although all formations are not present at all locations). For example, a well drilled through the Ogalalla Formation, the youngest strata on Figure 2, would at most locations successively encounter the underlying Arikaree, Brule and Chadron Formations. Beneath those formations, the geology is complicated by the folding and faulting associated with the creation of the Laramie Range and subsequent erosion. 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. Any new storage development project would have a current day water right. Given the limited water supply and shortages discussed elsewhere in this report, any new storage project would likely be able to store only during wet years when flows may be available.

No storage projects were identified through the project scoping process or 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 515 miles of stream channel within the GIS environment
- Field reconnaissance to verify the classifications.

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.

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.

Table 6.7-1 Horse creek Watershed Plan: Environmental Components.

Horse Creek Watershed Management Plan			
Watershed Management Plan Component	Watershed Management Plan Component	County	Project Name
ENV-001	Buchaults-002	Goshen	Buchaults Check Structure - Horse Creek
ENV-002	Frank-002	Goshen	Horse Creek Bank Stabilization Project
ENV-003	Kessler-001	Goshen	Bear Creek Sedimentation Project

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.

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.

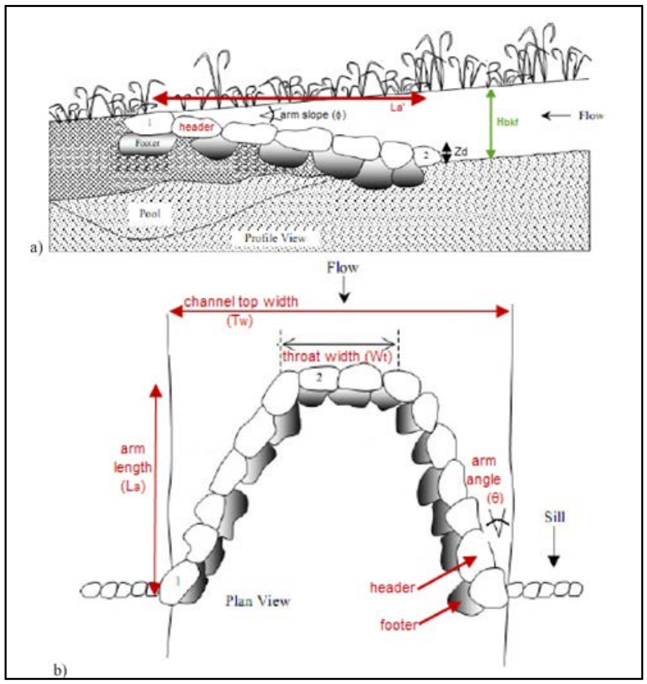


Figure 6.7-1 Rock Vortex Weir Structure Diagram (Adapted from Rosgen, 2006).

Figure 6.7-2 displays a photograph of a typical installation.

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 6.7-2 Stream Stabilization Structure: Rock Vortex Weir.

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.

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.

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

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 Horse Creek Watershed study area are likely to be the following:

1. **Sandy (Sy) 12 – 17-inch Central High Plains**, **Northern Part** (R067AY150WY) is the largest zone and covers approximately 237,000 acres (22.8%) of the study area.

2. **Loamy (Ly) 12 – 17-inch Central High Plains**, **Northern Part** (R067AY122WY) covers approximately 143,000 acres (13.7%) of the study area.

3. **Sandy (Sy) 15 – 17-inch Central High Plains**, **Northern Part** (R067AY250WY) covers approximately 138,000 acres (13.2%) of the study area.

4. **Loamy (Ly) 15 – 17-inch Central High Plains**, **Northern Part** (R067AY222WY) covers approximately 131,000 acres (12.6%) 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."

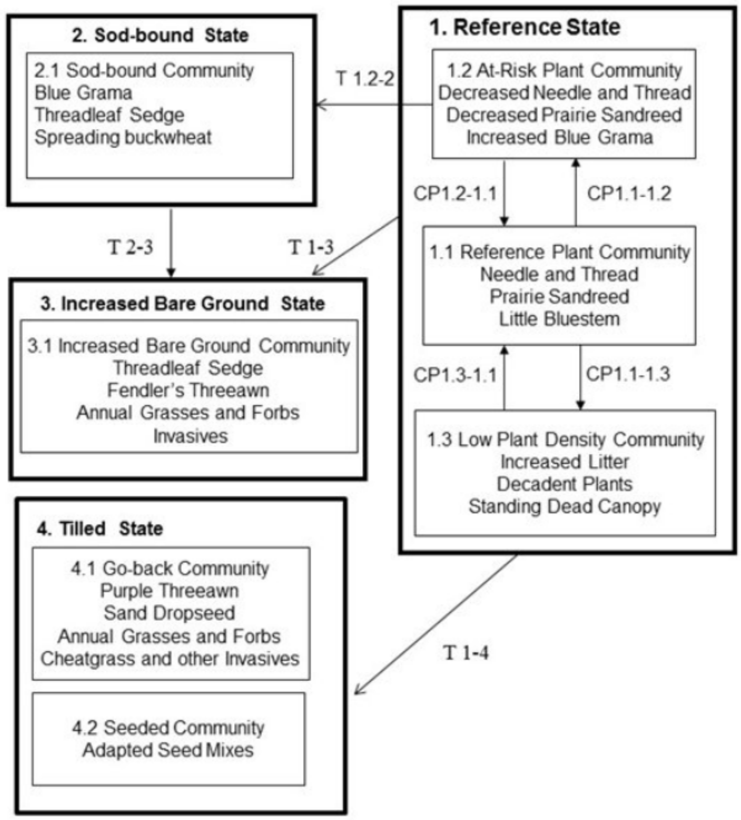
The state and transition model for this ecological site is displayed in Figure 6.8-1. The transitions, or pathways, described above are presented in the figure.

6.9 Aquatic Vegetation Management Opportunities

Aquatic weeds were identified by members of the SGCD board as in issue within the watershed. In the sections which follow, we present some background information pertaining to aquatic vegetation, issues associated with it, and some potential solutions.

Aquatic vegetation can be very problematic in irrigated systems because it reduces conveyance in open channel systems, and it can clog structures such as pipes or siphons. Much of the information below was obtained from the handbook "Aquatic and Ditchbank Weed Control" edited by Dr. Steven Dewey (Utah State University). Aquatic weeds can be broken into four categories: emerged, submerged, floating, and algae. Emerged plants are rooted in substrate with most of its vegetative tissue above water surface (e.g. cattail, tules, yellow waterlily). Submersed plants grow with all or most of its plant material below the water surface (e.g. pondweeds, coontail, elodea). Floating plants produce most of its tissue at the water surface and rise or lower with the water level (e.g. duckweeds, azolla, white waterlily). Algae can be submersed or free floating, but some may be anchored to the substratum by rocks or debris.

Aquatic plant and algae growth can be exacerbated when there are high levels of nitrogen and phosphorus. Sources of the nutrients can include: untreated waste or garbage dumps, stormwater from fertilized lawns, gardens, and farmland, livestock feeding lots, effluent from sewage treatment plants, or waste from industrial plants. These sources can be mitigated through water and land management best practices or regulation.



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

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

When ditches are being constructed, the establishment of bank weeds can be prevented by constructing steep banks with a 1 to 1.5 ratio slope that extend at least 3 feet below the designed water level. Alternatively, the canal banks can be seeded with desirable plant grasses (e.g. redtop at the waterline and crested wheat-grass on the shoulders and top of bank), and 2,4-D can be applied to prevent broadleaf plants. Providing roadways on both banks and means for controlling water levels and waterflow are also important design considerations for weed control.

Other prevention measures include early detection and eradication of newly introduced or invasive species. For example, recreational reservoirs are at risk for hydrilla introduction through boating. Signage at boat ramps, boat inspections, and wash stations can be used to prevent an unwanted infestation (Sytsma & Parker, 1999).

6.9.1 Typical Treatment of Aquatic Weeds

Since it is often difficult to identify or limit nutrient sources, prevention of aquatic weed growth is not often successful. Various methods of mechanical, biological, and chemical control have been used to combat aquatic plants, after they have already taken root.

Mechanical Treatment

Submersed or emerged weeds can be physically removed by mowing or through a controlled burn after the canal has been dewatered. A permit may be required to conduct a controlled burn. An underwater mower could be used to cut the weeds while they are still submerged, and they can then be collected with a mechanical weed harvester or chain, pulled along the canal. For dewatered concrete-lined channels, a moss cart could be pulled along the canal to remove algae and moss on the sides and bottom of the channel. A backhoe is needed to follow and remove the vegetation collected by the moss cart.

Ecological (Environmental Manipulation)

Manipulating the water level may be effective for removing submersed aquatic plants, which become stressed when they are exposed. Rooted plants may be fought with sediment amendment, removal, or cultivation. For example, the Talent Irrigation District in Oregon found that the application of acetic acid and barley straw was very effective in eliminating Sago pondweed (Sytsma & Parker, 1999). Dredging or excavation of sediment can also inhibit plant growth by removing nutrient rich sediment and exposing low-nutrient sediment. Bottom tillage or derooting during the winter months can uproot and dislodge overwintering root crowns. Although the technique has been successful in British Columbia, it should be noted that this technique may increase turbidity and plant fragments, increase canal seepage, and mobilize sediment contaminants. Lining the canals with concrete or geotextile material, may greatly reduce aquatic plant growth, although this method may be expensive and introduce maintenance. Methods of shading which inhibit aquatic plant growth by reducing light availability include dyes, shade fabrics, canal bank vegetation, and piping. These methods also introduce significant cost and maintenance, and thus are only practical in limited situations.

Biological Treatment

Insects can be used as biological control to target aquatic weed species or invasive weed species. For example, flea beetles have been used on alligatorweed, weevils on dyrilla, moths on water hyacinth. Recently insects have been used to control purple loosestrife and saltcedar (tamarisk). Plant pathogens are more rarely used, but *Cercospora* fungus has been used on water hyacinth.

Fish such as grass carp and white amur have been used to consume large quantities of submersed aquatic vegetation. However, special restrictions may apply when introducing non-native fish for weed control. Contact the Wyoming Game and Fish Department for information.

Chemical Treatment

Herbicides may also be used to kill aquatic plant species. The type of herbicide should be carefully selected based on the weed species present, the beneficial species present, the water uses and amount, and other characteristics which may affect the safety and effectiveness. It is also necessary to select the appropriate application method and type of formulation (e.g. liquid or granular). Before applying herbicides, it is important to check with Wyoming Game and Fish or other regulatory personnel to ensure proper licensing procedures. A more detailed guide on which herbicides should be used on which species is located at the end of the "Aquatic and Ditchbank Weed Control" handbook. It also includes the recommend rate of application, time of application, cautions, and other remarks for each type of herbicide. Vegetation is generally sprayed from March through August. Aquatic vegetation is most commonly treated with chemical techniques; however, this can be problematic. As stated in "Aquatic Vegetation in Irrigation Canals" (Sytsma & Parker, 1999):

> *"Interconnectedness and multiple uses of water in irrigation and natural systems increase the likelihood of non-target and off-site impacts of management activities and limit aquatic plant management options. Management goals and objectives may be radically different in manmade and natural aquatic systems, and vegetation management activities that may be appropriate in manmade systems may seriously damage natural systems."*

Screening Devices

Various methods of screening irrigation water exist; however, these strategies are fixed in place and are only effective at removing materials moving with the water. That is, their function is to remove material from water headed for sprinkler, gated pipes, etc.

Turbulent Fountain Screen (Bubbler)

Fountain screens, or "bubblers" are self-cleaning screens which separate floating debris from irrigation water at the farm turnout. They operate by forcing water upwards through an orifice in a screen and allowing the water to fall back through the screen (typically conical) into a catchment basin before sending it on to a sprinkler or gated pipe system (Figure 6.9-1). The device is effective; however, frequent maintenance is required.

Figure 6.9-1. Typical Turbulent Fountain "Bubbler" Screen.

Coanda Weir

Coanda screens function by allowing water to flow over the screen trapping debris and allowing the clear water to fall through. The screens can be sized for virtually any application. Clear water is captured in a catch basin under the screen and debris is forced to the bottom of the coanda screen (Figure 6.9-2).

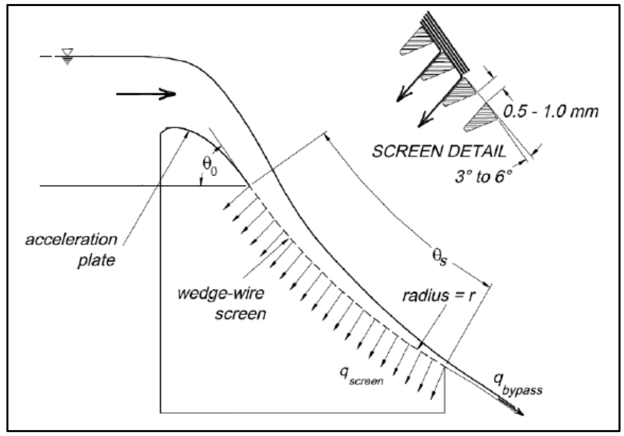


Figure 6.9-2 Typical Coanda Screen configuration.

Mechanical Self-cleaning Weed Screens

Self-cleaning mechanical weed screens function with a continually revolving screen equipped with some sort of 'rake' removing the collected debris. Figure 6.9-3 displays a photo of such a device installed at Heart Mountain Irrigation District in Cody, WY. This structure was placed on a main canal and therefore provides clear water for users downstream. It does not, however, have any effect on rooted vegetation in the canals upstream of downstream.

Figure 6.9-3. Self-cleaning weed screen device at Heart Mountain Irrigation District.

Existing Wyoming Strategies

Irrigators within the study area are certainly not alone when it comes to management of aquatic vegetation within irrigation systems. In an effort to determine what other irrigation districts or ditch companies are doing to control their nuisance vegetation, we contacted several district managers and discussed the issue with them.

Within the Horse Creek Conservation District (HCCD) which lies entirely within the project study area, aquatic vegetation has been managed by applying chemicals. However, costs of chemicals continue to escalate and application restrictions become increasingly tighter. According to HCCD staff, in addition to chemical treatment, the district typically tries to shut the system down for 4 to 5 days during the irrigation season to allow it to dry out in an attempt to stunt growth. However, for the last 5 years it hasn't been able to do so due to irrigator schedules and demands. There are two main canals in the HCCD: the South Main which is about 80 percent concrete ditch and the North Main which is entirely earthen. Aquatic vegetation is a bigger problem in the South Main where temperatures are likely warmer. Also, the North Main has widened due to mechanical cleaning.

The Heart Mountain Irrigation District (Cody, WY) has installed a self-cleaning weed screen device. According to district management, the screen does reduce the amount of vegetation and debris within the canal making management by irrigators using sprinkler systems or gated pipe easier. However, the district's success with vegetation management comes with a significant amount of "elbow grease". District staff routinely rake algae from ditches and during the non-irrigation season, dead rooted vegetation is physically raked from the ditches. District staff are investigating developing a means of mowing those portions of their ditch banks that are submerged during the irrigation season during the off season.

Wheatland Irrigation District (Wheatland, WY) applies chemicals at regular intervals during the irrigation season. According to district management, they spend approximately $14,000 per treatment at roughly three week intervals during the irrigation season. Although costly, the treatment is effective.

Kirby Irrigation District (Thermopolis, WY) recently completed rehabilitation of their ditch. After years of mechanical cleaning the ditch had been left widened and shallow. Aquatic vegetation has become a considerable management issue; conveyance was limited due to rooted vegetation. The district, with financial assistance of the WWDC, recently completed the reconfiguration of the ditch. Resulting flow conditions should result in deeper and faster flows limiting conditions conducive to vegetative growth.
Goshen Irrigation District (Torrington, WY) manages aquatic vegetation in a manner similar to Wheatland Irrigation District: with chemicals.

Summary

In summary, there are essentially two problems associated with aquatic vegetation in irrigation conveyance systems:

1. Restriction in conveyance capability of the ditch caused by rooted vegetation, and
2. Floating or moving vegetation / debris which can restrict effectiveness of sprinklers or gated pipe.

Each has different treatment options. Chemical treatment and 'elbow grease" appear to be the selected methods to reduce rooted vegetation restricting conveyance. Screening devices appear to be the selected methods for protecting infrastructure from floating/moving vegetation and debris.

Based upon our conversations with irrigation managers, there is simply put, "no silver bullet"; management of aquatic vegetation requires significant labor and expense. Specific recommendations which are included in the Horse Creek watershed management plan include the following:

- AVM-001 Chemical Treatment
- AVM-002 Mechanical Screening Devices
- AVM-003 Turbulent Fountain ("Bubblers")
- AVM-004 Coanda Screen Devices

It is important to note that chemical treatment options, while effective, would not be eligible for funding through the WWDC's Small Water Project Program or any of its other conventional funding programs. Implementation of any of the screening devices recommended (mechanical screen, turbulent fountain, or coanda screen) may or may not be eligible for funding depending upon its location and function. For example, a mechanical self-cleaning screen placed within a canal could be eligible for funding through the WWDC because it becomes a conveyance element and part of the canal system. On the other hand, a turbulent fountain or coanda screen placed at an individual farm turnout provides no public benefit and would not be considered eligible for WWDC funding.

Each of the aquatic vegetation management alternatives would require site-specific evaluation to determine the optimal solution in terms of type and size of structure, especially if a mechanical self-cleaning type of device is selected.

6.10 Horse Creek 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
- Environmental enhancement opportunities
- Aquatic Vegetation Management opportunities

These improvements focus on potential mitigation of several key issues that presently exist within the watershed. For the Horse Creek watershed, the watershed management plan consists of a compilation of the recommendations for each category. The plan is tabulated in Table 6.10-1.

6.11 Project Summary Matrix

In an effort to help the SGCD 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 6.11-1 provides a summary of the attributes and Table 6.11-2 presents the summary matrix.

Table 6.10-1 Horse Creek Watershed Management Plan.

Horse Creek Watershed Management Plan			
Watershed Management Plan Component	**Watershed Management Plan Component**	**County**	**Project Name**
HC ENV-001	Buchaults-002	Goshen	Buchaults Check Structure - Horse Creek
HC ENV-002	Frank-002	Goshen	Horse Creek Bank Stabilization Project
HC ENV-003	Kessler-001	Goshen	Bear Creek Sedimentation Project
Irrigation Components			
IRR-001	Alps-001	Goshen	Alps Ditch Conversion Project
IRR-002	Christofferson-001	Laramie	Christofferson Ditch Diversion Reconstruction
IRR-003	Davis-002	Goshen	Davis Pipeline Project
IRR 004	Frank-001	Goshen	Scoon Ditch Diversion Rehabilitation Project
IRR-005	Hanlon-001	Goshen	Schwab Ditch Conversion Project
IRR-006	Sipola-001	Goshen	Sipola Ditch Conversion Project
IRR-007	Tomayer-001	Goshen	Tomayer Pipeline Project
IRR-008	Thaler-002	Goshen	Bear Creek Ditch Measurement Device
IRR-009	Thaler-001	Goshen	Fox Creek Diversion Structure
Livestock / Wildlife Water Supply Projects			
L/W-001	Berry 001	Laramie	Berry Well Construction Project No. 1
L/W-002	Berry 002	Laramie	Berry Well Construction Project No. 2
L/W-003	Berry 003	Laramie	Berry Well Rehabilitation Project
L/W-004	Borchardt-001	Laramie	Borchardt Solar Platform Instatllation
L/W-005	Borchardt-002	Laramie	Borchardt Pipeline Extension Project
L/W-006	Borchardt-003	Laramie	Borchardt Stock Tank Project
L/W-007	Borchardt-004	Laramie	Borchardt Spring Development Project
L/W-008	Buchaults-001	Goshen	Buchaults Pipeline Project
L/W-009	Cecil-001	Goshen	Cecil Well Construction Project
L/W-010	Cecil-002	Goshen	Cecil Pipeline Project No. 1
L/W-011	Cecil-003	Goshen	Cecil Pipeline Project No. 2
L/W-012	Chamberlain-001	Goshen	Chamberlain Pipeline Project
L/W-013	Clark-001	Laramie	Clark Well Construction
L/W-014	Davis-001	Goshen	Davis Stock Reservoir Rehabilitation
L/W-015	Dereemer-001	Laramie	Dereemer Pipeline Project
L/W-016	Drake-001	Laramie	Drake Well Construction Project
L/W-017	Eklund-001	Laramie	Eklund Solar Platform / Pipeline Project
L/W-018	Frank-003	Goshen	Frank Pipeline Project
L/W-019	Grandstaff-001	Goshen	Grandstaff Pipeline Project
L/W-020	Jackson-001	Goshen	Jackson Pipeline Project
L/W-021	Ruiz-001	Goshen	Ruiz Solar Platform Project
L/W-022	Ruiz-002	Goshen	Ruiz Pipeline Project No. 1
L/W-023	Ruiz-003	Goshen	Ruiz Pipeline Project No. 2
L/W-024	ScheerD-001	Goshen	Scheer D. Well Construction Project
L/W-025	ScheerD-002	Goshen	Scheer D. Solar Platform Project
L/W-026	ScheerJ-001	Goshen	Scheer J. Pipeline Project
L/W-027	ScheerJ-002	Goshen	Scheer J. Irrigation Pipeline Project
L/W-028	Shimic-001	Goshen	Shimic Stock Reservoir Project
L/W-029	Shoun-001	Goshen	Shoun Well Construction Project No. 1
L/W-030	Shoun-002	Goshen	Shoun Well Construction Project No. 2
L/W-031	Tomayer-002	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 1
L/W-032	Tomayer-003	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 2
L/W-033	Tremain-001	Goshen	Tremain Solar Platform Project No. 1
L/W-034	Tremain-002	Goshen	Tremain Solar Platform Project No. 2
L/W-035	Tremain-003	Goshen	Tremain Solar Platform Project No. 3
L/W-036	Yeik-001	Goshen	Yeik Pipeline Project No. 1
L/W-037	Yeik-002	Goshen	Yeik Pipeline Project No. 2
L/W-038	Zimmerer-001	Goshen	Zimmerer Spring Development
Aquatic Vegetation Management			
AVM-001	NA	Either	Chemical treatment
AVM-002	NA	Either	Mechanical Screening Device
AVM-003	NA	Either	Turbulent Fountain ("Bubbler")
AVM-004	NA	Either	Coanda Screen Device

Table 6.11-1 Attributes of Project Summary Matrix.

Attribute	Project Evaluation Categories		
	Less Preferable →		Preferable
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, 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 6.11-2 Horse Creek Watershed Management Plan: Project Summary Matrix.

Horse Creek Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WWDC Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Environmental Components												
ENV-001	Buchaults-002	Buchaults Check Structure - Horse Creek	Installation of rock check structure in Horse Creek to facilitate irrigation diversion	SWPP	N/A	Low	Private	Moderate	Moderate	$171,875	riparian, channel stability, water quality, sedimentation	No
ENV-002	Frank-002	Horse Creek Bank Stabilization Project	Stabilization of streambank at county road	SWPP	N/A	Low	Private	Moderate	Moderate	$26,038	riparian, channel stability, water quality, sedimentation	No
ENV-003	Kessler-001	Bear Creek Sedimentation Project	Investigation of stream sedimentation causes / stream stabilization plan	SWPP	N/A	Low	Private	Moderate	Moderate	$56,250	riparian, channel stability, water quality, sedimentation	No
Irrigation Components												
IRR-001	Alps-001	Alps Ditch Conversion Project	Conversion of open ditch to buried pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$72,078	conservation	No
IRR-002	Christofferson-001	Christofferson Ditch Diversion Reconstruction	Replacement of diversion structure in poor condition	SWPP	Rehabilitation	Low	Private	Moderate	Moderate	$33,457	conservation	No
IRR-003	Davis-002	Davis Pipeline Project	Conversion of open ditch to buried pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$358,875	conservation	No
IRR 004	Frank-001	Scoon Ditch Diversion Rehabilitation Project	Reconfiguration of irrigation diversion structure	SWPP	Rehabilitation	Low	Private	Routine	Routine	$0	conservation	No
IRR-005	Hanlon-001	Schwab Ditch Conversion Project	Conversion of open ditch to buried pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$51,975	conservation	No
IRR-006	Sipola-001	Sipola Ditch Conversion Project	Conversion of open ditch to buried pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$4,422	conservation	No
IRR-007	Tomayer-001	Tomayer Pipeline Project	Conversion of open ditch to buried pipeline	SWPP	Rehabilitation	Low	Private	Routine	Routine	$16,500	conservation	No
IRR-008	Thaler-002	Bear Creek Ditch Measurement Device	Replacement of antiquated measurement device	SWPP	Rehabilitation	Low	Private	Routine	Routine	$34,375	conservation	No
IRR-009	Thaler-001	Fox Creek Diversion Structure	Replacement of existing diversion structure to reduce sedimentation	SWPP	Rehabilitation	Low	Private	Routine	Routine	$49,500	conservation	No

Table 6.11-2 Horse Creek Watershed Management Plan: Project Summary Matrix (Continued).

Horse Creek Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WWDC Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Livestock/Wildlife Water Supply Components												
L/W-001	Berry 001	Berry Well Construction Project No. 1	Replacement of existing well /installation of solar	SWPP	New Supply	High	Private	Routine	Routine	$56,513	wildlife / livestock	No
L/W-002	Berry 002	Berry Well Construction Project No. 2	Replacement of existing well /installation of solar	SWPP	New Supply	High	Private	Routine	Routine	$56,513	wildlife / livestock	No
L/W-003	Berry 003	Berry Well Rehabilitation Project	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$16,500	wildlife / livestock	No
L/W-004	Borchardt-001	Borchardt Solar Platform Installation	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$16,500	wildlife / livestock	No
L/W-005	Borchardt-002	Borchardt Pipeline Extension Project	Extension of existing pipeline project /	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$39,188	wildlife / livestock	No
L/W-006	Borchardt-003	Borchardt Stock Tank Project	Extension of existing pipeline project /	SWPP	New Supply	High	Private	Routine	Routine	$7,494	wildlife / livestock	No
L/W-007	Borchardt-004	Borchardt Spring Development Project	Develop spring/install stock tank	SWPP	New Supply	High	Private	Routine	Routine	$12,719	wildlife / livestock	No
L/W-008	Buchaults-001	Buchaults Pipeline Project	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$19,250	wildlife / livestock	No
L/W-009	Cecil-001	Cecil Well Construction Project	Construction of new well/ buried pipeline and stock	SWPP	New Supply	High	Private	Routine	Routine	$40,700	wildlife / livestock	No
L/W-010	Cecil-002	Cecil Pipeline Project No. 1	Construction of new well/ buried pipeline and stock	SWPP	New Supply	High	Private	Routine	Routine	$41,319	wildlife / livestock	No
L/W-011	Cecil-003	Cecil Pipeline Project No. 2	Construction of new well/ buried pipeline and stock	SWPP	New Supply	High	Private	Routine	Routine	$43,381	wildlife / livestock	No
L/W-012	Chamberlain-001	Chamberlain Pipeline Project	Extension of existing pipeline project /	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$38,198	wildlife / livestock	No
L/W-013	Clark-001	Clark Well Construction	Construction of new well / solar platform	SWPP	New Supply	High	Private	Routine	Routine	$50,669	wildlife / livestock	No
L/W-014	Davis-001	Davis Stock Reservoir Rehabilitation	Stock reservoir construction	SWPP	Rehabilitation	Medium	Federal	Routine	Routine	$40,159	wildlife / livestock	No
L/W-015	Dereemer-001	Dereemer Pipeline Project	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$49,473	wildlife / livestock	No
L/W-016	Drake-001	Drake Well Construction Project	Construction of new well / solar platform	SWPP	New Supply	High	Private	Routine	Routine	$88,344	wildlife / livestock	No
L/W-017	Eklund-001	Eklund Solar Platform / Pipeline Project	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private/State	Routine	Routine	$39,325	wildlife / livestock	No

Table 6.11-2 Horse Creek Watershed Management Plan: Project Summary Matrix (Continued).

Horse Creek Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WWDC Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Livestock/Wildlife Water Supply Components												
L/W-018	Frank-003	Frank Pipeline Project	Extension of existing pipeline project / installation of stock tanks	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$20,075	wildlife / livestock	No
L/W-019	Grandstaff-001	Grandstaff Pipeline Project	Buried pipeline installation and stock tanks	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$27,672	wildlife / livestock	No
L/W-020	Jackson-001	Jackson Pipeline Project	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$18,013	wildlife / livestock	No
L/W-021	Ruiz-001	Ruiz Solar Platform Project	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$21,313	wildlife / livestock	No
L/W-022	Ruiz-002	Ruiz Pipeline Project No. 1	Installation of solar platform / pump / buried pipeline / stock tanks	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$37,125	wildlife / livestock	No
L/W-023	Ruiz-003	Ruiz Pipeline Project No. 2	Installation of solar platform / pump / buried pipeline / stock tanks	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$26,813	wildlife / livestock	No
L/W-024	ScheerD-001	Scheer D. Well Construction Project	Installation of solar platform / pump / buried pipeline / stock tanks	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$28,806	wildlife / livestock	No
L/W-025	ScheerD-002	Scheer D. Solar Platform Project	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$21,313	wildlife / livestock	No
L/W-026	ScheerJ-001	Scheer J. Pipeline Project	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$22,138	wildlife / livestock	No
L/W-027	ScheerJ-002	Scheer J. Irrigation Pipeline Project	Spring development / buried pipeline	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$11,000	wildlife / livestock	No
L/W-028	Shimic-001	Shimic Stock Reservoir Project	Stock reservoir construction	SWPP	New Supply	High	Private	Routine	Routine	$76,425	wildlife / livestock	No
L/W-029	Shoun-001	Shoun Well Construction Project No. 1	Construction of new well / solar platform / stock tank	SWPP	New Supply	High	Private	Routine	Routine	$38,500	wildlife / livestock	No
L/W-030	Shoun-002	Shoun Well Construction Project No. 2	Construction of new well / solar platform / stock tank	SWPP	New Supply	High	Private	Routine	Routine	$38,500	wildlife / livestock	No
L/W-031	Tomayer-002	Tomayer Stock Reservoir Rehabilitation Project No. 1	Sediment removal from ditch / stock reservoir construction	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$11,000	wildlife / livestock	No
L/W-032	Tomayer-003	Tomayer Stock Reservoir Rehabilitation Project No. 2	Rehabilitation of existing stock reservoir	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$47,000	wildlife / livestock	No
L/W-033	Tremain-001	Tremain Solar Platform Project No. 1	Construction of new well / solar platform / stock tank	SWPP	New Supply	High	Private	Routine	Routine	$38,156	wildlife / livestock	No
L/W-034	Tremain-002	Tremain Solar Platform Project No. 2	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$21,313	wildlife / livestock	No
L/W-035	Tremain-003	Tremain Solar Platform Project No. 3	Installation of solar platform / pump	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$19,938	wildlife / livestock	No
L/W-036	Yeik-001	Yeik Pipeline Project No. 1	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$20,178	wildlife / livestock	No
L/W-037	Yeik-002	Yeik Pipeline Project No. 2	Installation of buried pipeline and stock tank	SWPP	Rehabilitation	Medium	Private	Routine	Routine	$21,725	wildlife / livestock	No
L/W-038	Zimmerer-001	Zimmerer Spring Development	Installation of spring development / solar pump / stock tank	SWPP	New Supply	High	Private	Routine	Routine	$32,863	wildlife / livestock	No

Table 6.11-2 Horse Creek Watershed Management Plan: Project Summary Matrix (Continued).

Horse Creek Watershed Management Plan												
Watershed Management Plan Component	Sponsor Reference	Project Name	Description	WWDC Program	Supply Type	WWDC Priority	Ownership	Implementation Practicality	Ease of Permitting	Estimated Cost	Benefits	Shovel Ready
Aquatic Vegetation Management												
AVM-001	NA	Chemical treatment	Application of chemicals to remove aquatic vegetation / algae / weeds	No	Rehabilitation	Medium	Private	Routine	Routine	NA	Conservation	No
AVM-002	NA	Mechanical Screening Device	Design/installation of mechanical self-cleaning algae/debri sweep	SWPP / Conventional	Rehabilitation	Medium	Private	Routine	Routine	Varies	Conservation	No
AVM-003	NA	Turbulent Fountain ("Bubbler")	Design/installation of turbulent fountain at farm turnout	SWPP	New Supply	Medium	Private	Routine	Routine	$2,000 - $4,000	Conservation	No
AVM-004	NA	Coanda Screen Device	Design / installation of coanda screen to remove floating debris / vegetation	SWPP/Conventional if on conveyance system / No if at individual farm turnout	Rehabilitation	Medium	Private	Routine	Routine	$4,000 and up	Conservation	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.

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. 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 Horse Creek 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	Buchaults-002	$137,500	$20,625	$13,750	$171,875
ENV-002	Frank-002	$20,830	$3,125	$2,083	$26,038
ENV-003	Kessler-001	$45,000	$6,750	$4,500	$56,250
IRR-001	Alps-001	$57,662	$8,649	$5,766	$72,078
IRR-002	Christofferson-001	$26,765	$4,015	$2,677	$33,457
IRR-003	Davis-002	$287,100	$43,065	$28,710	$358,875
IRR-004	Frank-001	This project currently construction through Laramie County Conservation District			
IRR-005	Hanlon-001	$41,580	$6,237	$4,158	$51,975
IRR-006	Sipola-001	$44,220	$44,220	$6,633	$4,422
IRR-007	Tomayer-001	$13,200	$1,980	$1,320	$16,500
IRR-008	Thaler-002	$27,500	$4,125	$2,750	$34,375
IRR-009	Thaler-001	$39,600	$5,940	$3,960	$49,500
L/W-001	Berry 001	$45,210	$6,782	$4,521	$56,513
L/W-002	Berry 002	$45,210	$6,782	$4,521	$56,513
L/W-003	Berry 003	$13,200	$1,980	$1,320	$16,500
L/W-004	Borchardt-001	$13,200	$1,980	$1,320	$16,500
L/W-005	Borchardt-002	$31,350	$4,703	$3,135	$39,188
L/W-006	Borchardt-003	$5,995	$899	$600	$7,494
L/W-007	Borchardt-004	$10,175	$1,526	$1,018	$12,719
L/W-008	Buchaults-001	$15,400	$2,310	$1,540	$19,250
L/W-009	Cecil-001	$32,560	$4,884	$3,256	$40,700
L/W-010	Cecil-002	$33,055	$4,958	$3,306	$41,319
L/W-011	Cecil-003	$34,705	$5,206	$3,471	$43,381
L/W-012	Chamberlain-001	$30,558	$4,584	$3,056	$38,198
L/W-013	Clark-001	$40,535	$6,080	$4,054	$50,669
L/W-014	Davis-001	$32,128	$4,819	$3,213	$40,159
L/W-015	Dereemer-001	$39,578	$5,937	$3,958	$49,473
L/W-016	Drake-001	$70,675	$10,601	$7,068	$88,344
L/W-017	Eklund-001	$31,460	$4,719	$3,146	$39,325
L/W-018	Frank-003	$16,060	$2,409	$1,606	$20,075
L/W-019	Grandstaff-001	$22,138	$3,321	$2,214	$27,672
L/W-020	Jackson-001	$14,410	$2,162	$1,441	$18,013
L/W-021	Ruiz-001	$17,050	$2,558	$1,705	$21,313
L/W-022	Ruiz-002	$29,700	$4,455	$2,970	$37,125
L/W-023	Ruiz-003	$21,450	$3,218	$2,145	$26,813
L/W-024	ScheerD-001	$23,045	$3,457	$2,305	$28,806
L/W-025	ScheerD-002	$17,050	$2,558	$1,705	$21,313
L/W-026	ScheerJ-001	$17,710	$2,657	$1,771	$22,138
L/W-027	ScheerJ-002	$8,800	$1,320	$880	$11,000
L/W-028	Shimic-001	$61,140	$9,171	$6,114	$76,425
L/W-029	Shoun-001	$30,800	$4,620	$3,080	$38,500
L/W-030	Shoun-002	$30,800	$4,620	$3,080	$38,500
L/W-031	Tomayer-002	$8,800	$1,320	$880	$11,000
L/W-032	Tomayer-003	$37,600	$5,640	$3,760	$47,000
L/W-033	Tremain-001	$30,525	$4,579	$3,053	$38,156
L/W-034	Tremain-002	$17,050	$2,558	$1,705	$21,313
L/W-035	Tremain-003	$15,950	$2,393	$1,595	$19,938
L/W-036	Yeik-001	$16,143	$2,421	$1,614	$20,178
L/W-037	Yeik-002	$17,380	$2,607	$1,738	$21,725
L/W-038	Zimmerer	$26,290	$3,944	$2,629	$32,863

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 environment: 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.

7.4 Aquatic Vegetation Management Opportunities

Costs associated with these plan components will vary greatly depending upon the ultimate design and configuration employed. Costs of mechanical self-cleaning weed screens can range up to $500,000 depending upon the size and application. Turbulent fountains are a much more economical solution for installation at individual farm turnouts and according to NRCS information can range from $2,000 to $5,000 depending upon the capacity required. Coanda screens capable of installation at individual farm turnouts were quoted at $1,000 for a screen capable of conveying 1 cfs and $2,000 for a screen conveying 5 cfs. A concrete structure is required to house and support the screen in addition to the cost of the screen, bringing the estimated cost to $5,000 and $6,000 respectively. Coanda screens can also be designed for larger canal/ditch application at accordingly higher costs.

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 within the Horse Creek Watershed. 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:

- South Goshen Conservation District (307-532-4880 ext. 101)
- Laramie County Conservation District (307-772-2600)
- NRCS Torrington Field Office: (307-532-4880)
- Bureau of Land Management/Rawlins Field Office (307-328-4200)
- Bureau of Land Management/Casper Field Office (307-261-7600)
- 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 Goshen County and Laramie County (small portions spill into Platte and Albany 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:

South Goshen and North Platte Valley Conservation Districts
1441 East M, Suite B
Torrington, WY 82240
307-532-4880 ext. 101

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

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

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 Laramie and Goshen County Weed and Pest Districts also provide 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:

Goshen County Weed and Pest Control District
Mailing: PO Box 757
Physical: 4522 U.S Hwy 26/85
Torrington, WY 82240
(307) 532-3713

Laramie County Weed and Pest Council
801 Muddy Creek Drive
Pine Bluffs, WY 80282
(307) 245-3213

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 sponsor's 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.

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

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

3) **Preliminary Recommendations**: At the May 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.

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).

- 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 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) ensures 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 6.1-1.

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 Horse Creek 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 landowner (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

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	
Goshen County Albany 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, 2018]:

Petition Under Review:	Regal Fritillary (Speyeria idalia) Little Brown Myotis (Myotis lucifugus) Plains Spotted Skunk (Spilogale putorius interrupta)
Threatened:	Piping Plover (Charadrius melodus) Greenback Cutthroat Trout (Oncorhynchus clarkii stomias) Canada Lynx (Lynx canadensis) Preble's Meadow Jumping Mouse (Zapus hudsonius preblei)
Proposed Threatened:	North American Wolverine (Gulo gulo luscus)
Endangered:	Least Tern (Sternula antillarum) Whooping Crane (Grus americana)*

**The whooping crane is designated as “Listed Endangered (LE), and Endangered - Nonessential Experimental Population (LEXN)”*

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 48 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 7 amphibians, 108 birds, 11 crustaceans, 10 fish, 5 insects, 46 mammals, 9 mollusks, and 27 reptiles [WYNDD, 2018]. 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

Although there are no mapped Sage Grouse Core Areas within the Horse Creek study area, coordination with Wyoming Game and Fish is recommended to ensure compliance. Sponsors of 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 can 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 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 can be 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 Horse Creek 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 SGCD and LCCD 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,*
- *Grazing Management Opportunities, and*
- *Aquatic Vegetation 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. The Horse Creek Conservation District (HCCD) represents the major stakeholder in the area with respect to irrigation and serves about 10,200 irrigated acres. An irrigation district master plan was completed in 2013 by AVI, PC and included a lengthy list of recommendations for district managers to use for planning purposes. The master plan should continue to be referenced by HCCD to drive future planning efforts.

2. Several of the projects included in the Watershed Management Plan were recommended by stakeholders within the HCCD and involve smaller conservation/pipeline projects on lands located “downstream” of HCCD responsibility. We recommend that the SGCD work together with these and other stakeholders and the HCCD to strive to develop projects that may benefit greater numbers of users and be consistent with HCCD 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 HCCD, 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 38 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. All of the livestock / wildlife projects identified could be completed entirely on private lands. Consequently, permitting issues are greatly simplified.

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 must be 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 channel migration threatens activities such as pastures, crops, etc.

2. Bear Creek and Fox Creek show signs of instability; sedimentation and aggradation of the channel is occurring. This is causing the stream to widen and become undefined through 'boggy' areas. The source of the sediment appears to be upstream bank erosion. Within the areas where sedimentation is occurring, irrigators face maintenance issues associated with sediment conveyed into ditches as well as diversions being problematic to use. Earthwork could restore channel alignment to make diversions feasible, however, efforts would likely be short-lived as sediment delivered from upstream would likely 'undo' these efforts. A more comprehensive plan involving stabilization of the upstream sediment sources should be undertaken.

3. Channel degradation does not appear to be systemic throughout the Horse Creek watershed. 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.

10.1.7 Aquatic Vegetation Management

1. Aquatic vegetation is reportedly problematic in area canals and ditches. Two general types of management strategies appear to exist:

   (a) control of rooted vegetation which, when dense, can restrict conveyance capabilities of a canal/ditch system and
   (b) floating or moving vegetation / debris which becomes problematic for sprinklers or gated pipe systems.

2. Chemical treatment, while expensive and increasingly more regulated to apply, appears to be the most effective means of controlling rooted vegetation.

3. Physical screening appears to be a viable means of managing vegetation / debris entrained in a canal/ditch to protect sprinklers and gated pipe systems.

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 SGCD, the LCCD, 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 SGCD and the LCCD 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, SGCD and LCCD 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.

4. Landowners or managers seeking to participate in the SWPP should consult and coordinate with the SGCD and the LCCD, 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 Horse Creek 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 SGCD and LCCD 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 SGCD and LCCD sponsorship. Project narratives, conceptual designs, cost estimates, and discussion of project benefits can all be incorporated directly into the SWPP application by the SGCD and the LCCD.

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 are 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 Horse Creek Watershed Management plan was completed based primarily upon input obtained from the SGCD, the LCCD, and participating agencies, landowners, and stakeholders.

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APPENDIX 2A

FINAL RESULTS PRESENTATION MATERIALS

Horse Creek Watershed Study
Results Presentation

November 5th, 2019 6 p.m.
Platte Valley Bank
2201 Main Street
Torrington, WY
82240

Please join us as we discuss the results of the Horse Creek Watershed Study funded by the Wyoming Water Development Commission and sponsored by the South Goshen Conservation 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

Horse Creek Final Results Presentation:

Date: 11/5/19

Location: Platte Valley Bank, Torrington, Wyoming

Time: 6pm

6pm Jodee Pring (WWDO) started the meeting with a presentation describing the WWDC investigation process, levels of effort, and general project goals.

Jay Schug (Anderson Consulting Engineers) presented a summary of the project and the results.

The presentation ended around 7pm.

The presentation was followed by a lengthy question and answer period.

Q/A Session:

1. Much of the discussion revolved around the responsibility of the South Goshen Conservation District and their sponsorship of potential projects.

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. Questions 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.

6. WWDC Funding process was discussed with limitations and deadlines

Horse Creek Watershed Study Level I

Presented to:

Wyoming Water Development Commission

South Goshen Conservation District
Laramie County Conservation District

November 5, 2019

Anderson Consulting Engineers   Hinckley Consulting

Project Funding:

- Wyoming Water Development Commission

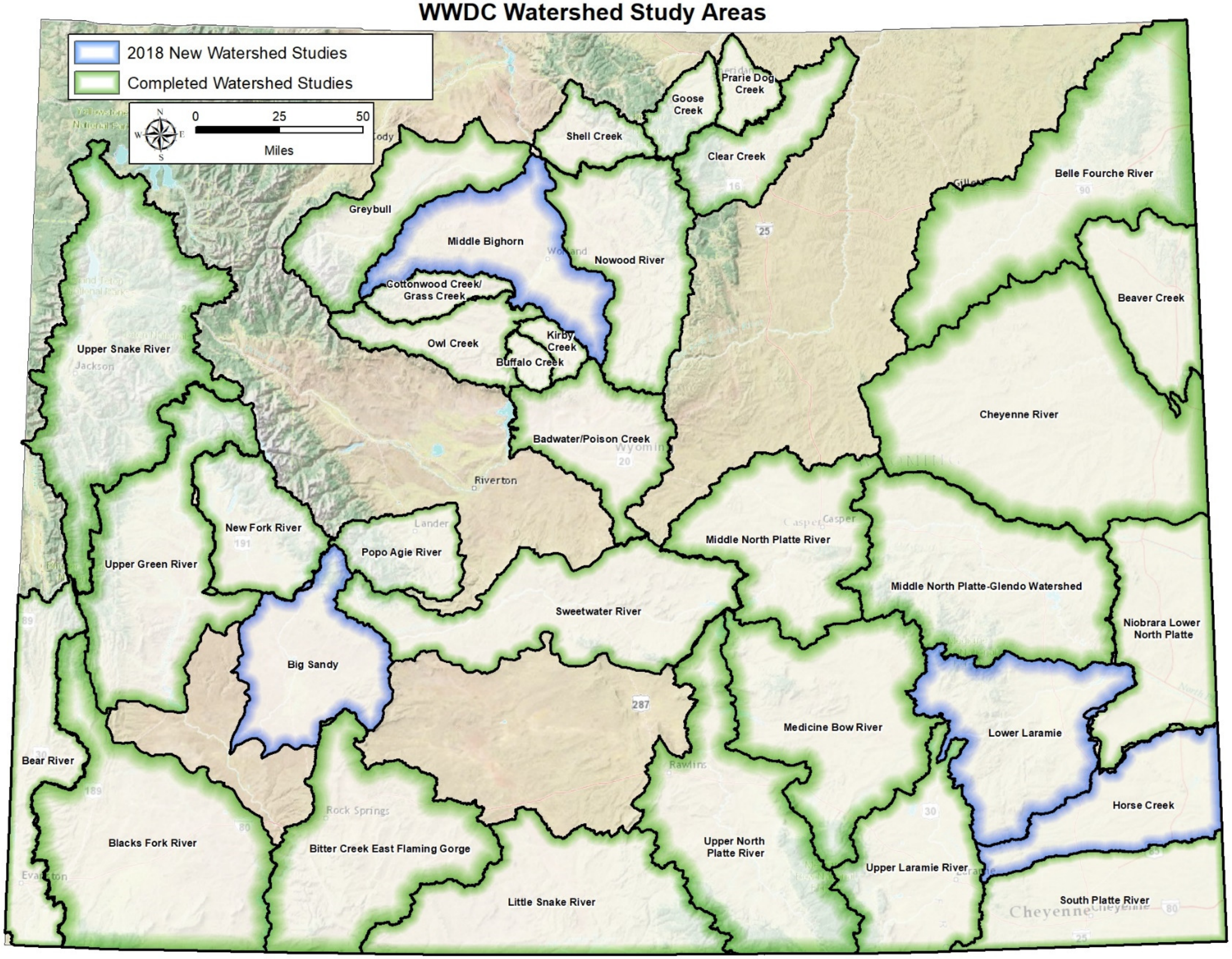
Project Sponsors:

- South Goshen Conservation District
- Laramie County Conservation District (Participating)

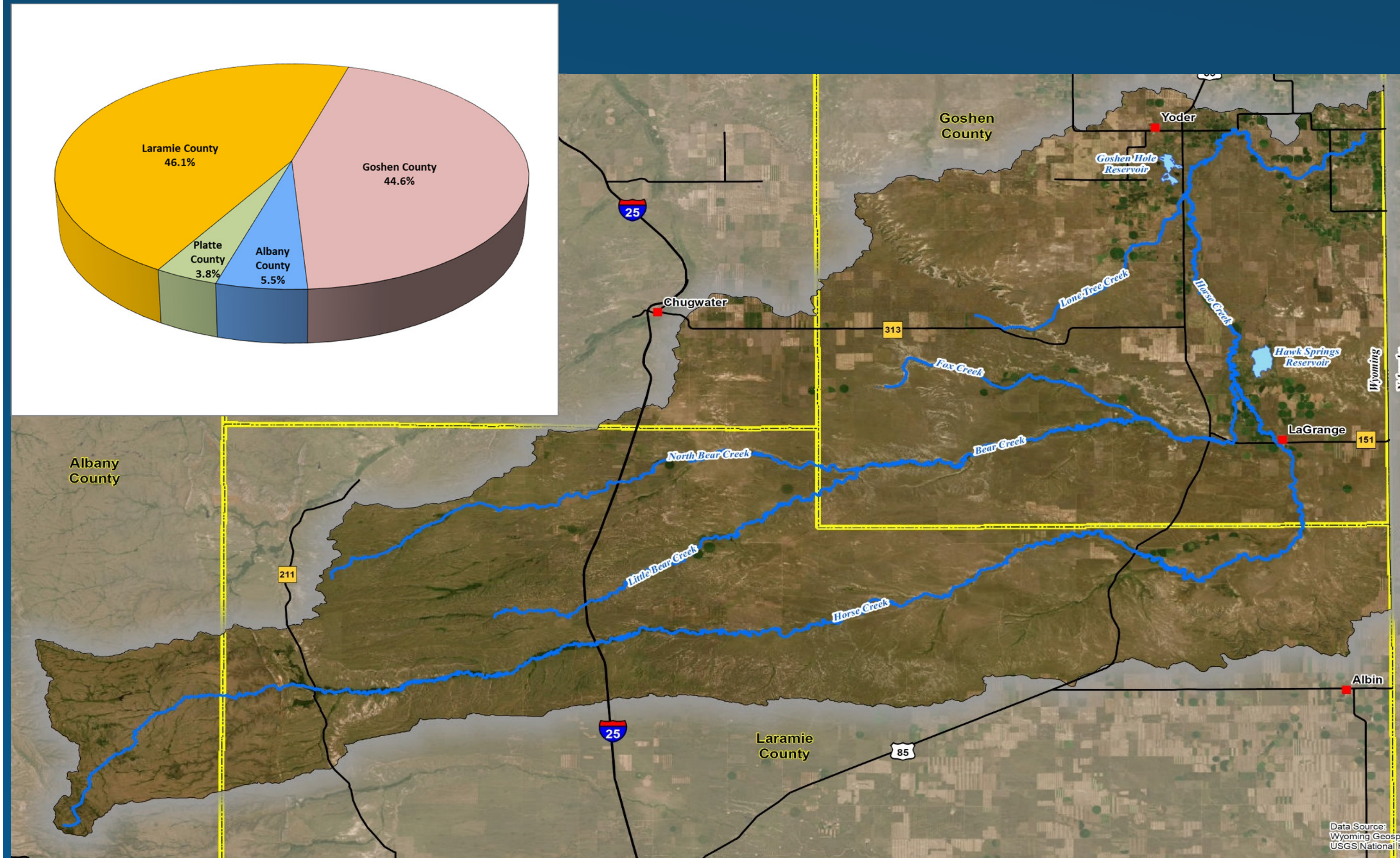
Project Contractor:

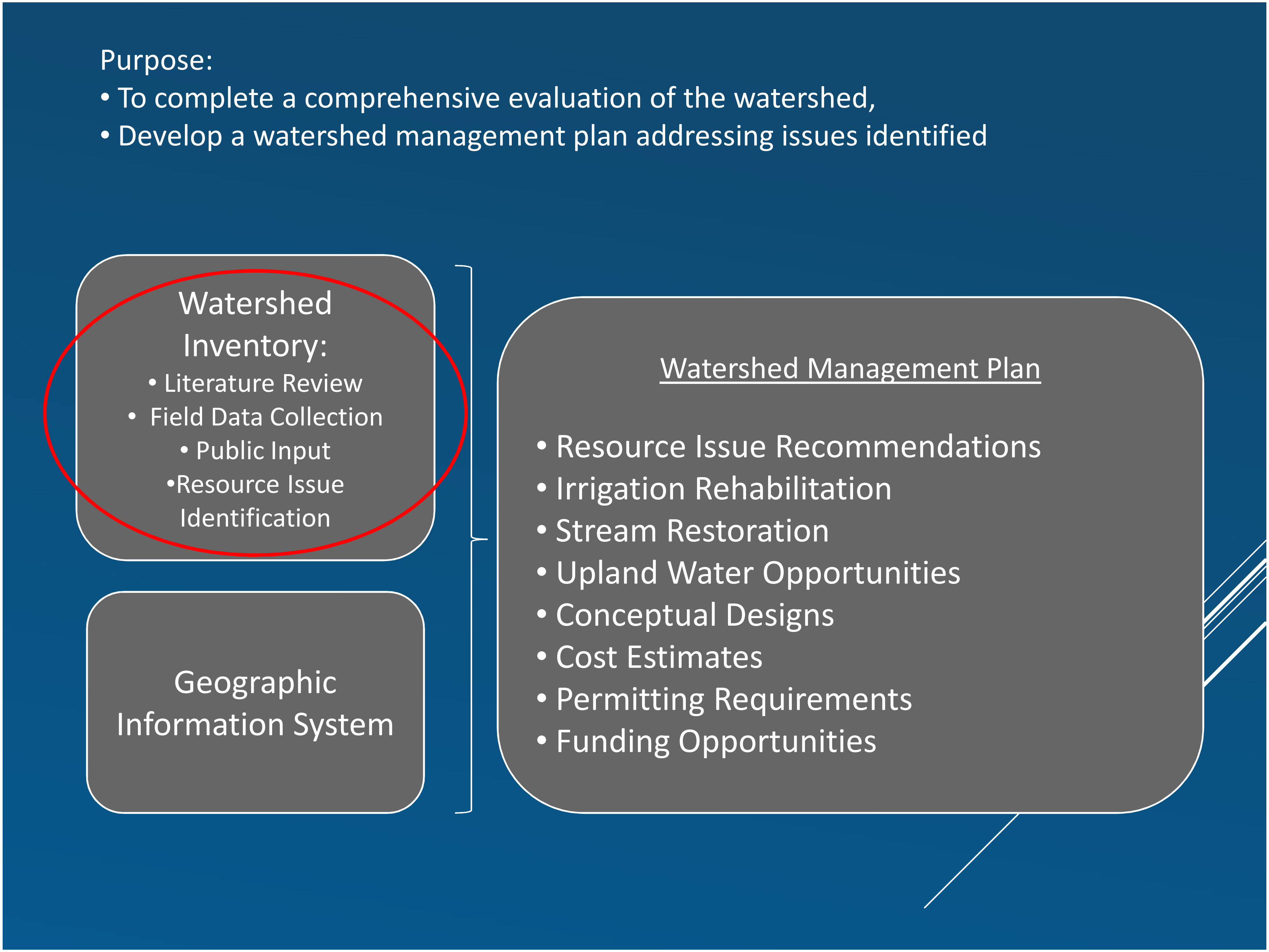
- Anderson Consulting Engineers

WWDC Watershed Study Areas



Project Study Area




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

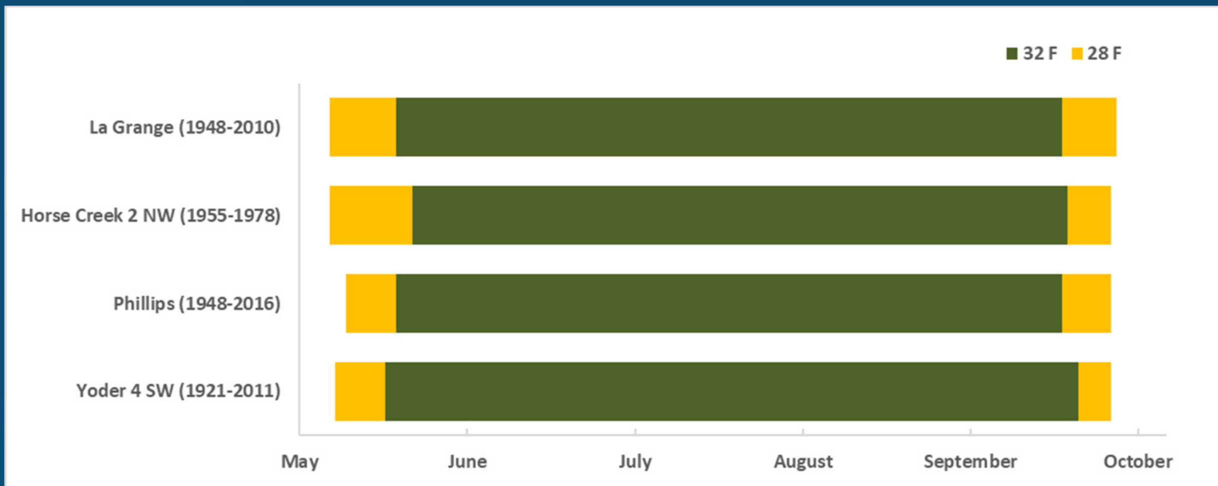
Watershed Inventory and Assessment

- 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

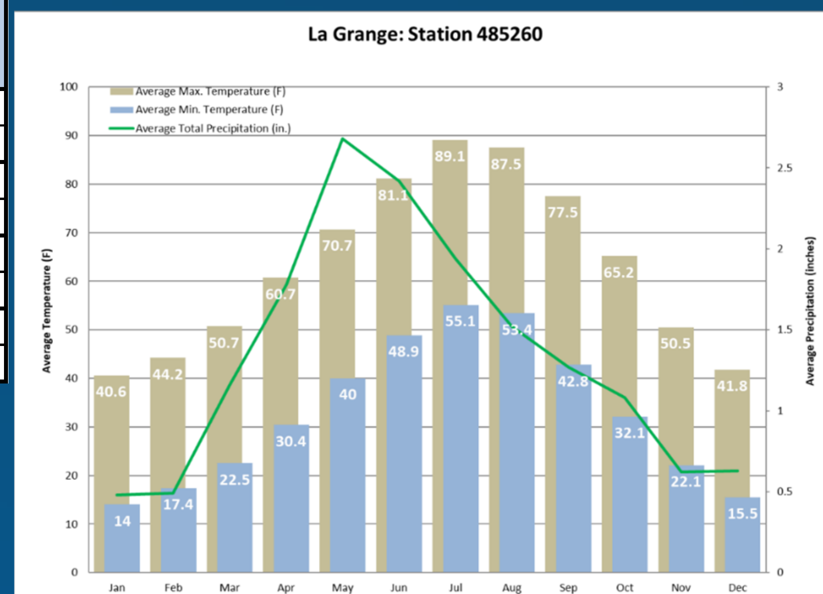
Watershed Inventory and Assessment provides an extensive amount of information for future permitting efforts, investigations, etc.

- 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
- Stock Reservoir Evaluation
- Waters Requiring TMDLs
- Water Storage and Retention
- Surface Water Availability and Shortages
- Available Flows Analysis

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)
Yoder 4 SW	1921-2011	28°F	8-May	27-Sep	140
		32°F	17-May	21-Sep	124
Phillips	1948-2016	28°F	10-May	27-Sep	138
		32°F	19-May	18-Sep	122
Horse Creek 2 NW	1955-1978	28°F	7-May	27-Sep	145
		32°F	22-May	19-Sep	117
La Grange	1948-2010	28°F	7-May	28-Sep	144
		32°F	19-May	18-Sep	122



Incorporation of existing data

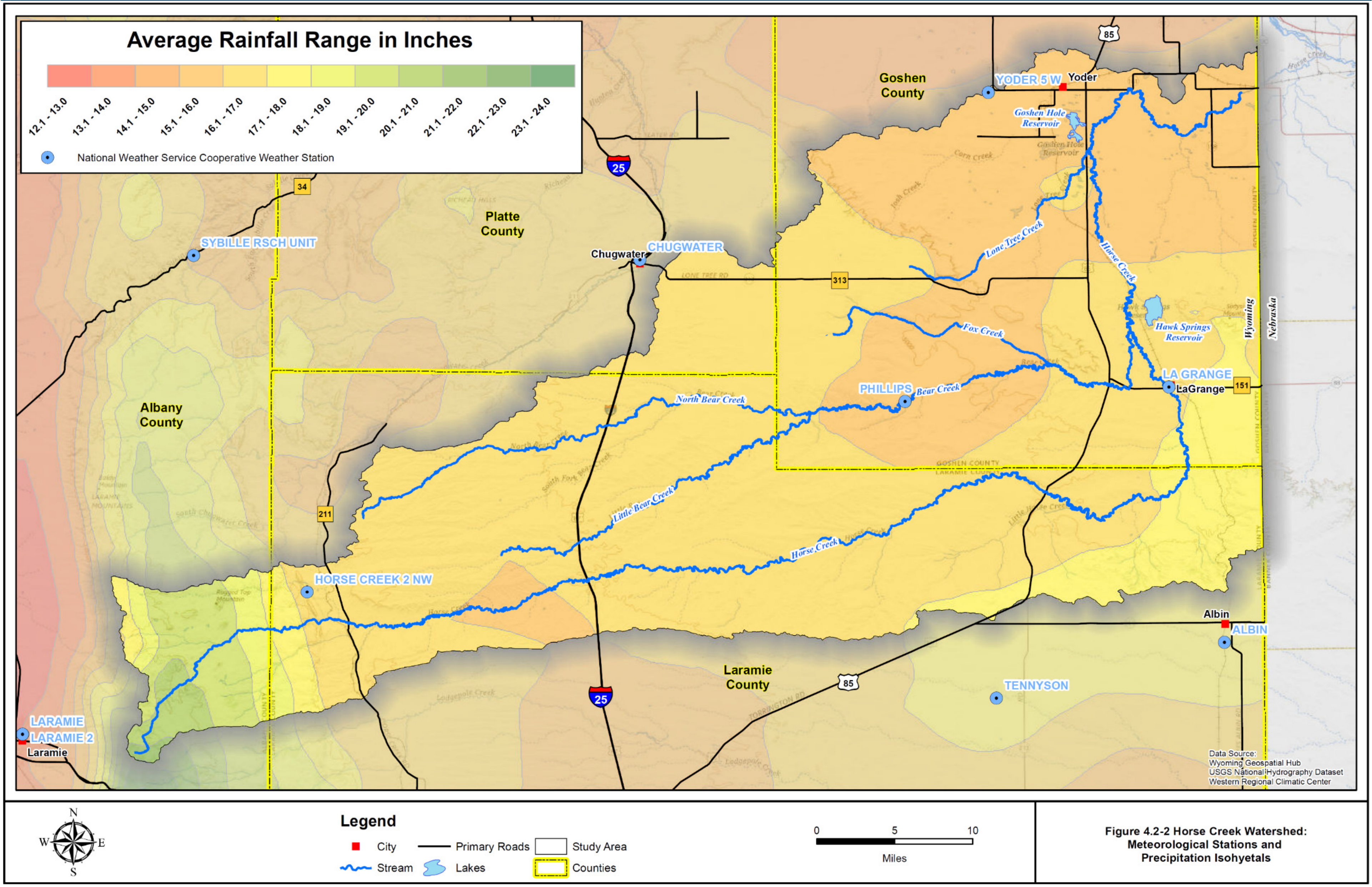


Figure 4.2-2 Horse Creek Watershed: Meteorological Stations and Precipitation Isohyetals

Watershed Inventory and Assessment

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 2AB
- Horse Creek (upstream of Stinking Water Creek)
- Bear Creek
- Fox Creek
- Little Bear Creek
- Bushnell Creek
- Little Horse Creek
- S Fork Horse Creek
- Mill Creek

Class 2ABWW (warm water fishery)
- Horse Creek (Downstream of Stinking Water Creek)
- Goshen Hole Reservoir
- Bump-Sullivan Reservoir
- Sinnard Reservoir
- Hawk Springs Reservoir

Class 2C
- Dry Creek

Class 3B
- Robb Draw
- Corn Creek
- Josh Creek
- Lone Tree Creek
- N Bear Creek
- S Bear Creek
- Four Mile Draw
- Springer Creek
- Carey Creek
- Spring Creek

Incorporation of existing data

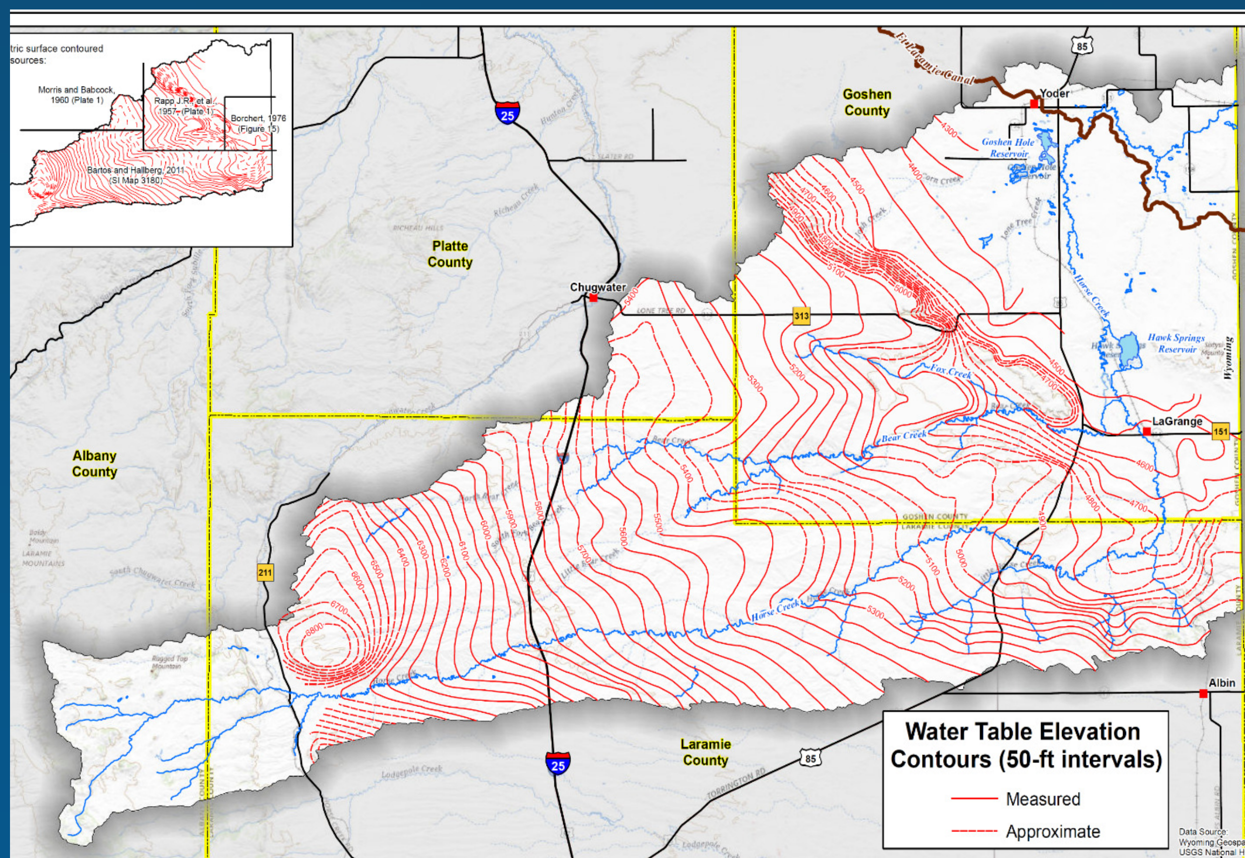
Watershed Inventory and Assessment

Geology:

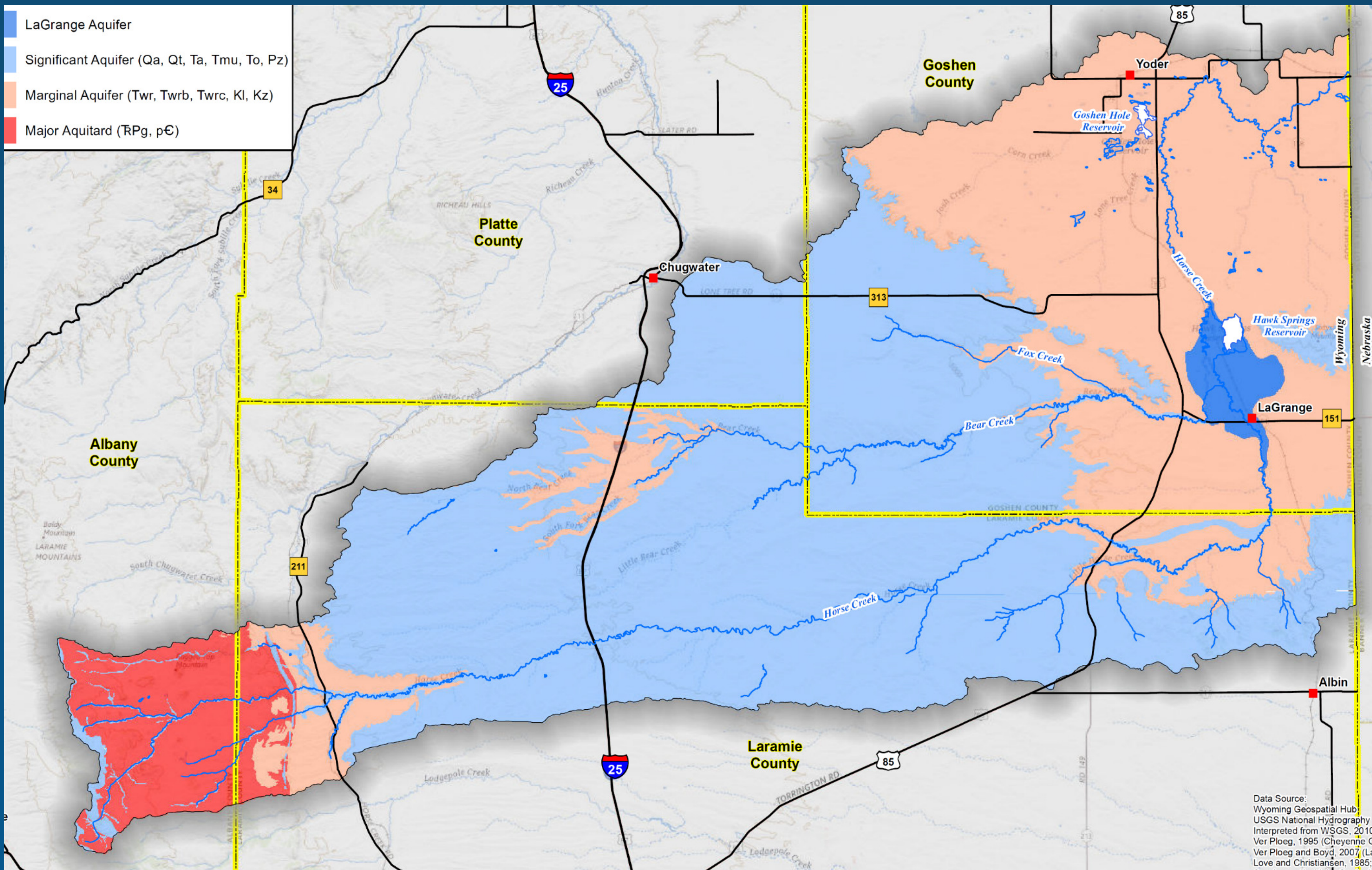
- Surficial
- Bedrock
- Stratigraphy
- Geologic Structure
- Geologic Hazards

Groundwater:

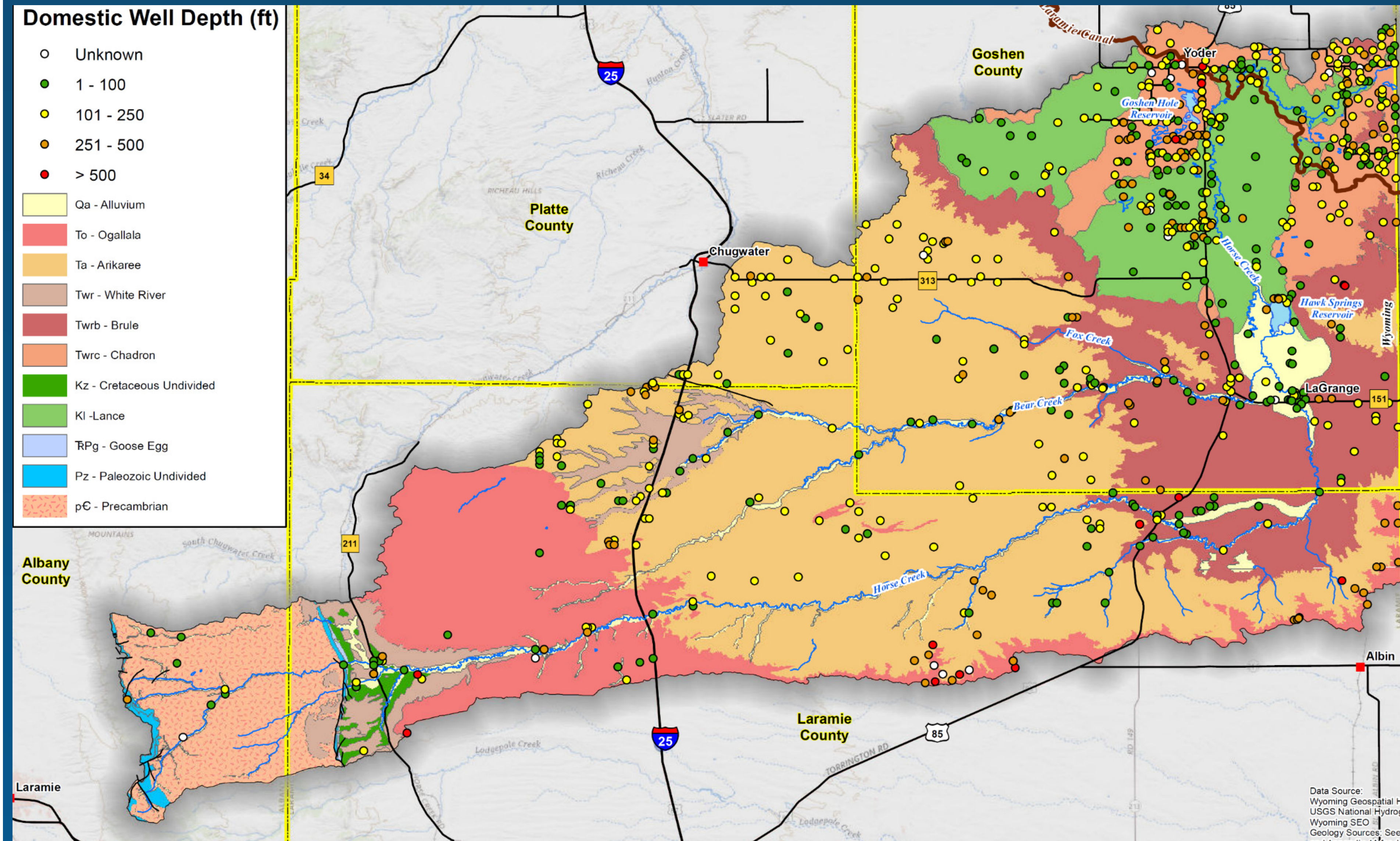
- Recharge
- Levels and Flow
- Discharge
- Aquifers
- Quality/Sensitivity
- Use



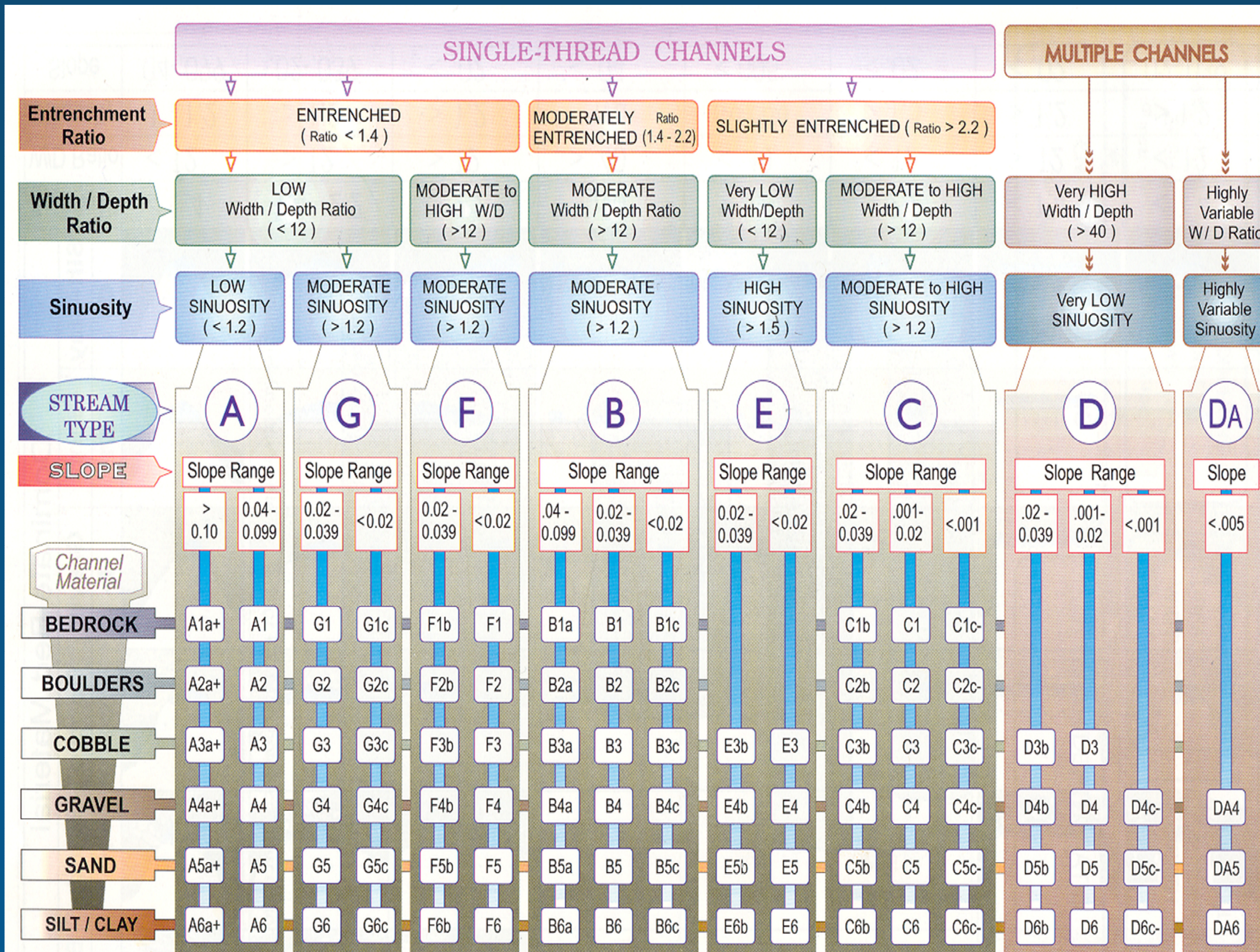
Watershed Inventory and Assessment



Watershed Inventory and Assessment



Watershed Inventory and Assessment: Geomorphology



Watershed Inventory and Assessment: Geomorphology

Type B: Upper Bear Creek

Type C: Horse Creek

Bank Erosion: Horse Creek

Watershed Inventory and Assessment: Geomorphology

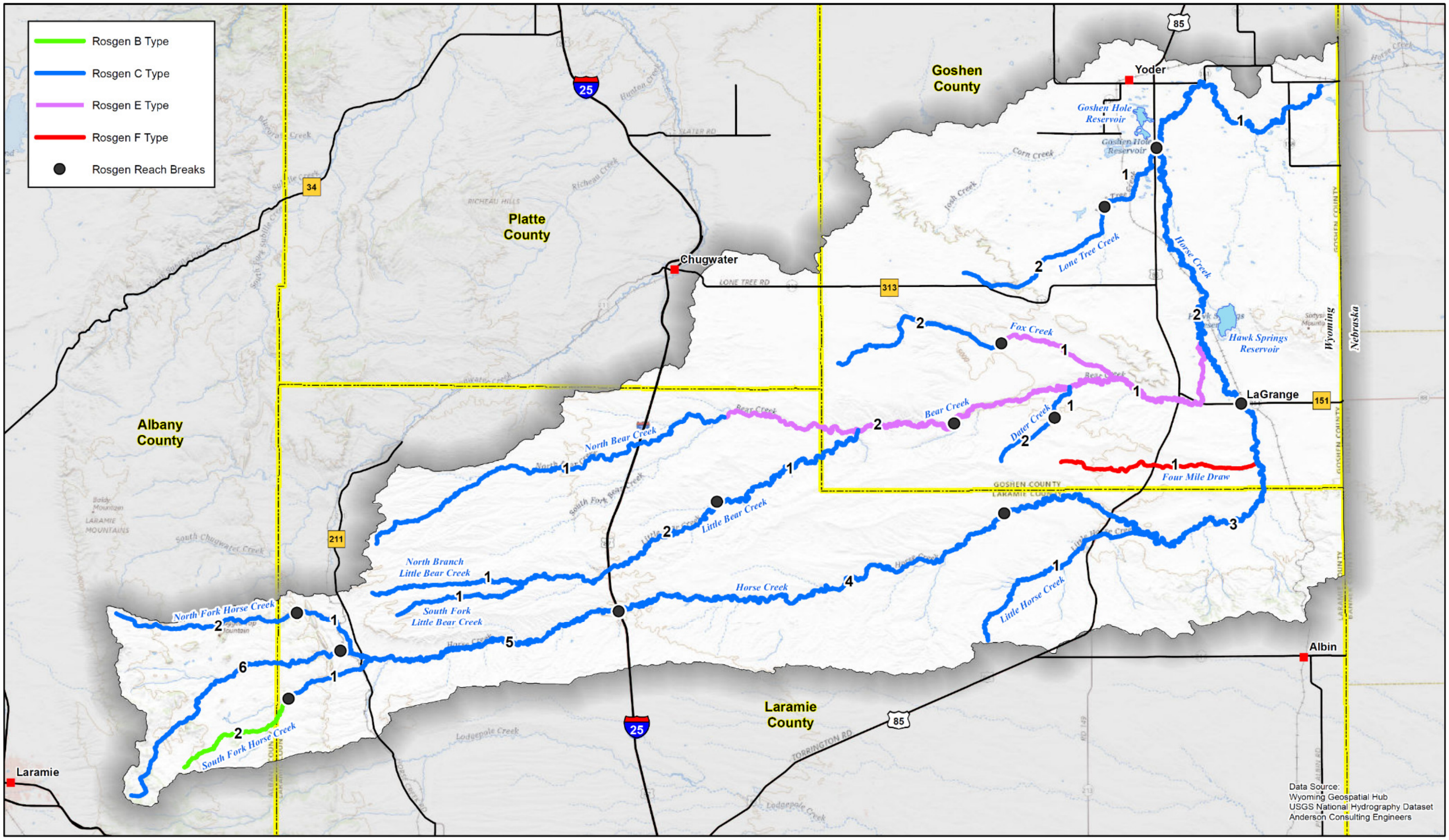


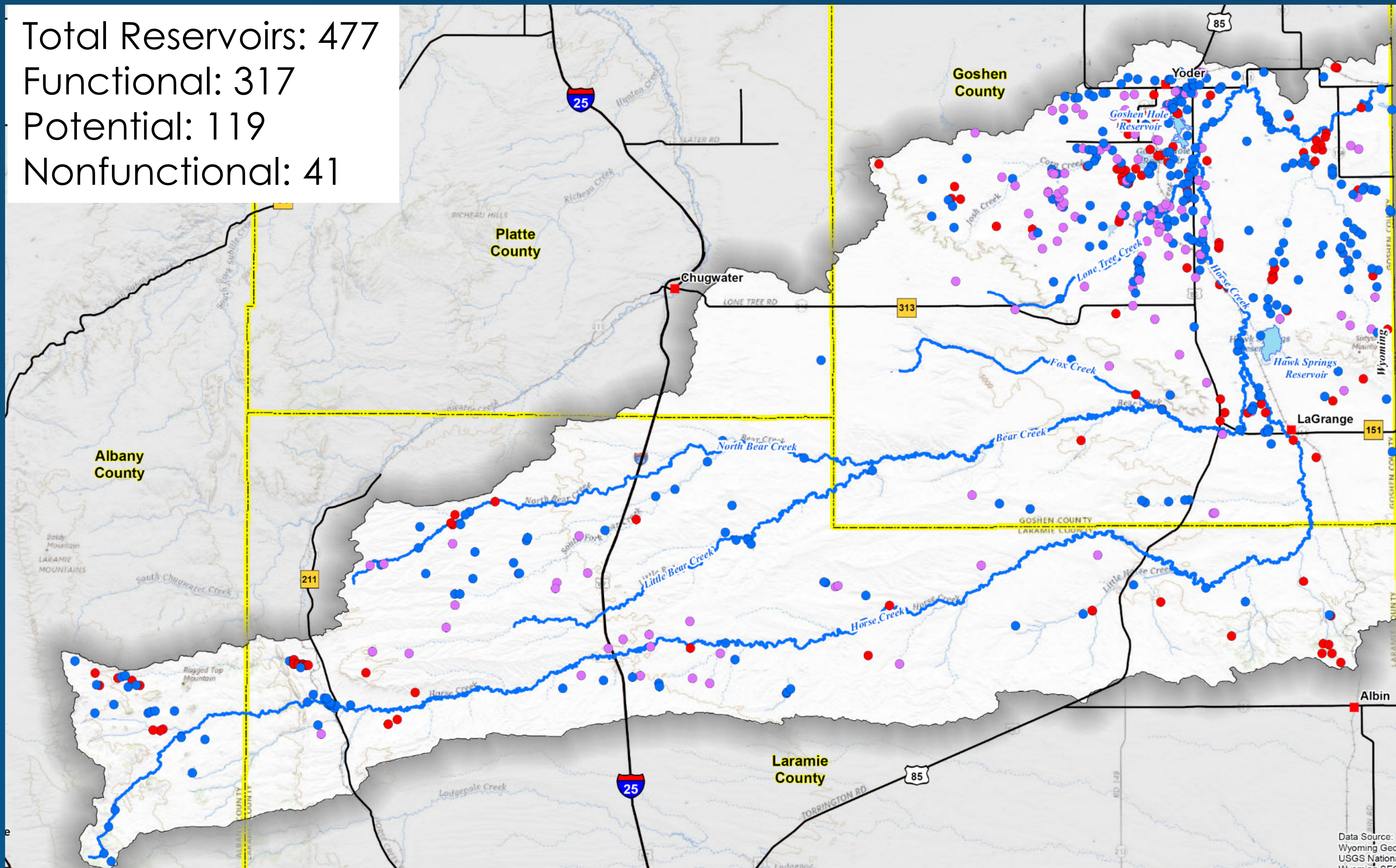
Figure 4.2-26 Horse Creek Watershed: Results of Level I Classification Effort

Watershed Inventory and Assessment: Geomorphology

Watershed Inventory and Assessment: Stock Reservoirs

Watershed Inventory and Assessment: Stock Reservoirs

Total Reservoirs: 477
Functional: 317
Potential: 119
Nonfunctional: 41



Watershed Inventory and Assessment: Site Visits

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

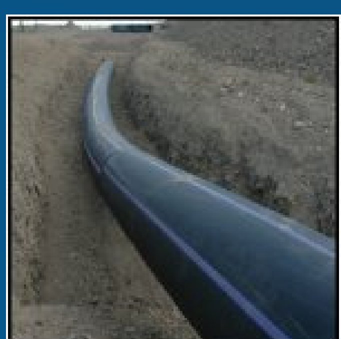
- Resource Issue Recommendations
- Irrigation Rehabilitation
- Stream Restoration
- Upland Water Opportunities
- Conceptual Designs
- Cost Estimates
- Permitting Requirements
- Funding Opportunities

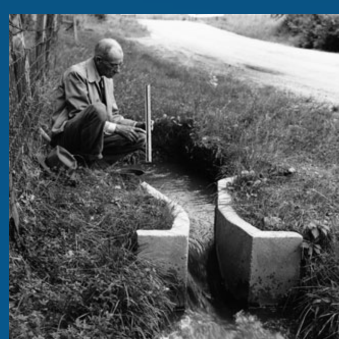
GOAL: Develop and evaluate practical and economical alternatives

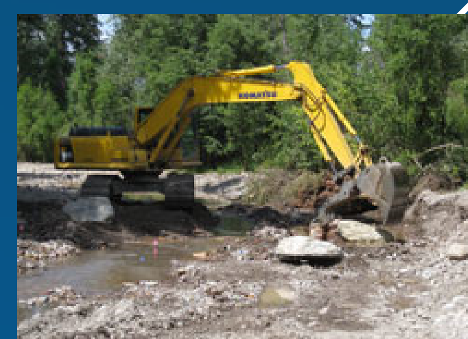
<u>Components of the Plan:</u>

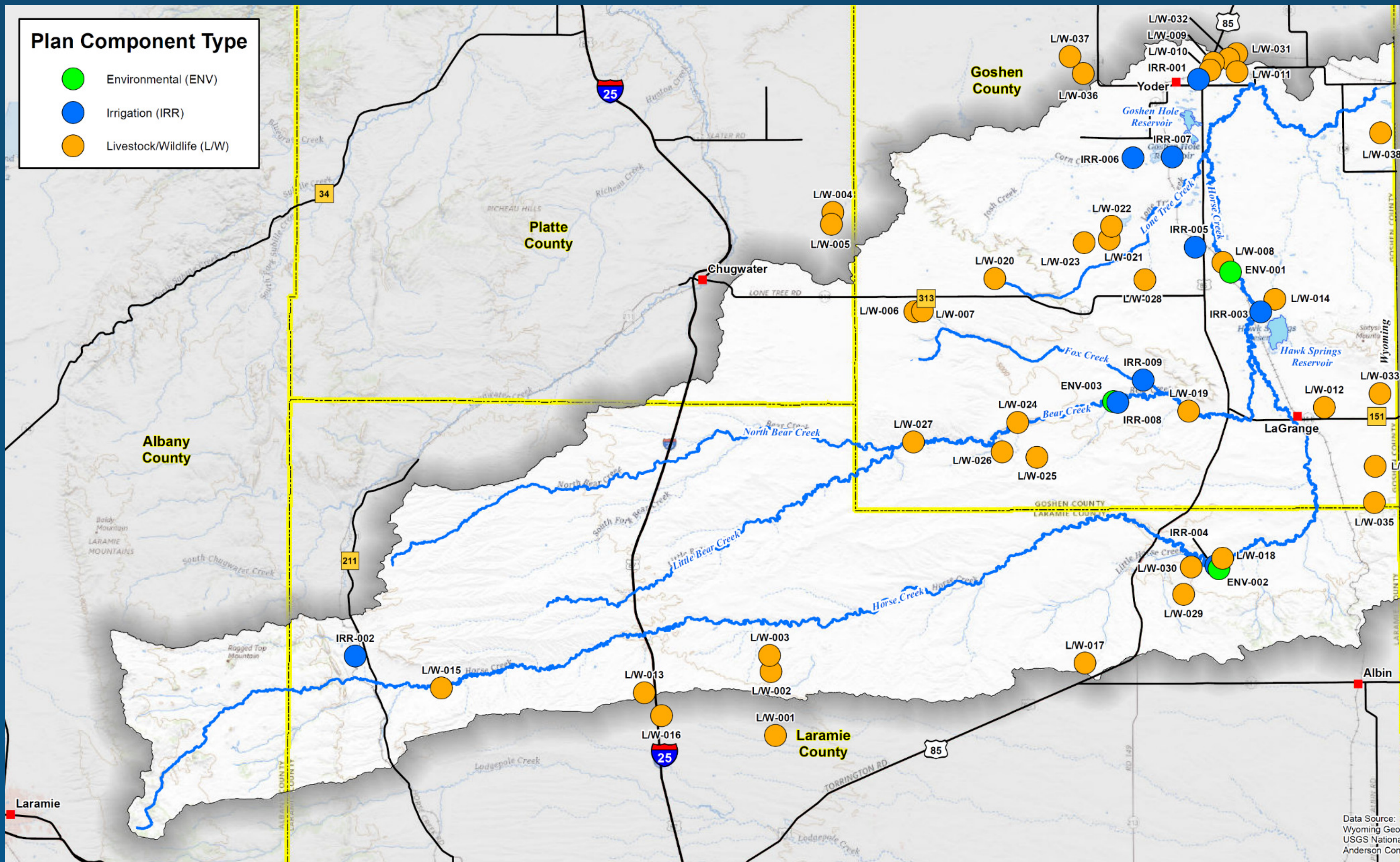
A. Upland Livestock/Wildlife
B. Channel Stability
C. Irrigation
D. Aquatic Vegetation

- Evaluate, Describe and Prioritize
- Project Plans, Maps, Designs, and Costs
- Facilitate Preparation of SWPP applications









Plan Component Type
Environmental (ENV)
Irrigation (IRR)
Livestock/Wildlife (L/W)
Albany County
Platte County
Goshen County
Laramie County
Laramie
Chugwater
Yoder
LaGrange
Albin
Goshen Hole Reservoir
Hawk Springs Reservoir
North Bear Creek
Little Bear Creek
Horse Creek
Bear Creek
Fox Creek
Lone Tree Creek
IRR-001
IRR-002
IRR-003
IRR-004
IRR-005
IRR-006
IRR-007
IRR-008
IRR-009
ENV-001
ENV-002
ENV-003
L/W-001
L/W-002
L/W-003
L/W-004
L/W-005
L/W-006
L/W-007
L/W-008
L/W-009
L/W-010
L/W-011
L/W-012
L/W-013
L/W-014
L/W-015
L/W-016
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L/W-028
L/W-029
L/W-030
L/W-031
L/W-032
L/W-033
L/W-035
L/W-036
L/W-037
L/W-038
25
34
85
151
211
313
Data Source:

Irrigation Components

Horse Creek Watershed Management Plan			
Watershed Management Plan Component	Watershed Management Plan Component	County	Project Name
Irrigation Components			
IRR-001	Alps-001	Goshen	Alps Ditch Conversion Project
IRR-002	Christofferson-001	Laramie	Christofferson Ditch Diversion Reconstruction
IRR-003	Davis-002	Goshen	Davis Pipeline Project
IRR 004	Frank-001	Goshen	Scoon Ditch Diversion Rehabilitation Project
IRR-005	Hanlon-001	Goshen	Schwab Ditch Conversion Project
IRR-006	Sipola-001	Goshen	Sipola Ditch Conversion Project
IRR-007	Tomayer-001	Goshen	Tomayer Pipeline Project
IRR-008	Thaler-002	Goshen	Bear Creek Ditch Measurement Device
IRR-009	Thaler-001	Goshen	Fox Creek Diversion Structure

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

Livestock / Wildlife Water Supply Projects			
1	Berry 001	Laramie	Berry Well Construction Project No. 1
2	Berry 002	Laramie	Berry Well Construction Project No. 2
3	Berry 003	Laramie	Berry Well Rehabilitation Project
4	Borchardt-001	Laramie	Borchardt Solar Platform Instatllation
5	Borchardt-002	Laramie	Borchardt Pipeline Extension Project
[illegible]5	Borchardt-003	Laramie	Borchardt Stock Tank Project
L/W-007	Borchardt-004	Laramie	Borchardt Spring Development Project
L/W-008	Buchaults-001	Goshen	Buchaults Pipeline Project
L/W-009	Cecil-001	Goshen	Cecil Well Construction Project
L/W-010	Cecil-002	Goshen	Cecil Pipeline Project No. 1
L/W-011	Cecil-003	Goshen	Cecil Pipeline Project No. 2
L/W-012	Chamberlain-001	Goshen	Chamberlain Pipeline Project
L/W-013	Clark-001	Laramie	Clark Well Construction
L/W-014	Davis-001	Goshen	Davis Stock Reservoir Rehabilitation
L/W-015	Dereemer-001	Laramie	Dereemer Pipeline Project
L/W-016	Drake-001	Laramie	Drake Well Construction Project
L/W-017	Eklund-001	Laramie	Eklund Solar Platform / Pipeline Project
L/W-018	Frank-003	Goshen	Frank Pipeline Project
L/W-019	Grandstaff-001	Goshen	Grandstaff Pipeline Project
L/W-020	Jackson-001	Goshen	Jackson Pipeline Project
L/W-021	Ruiz-001	Goshen	Ruiz Solar Platform Project
L/W-022	Ruiz-002	Goshen	Ruiz Pipeline Project No. 1
L/W-023	Ruiz-003	Goshen	Ruiz Pipeline Project No. 2
L/W-024	ScheerD-001	Goshen	Scheer D. Well Construction Project
L/W-025	ScheerD-002	Goshen	Scheer D. Solar Platform Project
L/W-026	ScheerJ-001	Goshen	Scheer J. Pipeline Project
L/W-027	ScheerJ-002	Goshen	Scheer J. Irrigation Pipeline Project
L/W-028	Shimic-001	Goshen	Shimic Stock Reservoir Project
L/W-029	Shoun-001	Goshen	Shoun Well Construction Project No. 1
L/W-030	Shoun-002	Goshen	Shoun Well Construction Project No. 2
L/W-031	Tomayer-002	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 1
L/W-032	Tomayer-003	Goshen	Tomayer Stock Reservoir Rehabilitation Project No. 2
L/W-033	Tremain-001	Goshen	Tremain Solar Platform Project No. 1
L/W-034	Tremain-002	Goshen	Tremain Solar Platform Project No. 2
L/W-035	Tremain-003	Goshen	Tremain Solar Platform Project No. 3
L/W-036	Yeik-001	Goshen	Yeik Pipeline Project No. 1
L/W-037	Yeik-002	Goshen	Yeik Pipeline Project No. 2
L/W-038	Zimmerer-001	Goshen	Zimmerer Spring Development

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

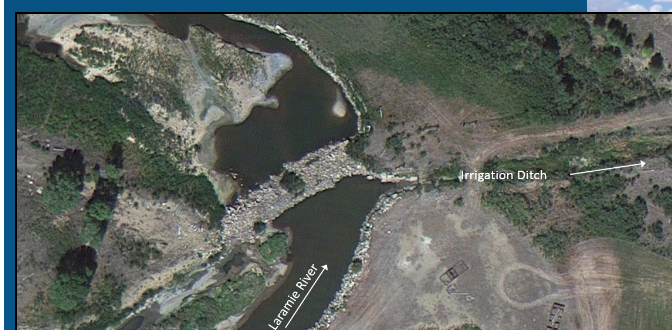
Horse Creek Watershed Management Plan			
Watershed Management Plan Component	**Watershed Management Plan Component**	**County**	**Project Name**
ENV-001	Buchaults-002	Goshen	Buchaults Check Structure - Horse Creek
ENV-002	Frank-002	Goshen	Horse Creek Bank Stabilization Project
ENV-003	Kessler-001	Goshen	Bear Creek Sedimentation Project

Environmental Components

- Channel Bed / Bank Protection Alternatives
  - Structural Bank Protection
  - Bioengineered Protection
  - Integration of both structural / bioengineered
  - Land Management

Diversion Structure Alternatives

- Identify / develop alternatives that enhance/maintain aquatic habitat / Barriers to fisheries



Barriers to Fish Passage

Channel Gradient Restoration Alternatives

Environmental Components

Aquatic Vegetation Components

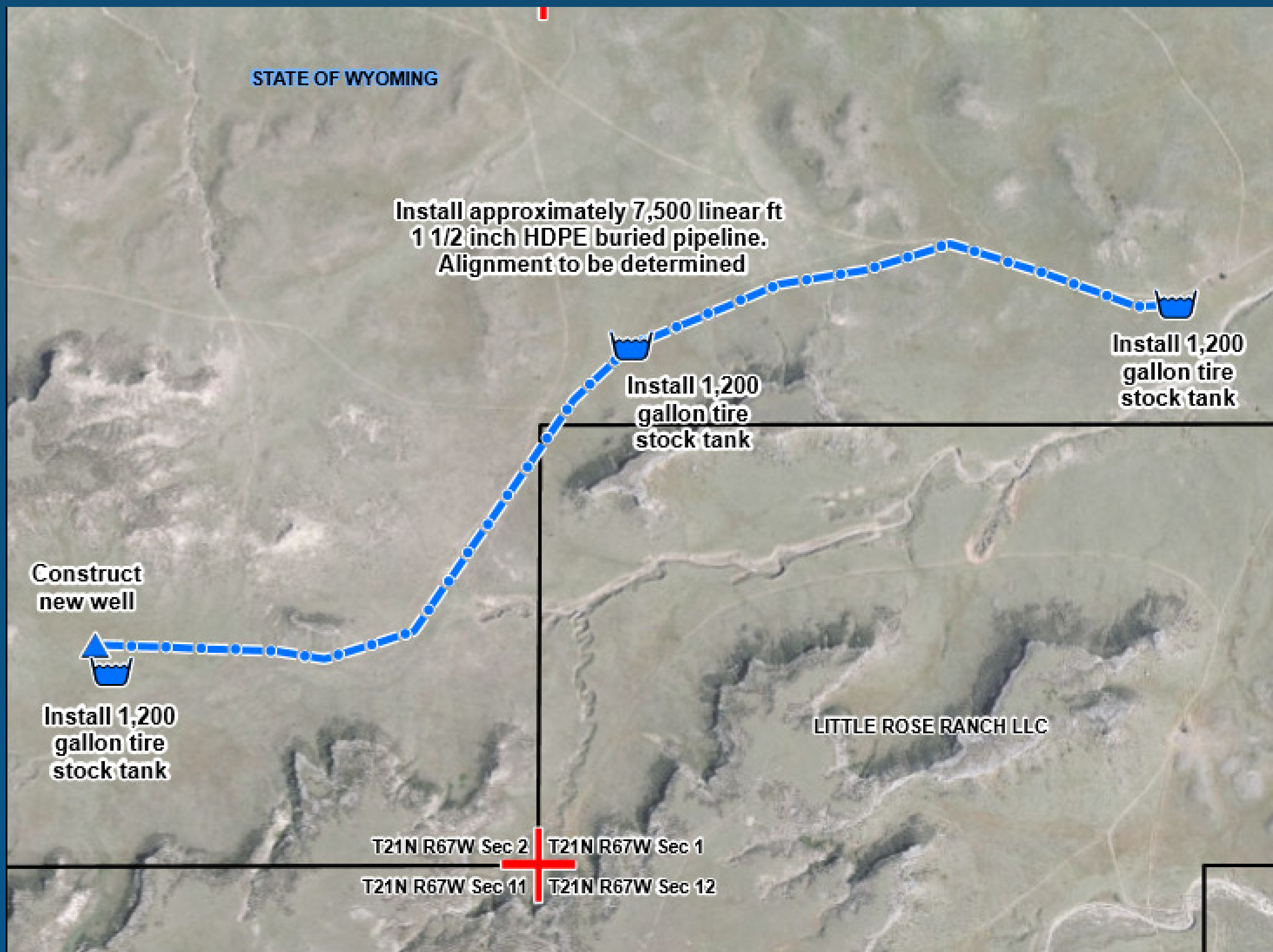
Interviewed Wyoming Irrigation District Management:

- Horse Creek Conservation District: chemicals
- Heart Mountain Irrigation District: chemicals / screen / physical removal
- Midvale Irrigation District: chemical
- Big Horn Canal Irrigation District: turbulent fountains
- Wheatland Irrigation District: chemicals
- Kirby Irrigation District: ditch reconfiguration
- Goshen Irrigation District: chemicals

Rooted vegetation vs floating vegetation/debris
Chemical vs Structures
Labor intensive: no "silver bullet"

Aquatic Vegetation 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

<u>State Sources</u>

- 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

<u>Federal Sources</u>

- 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*

Purpose:

- To complete a comprehensive evaluation of the watershed,
- Develop a watershed management plan addressing issues identified

Watershed Inventory:

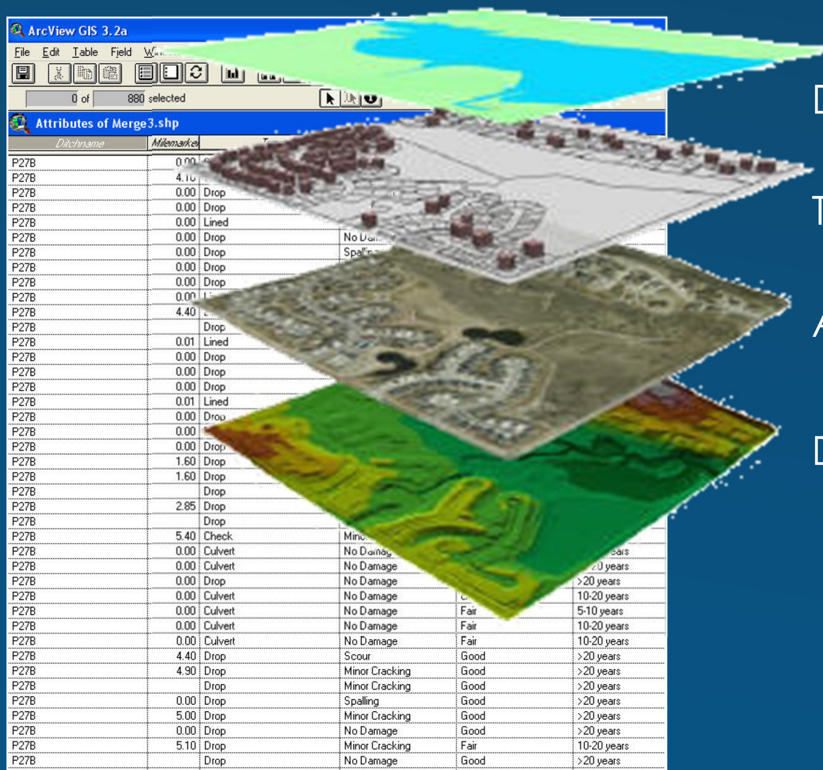
- Literature Review
- Field Data Collection
- Public Input
- Resource Issue Identification

Geographic Information System

<u>Watershed Management Plan</u>

- 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.

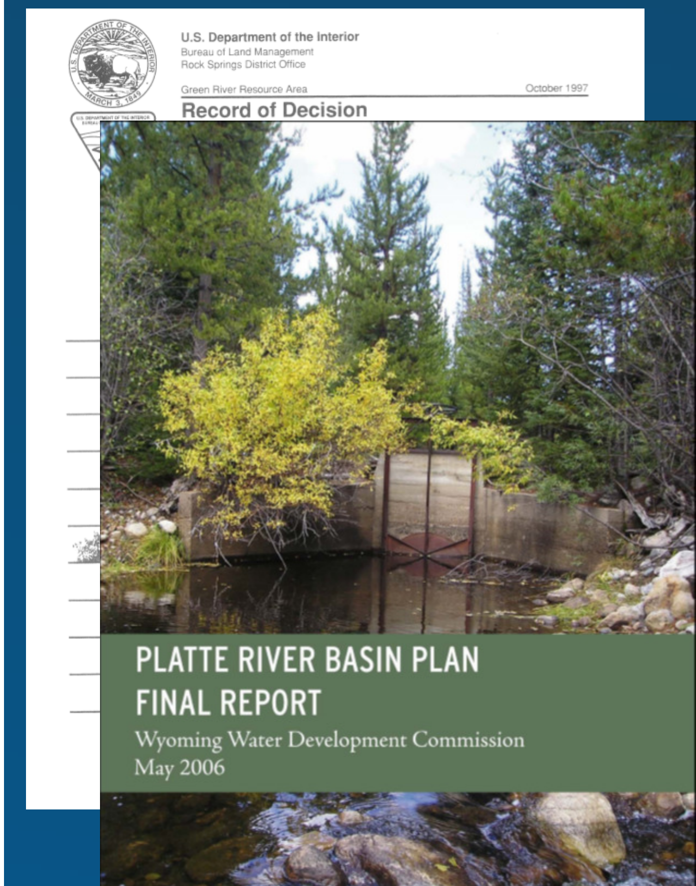
Topographic Mapping

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.

3

- Review of Existing Information

The Horse Creek Digital Library

Spreadsheet – driven annotated bibliography
Documents accessed via hypertext
Macro-driven revisions to the database (sort / add / remove docs)

Next Steps:

Follow up with the SGCD

There are several funding / tech assistance programs available

Horse Creek 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	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.
13	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.
14	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.
15	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
16	Aquatic and Ditchbank Weed Control	Excerpt from the 2006-2007 Weed Management Handbook which outlines the mechanical, biological and chemical solutions to control aquatic weeds.
17	Aquatic Vegetation in Irrigation Canals	Guidance manual for aquatic vegetation management which provides water conveyance system managers a summary of available technologies for aquatic vegetation management.
18	Assessing Channel Change and Bank Stability Downstream of a Dam, Wyoming	Evaluation of effects of a reservoir on the creek downstream.

Item Number	Title	Description
19	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.
20	Auxiliary Spillway Cross Section & Profile (378-08b)	NRCS Design Drawing for Wetland Standard Auxiliary spillway profile cross section and profile
21	Auxiliary Spillway Cross Section & Profile Example (378-08b)	Example of completed "Auxiliary Spillway Cross Section & Profile" NRCS Wetland Standard Design Drawing
22	Beginner's Guide to Greater Sage Grouse	Provides key points about seasonal habitats, natural history and population trend analyses for the greater Sage Grouse.
23	Beneficial Use Reconnaissance Monitoring and Assessment Report - Bear Creek	Documents the findings of the 1999 assessment of Bear Creek and provides a determination of the whether designated uses assigned to Bear Creek are supported.
24	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.
25	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.
26	C.M. Pipe Drop Inlet with Pond Drain	NRCS Design Drawing for CMP drop inlet pond
27	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.
28	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.
29	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).
30	Closing Remarks/Workshop Summay (Western Invasive Weed Summit)	Summarizes what is at stake if invasive plants are ignored, and the importance of mitigation efforts.
31	CMP Water Control Structure (587-09)	NRCS Design Drawing for CMP Water Control Structure with two gated pipes
32	CMP Water Control Structure (587-10)	NRCS Design Drawing for CMP Water Control Structure
33	CMP Water Control Structure (587-11a and 587-11)	NRCS Design Drawing for CMP Water Control Structure
34	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.
35	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.
36	Concrete Ditch Lining (428-01)	NRCS Design Drawing for concrete ditch lining for flows less than 1.5 cfs
37	Concrete Ditch Lining (428-02)	NRCS Design Drawing for concrete ditch lining for flows between 1.5 cfs and 2.5cfs

Item Number	Title	Description
38	Concrete Water Control Structure (587-07)	NRCS Design Drawing for 4'x4' Concrete box irrigation structure with two gated pipes
39	Concrete Water Control Structure (587-08)	NRCS Design Drawing for 4'x4' Concrete box irrigation structure with one gated pipe
40	Construction and Testing Report Yoder No 2 Production Well - Final Report	Evaluates hydrologic parameters, and water quality data collected during the construction, testing, and sampling of the Yoder No. 2 Production Well.
41	Consumptive Use of Irrigation Water in Wyoming	Estimating water requirements and consumptive water use based on the Blaney-Criddle Method
42	Crucial Habitat Area Narrative - Lower Horse Creek (Aquatic)	Describes the habitat values, reason selected, and conservation solutions
43	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.
44	Ditch Rights and Easements	FAQ for legal aspects relating to ditch rights and easements
45	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
46	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.
47	Earthquakes and Related Geologic Hazards in Wyoming	Causes, mechanisms, and measuremnet of earthquakes; history and earthquake potential in Wyoming; related geologic hazards
48	Ecological Site and State-and-Transition	ESD definition and significance. Summary and descriptions of predominant ESD's in study area
49	Economic Benefits of Watershed Restoration	Quantifying economic benefits that arise from watershed resotration
50	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.
51	Embankment Pond Profile & Cross Section (378-08a)	NRCS Design Drawing for Wetland Standard Embankment Pond profile and cross section
52	Embankment Pond Profile & Cross Section Example (378-08a)	Example of completed "Embankment Profile and Cross Section" NRCS Wetland Standard Design Drawing
53	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.
54	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.
55	Enhancement Habitat Area Narrative - Mixed Mountain Shrub (Terrestrial)	Describes the habitat values, reason selected, and conservation solutions
56	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.
57	ESIS User Guide NRCS	Introduction to Ecological Site Information System, ESD Application, and guidance for facilitating an ESD effort in your state
58	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
59	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
60	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.
61	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
62	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
63	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
64	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.
65	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).
66	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.
67	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.
68	Freeze / Frost Occurrence Data	Probablility of last freeze (spring) date, first freeze (fall) date, freeze free period, and annual freeze/frost probability.
69	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.
70	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.
71	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.
72	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.
73	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
74	Geosynthetic Clay Liners (GCL's)	Applications and product specifications for geosynthetic clay liners.
75	Geotechnical Engineering Site Comparison Feasibility Report - Horse Creek Reservoir Project	Site comparison between the two sites (Lower and Upper Bureau) on Horse Creek, near Torrington, Wyoming for the proposed water storage reservoir.
76	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.
77	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.

Item Number	Title	Description
78	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.
79	Goshen Hole and Goshen Mutual Canal Companies Improvements Project, Level II - Executive Summary	A feasibility study of structural or management measures associated with both of the canal companies to improve operation/management, reduce maintenance, and rehabilitate structures associated with supply ditches, main canals, and laterals.
80	Goshen Hole and Goshen Mutual Canal Companies Improvements Project, Level II - Final Report	A feasibility study of structural or management measures associated with both of the canal companies to improve operation/management, reduce maintenance, and rehabilitate structures associated with supply ditches, main canals, and laterals.
81	Goshen Irrigation District Horse Creek Reregulating Reservoir, Level II Project - Executive Summary	Investigates the feasibility of storing excess flows (operational waste) and storm flows in a re-regulating reservoir located on Horse Creek.
82	Goshen Irrigation District Horse Creek Reregulating Reservoir, Level II Project - Final Project	Investigates the feasibility of storing excess flows (operational waste) and storm flows in a re-regulating reservoir located on Horse Creek.
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 improvemnets, 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 improvemnets, 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	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.

Item Number	Title	Description
95	Groundwater Quality of Southeastern Wyoming	A summary of groundwater supply and groundwater quality in Platte, Goshen, and Laramie counties.
96	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.
97	Hawk Springs Master Plan Study, Level II - Executive Summary	Updates the Horse Creek Conservation District's previous water system master plan, inventories and evaluates the existing system, performs a bathymetric survey of Hawk Springs Reservoir, creates a contour map of the reservoir bottom, determines sediment accumulation, develops a present day area capacity table, and prepares a reservoir operations model for the Hawk Springs Reservoir.
98	Hawk Springs Master Plan Study, Level II - Final Report	Updates the Horse Creek Conservation District's previous water system master plan, inventories and evaluates the existing system, performs a bathymetric survey of Hawk Springs Reservoir, creates a contour map of the reservoir bottom, determines sediment accumulation, develops a present day area capacity table, and prepares a reservoir operations model for the Hawk Springs Reservoir.
99	Hawk Springs Reservoir Enlargement Analysis - Final Report	Identifies needed improvements and approximate cost analysis for the 1-ft vertical enlargement of Hawk Springs Reservoir.
100	Hawk Springs Water Supply Project - Executive Summary	Identifies four alternatives for the water supply system of Hawk Springs
101	Hawk Springs Water Supply Project - Final Report	Identifies four alternatives for the water supply system of Hawk Springs
102	Horse Creek Conservation District Improvements Project, Level II - Executive Summary	A feasibility study of structural and management measures to improve operation of the irrigation delivery system, reduce maintenance and rehabilitate the structures associated with the laterals for Horse Creek Conservation District.
103	Horse Creek Conservation District Improvements Project, Level II - Final Report	A feasibility study of structural and management measures to improve operation of the irrigation delivery system, reduce maintenance and rehabilitate the structures associated with the laterals for Horse Creek Conservation District.
104	Horse Creek Groundwater / Surface Water Connection Investigation Goshen and Laramie Counties, Wyoming	A study of the relationship between groundwater and surface water in the Horse Creek Basin of Goshen and Laramie Counties in eastern Wyoming, with particular reference to the availability of water for irrigation
105	Horse Creek Reservoir, Level II Study - Executive Summary	Establishes the cost and benefits of a reservoir on Horse Creek. The study included four major phases: hydrology, dam site selection, feasibility analysis, and economic analysis.
106	Horse Creek Reservoir, Level II Study - Final Report	Establishes the cost and benefits of a reservoir on Horse Creek. The study included four major phases: hydrology, dam site selection, feasibility analysis, and economic analysis.
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 Study of the Laramie County Control Area	Informal overview for Laramie County Commission Workshop
109	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.
110	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.
111	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.
112	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.

Item Number	Title	Description
113	Invasive Plant Management and Greater Sage Grouse Conservation	A review and status report with strategic recommendations for improvement
114	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
115	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."
116	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."
117	Linings For Irrigation Canals	Presents instructions, standards and procedures for use in the lining of irrigation canals.
118	Little Horse Creek Conveyance Loss Study	Study to determine if water from Little Horse Creek, upon regulation of upstream diversions (Springvale, Wood and Lykins), does reach the Brown and LaGrange diversion downstream on Horse Creek.
119	Livestock Pipeline Appurtenances (516-01)	NRCS Design Drawing for livestock pipeline appurtenances
120	Log Deflector	NRCS Design Drawing for Log Deflector
121	Male Greater Sage Grouse Detectability 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
122	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.
123	Mapping breeding densities of greater Sage Grouse: A tool for range-wide conservation planning	Sage Grouse breeding density and how it is measured
124	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.
125	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.
126	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.
127	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
128	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
129	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).
130	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.
131	Modified Pfankuch Channel Stability Rating Procedure Summary	Worksheet for quantifying channel stability based on slope, debris, vegetation, capacity, obstructions, scouring/deposition, etc.
132	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
133	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.
134	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.

Item Number	Title	Description
135	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.
136	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.
137	NRCS Design Steel Watering Tank with Concrete Base (614-01)	NRCS Design Drawing for steel watering tank with concrete base
138	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 downstream velocity and bed shear stress).
139	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.
140	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.
141	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.
142	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.
143	Peak-Flow Characteristics of Wyoming Streams	Water Resources Investigations Report on peak-flow characteristics and frequency relations for unregulated streams in Wyoming
144	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.
145	Plan Layout - Embankment Pond (378-08)	NRCS Design Drawing for Wetland Standard Embankment Pond
146	Plan Layout - Embankment Pond Example (378-08)	Example of completed "Plan Layout - Embankment Pond" NRCS Wetland Standard Design Drawing
147	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
148	Platte River Basin Plan	Presents estimated current and estimated future uses of water in Wyoming's Platte River Basin
149	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.
150	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.
151	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
152	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.
153	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.
154	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

Item Number	Title	Description
155	Proposed Reclassification of Horse Creek, North Platte River Basin in Goshen County, Wyoming	Recommends the reclassification of the main stem of Horse Creek from its confluence with Stinking Water Creek downstream to the Nebraska State Line from 2AB (supports a coldwater fishery and drinking water) to 2ABww (supports a warmwater fishery and drinking water.
156	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.
157	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.
158	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).
159	Rawlins Final EIS: Chapter 3 - Affected Environment	Characterizes the existing environment of the Rawlins Resource Management Plan Planning Area.
160	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.
161	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.
162	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.
163	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.
164	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.
165	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.”
166	Riparian Area Management - Grazing Management for Riparian-Wetland Areas	Presents information from various land managers and researchers to guide livestock management in riparian areas
167	Rock Riprap Streambank Stabilization (580-06)	NRCS Design Drawing for rock riprap streambank stabilization
168	Root Wad	NRCS Design Drawing for Root Wad
169	Rubber Tire Stock Tank Details (614-02)	NRCS Design Drawing for rubber tire watering tank with interior CMP or PE pipe inlet
170	Rubber Tire Stock Tank Details (614-03)	NRCS Design Drawing for rubber tire watering tank with frost free hydrant
171	Rubber Tire Trough	NRCS Design Drawing for Tire Trough
172	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
173	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.
174	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.
175	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.
176	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.

Item Number	Title	Description
177	Science and Management Integration Plan	Provides guidance for research needs of the WLCI, and maintains adaptive management as the framework for WLCI processes.
178	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).
179	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
180	Seepage Protection Filter (378-07a)	NRCS Design Drawing for seepage protection filter
181	Sheet Piling Structure Capacity and Quantity Computations	NRCS Design Drawing and calculation format for sheet piling structure
182	Sheet Piling Structure with Catwalk	NRCS Design Drawing for sheet piling structure with catwalk
183	Small Water Projects Program 101 (Slideshow)	Describes general SWPP concepts, eligibility, recent criteria changes, project timelines, and steps to project completion.
184	Solar Panel Well and Surface Installation (533-01)	NRCS Design Drawing for solar panel well and surface installation
185	Spring Development (574-01)	NRCS Design Spring Development Box with gravity flow supply outlet
186	Spring Development with Pump Manifold Outlet	NRCS Design Spring Development Box with pumping system outlet
187	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.
188	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.
189	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.
190	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.
191	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.
192	Steet Sheet Pile Drop Structure	NRCS Standard design drawing for steel sheet pile drop structure
193	Strategic Habitat Plan	Strategies to promote and maintain the availability of high quality habitat to sustain and enhance wildlife populations in the future.
194	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.
195	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.
196	Strategic Plan (WLCI)	Describes the goals and objectives of the WLCI and the strategies needed to successfully accomplish a science-based, landscape-scale initiative.
197	Stream Bank Stablization Rock Riffle Details	NRCS Design Drawing for Rock Riffle Structure
198	Stream Barbs (580-05)	NRCS Design Drawing for stream barbs
199	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.
200	Stream Classification	Presentation on the Rosgen Stream Classification System.
201	Stream Crossing and Livestock Access (578-01)	NRCS Design Drawing for stream crossing and livestock access

Item Number	Title	Description
202	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
203	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
204	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.
205	Summary of State Loan Programs and Associated Loan Loss Reserve Funds	State loan program summaries and loan schedules.
206	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
207	Technical Memorandum 2.6 - Water Use from Storage	Technical Memo on water use from storage in support of the Platte River Basin Plan
208	Technical Notes: Watering Facility Wildlife Escape Structures	Provides approved designs for wildlife escape structures in watering facilities.
209	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.
210	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.
211	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.
212	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
213	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.
214	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.
215	Town of Lingle Water Supply Master Plan, Level I Project - Executive Summary	A Level 1 reconnaissance investigation to develop a water supply master plan for the Town of Lingle, projecting water supply needs for the next 30 years.
216	Town of Lingle Water Supply Master Plan, Level I Project - Final Report	A Level 1 reconnaissance investigation to develop a water supply master plan for the Town of Lingle, projecting water supply needs for the next 30 years.
217	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.
218	Vortex Weir	NRCS Design Drawing for vortex weir
219	WAFWA Greater Sage Grouse Management Zone II	Sage Grouse Breeding Density Map
220	Water Management & Conservation Assistance Programs 2014 Directory	An overview of local, state and federal incentive assistance programs
221	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
222	Water Rights, Streamflow & Hydrogeology of the Horse Creek Basin, Wyoming	This report was prepared at the request of the Wyoming Attorney General's Office to investigate the contribution of Horse Creek to the flows of the North Platte River.
223	Weed and Pest Declared List (By County) Amended February 2017	Declared weeds and pests listed by county
224	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.
225	Wetlands and Deepwater Habitats Classification	Chart used to classify wetlands and deepwater habitats by system, subsystem, class, and subclass
226	Where the Wild Lands Are: Wyoming	Importance of backcountry areas to Wyoming fish, wildlife, hunting and angling
227	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.
228	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.
229	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.
230	Wildlife Guzzler Type A (636-5)	NRCS Design Drawing for Type A Wildlife Guzzler
231	Wildlife Guzzler Type B (636-2)	NRCS Design Drawing for Type B Wildlife Guzzler
232	Wildlife Guzzler Type C (636-3)	NRCS Design Drawing for Type C Wildlife Guzzler
233	Wildlife Guzzler Type D (636-4)	NRCS Design Drawing for Type D Wildlife Guzzler
234	Wildlife Guzzler Type E (636-5)	NRCS Design Drawing for Type E Wildlife Guzzler
235	WLCI Habitat Project Funding Application (2018)	Funding application form for 2016 habitat project funding through Wyoming Landscape Conservation Initiative (WLCI)
236	WLCI Project Funding Application Addendum	Wyoming Landscape Conservation Initiative (WLCI) funding application addendum
237	WLCI Project Tracking Checklist	List of actions, person/enitity responsible, and date complete from initial site inspection to post-project monitoring/maintenance
238	Wyoming Agricultural Management Assistance - Fiscal Year 2018	Unit costs for components of Agricultural Management Assistance (AMA) projects for fiscal year 2018.
239	Wyoming Environmental Quality Incentives Program - Fiscal Year 2018	Unit costs for components of Environmental Quality Incentives Program (EQIP) projects for fiscal year 2018.
240	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).
241	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.
242	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.
243	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
244	Wyoming Landscape Conservation Initiative Habitat Project Funding Application	Application form for WLCI habitat project funding

Item Number	Title	Description
245	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.
246	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.
247	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.
248	Wyoming Sage Grouse Conservation Project Proposal Form 2018-2019	Project application criteria and application form for Wyoming Sage Grouse Conservation Funds (WSGCF)
249	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.
250	Wyoming Surface Water Classification List	Surface water classification list based on Water Quality Division Surface Water Standards
251	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)
252	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
253	Wyoming Water Law : A Summary	Summary of different types of water rights managed by the state.
254	Wyoming Weed & Pest Control Act State Designated Weeds and Pests	Statewide Designated Weeds and Pests
255	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.
256	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.
257	Wyoming Wildlife and Natural Resource Trust - Application for Funding	Funding applciation form for WWNRT
258	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
259	Yoder Groundwater Level II Study - Executive Summary	The study objective is to locate, construct, and test a new well with a production capacity of at least 25 gpm and water quality that satisfies EPA primary drinking water standards. Also presents water treatment options in the event that water quality does not comply with EPA primary drinking water standards.
260	Yoder Groundwater Level II Study - Final Report	The study objective is to locate, construct, and test a new well with a production capacity of at least 25 gpm and water quality that satisfies EPA primary drinking water standards. Also presents water treatment options in the event that water quality does not comply with EPA primary drinking water standards.
261	Yoder Groundwater Resources Investigation - Final Report	Objectives were to identify and describe the local major groundwater aquifers, determine the most suitable aquifer for present development to satisfy Yoder's current and projected needs, and drill that aquifer to test for development of a potable water supply.

APPENDIX 4A

GEOLOGIC UNIT DESCRIPTIONS

Appendix 4A - Geologic Units in the Horse Creek Watershed
(compiled from Rapp et al. (1957), McLaughlin and Harris (2005), VerPloeg (1995), VerPloeg and Boyd (2007); Taucher et al. (2013), and Love and Christiansen (1985).

CENOZOIC GEOLOGIC UNITS

Qa Alluvium (Holocene-Pleistocene) - Alluvial deposits - sand, silt, gravel, and clay within flood plains, river channels, and lowest (Holocene) terrace deposits along major streams, may include minor alluvial fan deposits and colluvium. Thickness up to 50 ft.

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 200 feet.

Ta Arikaree Formation (Lower Miocene and Upper Oligocene). Thickness up to 1,000 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 an 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 250 feet.

MESOZOIC GEOLOGIC UNITS

Kz Cretaceous-age formations undivided (i.e. a combination of those listed below).

Kl 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 1,400 feet.

Fox Hills (Upper Cretaceous) - Gray, fine-grained sandstone, tan and gray siltstone, and interbedded dark gray shale. Thickness up to 190 ft.

Pierre Shale (Upper Cretaceous) - Dark gray shale with thin to moderately thick, sometimes persistent sandstone beds. Thickness about 5,500 feet.

Niobrara Shale (Upper Cretaceous) - Black or gray to yellow speckled, calcareous shale, and light-colored limestone and chalk. Thickness approximately 350 feet.

Mowry and Thermopolis Shale. Thickness approximately 1,400 feet

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. Thickness approximately 150 feet.

Morrison Formation – Dully variegated, siliceous claystone, nodular white limestone, and gray silty sandstone. Thickness approximately 220 feet.

Sundance Formation (Upper Jurassic to Middle Jurassic) – Greenish-gray, glauconitic sandstone and shale, underlain by red and gray non-glauconitic sandstone and shale. Thickness approximately 400 feet.

^Pg Chugwater and Goose Egg Formations. Thickness approximately 700 feet.
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).

Minnekahta Formation (Permian) - Purple to blue slabby, thin-bedded limestone and yellow to pink slabby, silty limestone. Thickness approximately 40 feet. (Forelle Formation equivalent in Laramie Basin)

Opeche Shale (Permian) - Bright-red silty shale and yellow to red sandstone; contains geodes and thin lenses of purple, red, and gray chert. Thickness 75 to 300 feet. (Satanka Formation equivalent in Laramie Basin)

Hartville and Casper Formations (Lower Permian-Upper and Middle Pennsylvanian)

Hartville Formation (Lower Permian-Upper, Middle, and Lower Pennsylvanian) – Sandstone, limestone, shale, dolomite, and breccia. At the top are 50 to 90 feet of soft white to yellow porous sandstone which probably correlates with the " Converse sand."

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.

PRECAMBRIAN GEOLOGIC UNITS

p_ Precambrian rocks (Middle Proterozoic through middle Archean) - This group encompasses a wide range of igneous and metomorphic rocks forming the core of the Laramie Range. Commonly classed as “crystaline”, “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

Horse Creek 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**
Craton Draw	Western Great Plains Shortgrass Prairie	Grassland	21275.3	14836.18	69.73%	69.7%
Craton Draw	Western Cool Temperate Developed Ruderal Grassland	Developed	21275.3	2735.46	12.86%	82.6%
Craton Draw	Western Cool Temperate Wheat	Agricultural	21275.3	985.34	4.63%	87.2%
Craton Draw	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	21275.3	665.25	3.13%	90.3%
Craton Draw	Western Great Plains Sandhill Grassland	Shrubland	21275.3	614.21	2.89%	93.2%
Craton Draw	Western Cool Temperate Fallow/Idle Cropland	Agricultural	21275.3	410.25	1.93%	95.2%
Craton Draw	Developed-Roads	Developed-Roads	21275.3	351.47	1.65%	96.8%
Craton Draw	Other	Other	21275.3	677.18	3.18%	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**
Dry Creek	Western Great Plains Shortgrass Prairie	Grassland	16826.1	11064.31	65.76%	65.8%
Dry Creek	Western Cool Temperate Close Grown Crop	Agricultural	16826.1	1723.63	10.24%	76.0%
Dry Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	16826.1	1148.18	6.82%	82.8%
Dry Creek	Western Great Plains Sandhill Grassland	Shrubland	16826.1	853.65	5.07%	87.9%
Dry Creek	Developed-Roads	Developed-Roads	16826.1	446.27	2.65%	90.6%
Dry Creek	Western Cool Temperate Row Crop	Agricultural	16826.1	409.58	2.43%	93.0%
Dry Creek	Open Water	Open Water	16826.1	350.02	2.08%	95.1%
Dry Creek	Western Great Plains Tallgrass Prairie	Grassland	16826.1	277.31	1.65%	96.7%
Dry Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	16826.1	234.83	1.40%	98.1%
Dry Creek	Other	Other	16826.1	318.30	1.89%	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 Creek Drain	Western Great Plains Shortgrass Prairie	Grassland	6831.7	1791.74	26.23%	26.2%
Dry Creek Drain	Western Cool Temperate Close Grown Crop	Agricultural	6831.7	1614.22	23.63%	49.9%
Dry Creek Drain	Western Cool Temperate Developed Ruderal Grassland	Developed	6831.7	1256.33	18.39%	68.2%
Dry Creek Drain	Western Cool Temperate Wheat	Agricultural	6831.7	705.39	10.33%	78.6%
Dry Creek Drain	Western Cool Temperate Fallow/Idle Cropland	Agricultural	6831.7	438.36	6.42%	85.0%
Dry Creek Drain	Developed-Roads	Developed-Roads	6831.7	281.35	4.12%	89.1%
Dry Creek Drain	Western Cool Temperate Row Crop	Agricultural	6831.7	248.14	3.63%	92.7%
Dry Creek Drain	Western Great Plains Sandhill Grassland	Shrubland	6831.7	126.28	1.85%	94.6%
Dry Creek Drain	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	6831.7	108.91	1.59%	96.2%
Dry Creek Drain	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	6831.7	89.54	1.31%	97.5%
Dry Creek Drain	Other	Other	6831.7	171.41	2.51%	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**
Fourmile Draw	Western Great Plains Shortgrass Prairie	Grassland	16282.5	14362.37	88.21%	88.2%
Fourmile Draw	Western Great Plains Sandhill Grassland	Shrubland	16282.5	588.51	3.61%	91.8%
Fourmile Draw	Western Cool Temperate Developed Ruderal Grassland	Developed	16282.5	467.45	2.87%	94.7%
Fourmile Draw	Developed-Roads	Developed-Roads	16282.5	368.06	2.26%	97.0%
Fourmile Draw	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	16282.5	337.88	2.08%	99.0%
Fourmile Draw	Other	Other	16282.5	158.25	0.97%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Goshen Hole Reservoir	Western Cool Temperate Developed Ruderal Grassland	Developed	35289.3	9058.07	25.67%	25.7%
Goshen Hole Reservoir	Western Cool Temperate Close Grown Crop	Agricultural	35289.3	6641.53	18.82%	44.5%
Goshen Hole Reservoir	Western Great Plains Shortgrass Prairie	Grassland	35289.3	5690.19	16.12%	60.6%
Goshen Hole Reservoir	Western Cool Temperate Row Crop	Agricultural	35289.3	3383.53	9.59%	70.2%
Goshen Hole Reservoir	Western Cool Temperate Wheat	Agricultural	35289.3	2255.27	6.39%	76.6%
Goshen Hole Reservoir	Western Cool Temperate Fallow/Idle Cropland	Agricultural	35289.3	2238.89	6.34%	82.9%
Goshen Hole Reservoir	Developed-Roads	Developed-Roads	35289.3	1103.46	3.13%	86.1%

Goshen Hole Reservoir	Northwestern Great Plains Mixedgrass Prairie	Grassland	35289.3	572.05	1.62%	87.7%
Goshen Hole Reservoir	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	35289.3	556.32	1.58%	89.3%
Goshen Hole Reservoir	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	35289.3	499.59	1.42%	90.7%
Goshen Hole Reservoir	Western Great Plains Floodplain Forest and Woodland	Riparian	35289.3	479.09	1.36%	92.0%
Goshen Hole Reservoir	Western Cool Temperate Urban Herbaceous	Developed	35289.3	410.68	1.16%	93.2%
Goshen Hole Reservoir	Western Great Plains Sand Prairie Grassland	Grassland	35289.3	377.63	1.07%	94.3%
Goshen Hole Reservoir	Western Cool Temperate Developed Ruderal Shrubland	Developed	35289.3	359.01	1.02%	95.3%
Goshen Hole Reservoir	Other	Other	35289.3	1664.02	4.72%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Harry Dayton Ranch	Northwestern Great Plains Mixedgrass Prairie	Grassland	12406.6	9781.15	78.84%	78.8%
Harry Dayton Ranch	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	12406.6	1195.21	9.63%	88.5%
Harry Dayton Ranch	Western Great Plains Shortgrass Prairie	Grassland	12406.6	477.84	3.85%	92.3%
Harry Dayton Ranch	Western Cool Temperate Close Grown Crop	Agricultural	12406.6	181.37	1.46%	93.8%
Harry Dayton Ranch	Western Cool Temperate Fallow/Idle Cropland	Agricultural	12406.6	175.09	1.41%	95.2%
Harry Dayton Ranch	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	12406.6	167.23	1.35%	96.5%
Harry Dayton Ranch	Western Cool Temperate Developed Ruderal Grassland	Developed	12406.6	126.34	1.02%	97.6%
Harry Dayton Ranch	Other	Other	12406.6	302.35	2.44%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Hawk Springs Reservoir	Western Great Plains Shortgrass Prairie	Grassland	23974.8	13470.34	56.19%	56.2%
Hawk Springs Reservoir	Western Cool Temperate Row Crop	Agricultural	23974.8	2083.55	8.69%	64.9%
Hawk Springs Reservoir	Western Cool Temperate Developed Ruderal Grassland	Developed	23974.8	2033.01	8.48%	73.4%
Hawk Springs Reservoir	Western Cool Temperate Close Grown Crop	Agricultural	23974.8	1591.40	6.64%	80.0%
Hawk Springs Reservoir	Open Water	Open Water	23974.8	1019.88	4.25%	84.2%
Hawk Springs Reservoir	Western Great Plains Sandhill Grassland	Shrubland	23974.8	791.46	3.30%	87.5%
Hawk Springs Reservoir	Western Cool Temperate Wheat	Agricultural	23974.8	693.58	2.89%	90.4%
Hawk Springs Reservoir	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	23974.8	482.16	2.01%	92.5%
Hawk Springs Reservoir	Developed-Roads	Developed-Roads	23974.8	455.86	1.90%	94.4%
Hawk Springs Reservoir	Barren	Barren	23974.8	350.98	1.46%	95.8%
Hawk Springs Reservoir	Western Cool Temperate Fallow/Idle Cropland	Agricultural	23974.8	299.55	1.25%	97.1%
Hawk Springs Reservoir	Other	Other	23974.8	702.99	2.93%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Bushnell Creek	Western Great Plains Shortgrass Prairie	Grassland	36552.8	27084.49	74.10%	74.1%
Horse Creek-Bushnell Creek	Western Great Plains Sandhill Grassland	Shrubland	36552.8	1639.86	4.49%	78.6%
Horse Creek-Bushnell Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	36552.8	1419.64	3.88%	82.5%
Horse Creek-Bushnell Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	36552.8	1198.10	3.28%	85.7%
Horse Creek-Bushnell Creek	Western Cool Temperate Wheat	Agricultural	36552.8	1101.97	3.01%	88.8%
Horse Creek-Bushnell Creek	Western Cool Temperate Close Grown Crop	Agricultural	36552.8	936.32	2.56%	91.3%
Horse Creek-Bushnell Creek	Developed-Roads	Developed-Roads	36552.8	770.88	2.11%	93.4%
Horse Creek-Bushnell Creek	Western Cool Temperate Row Crop	Agricultural	36552.8	669.29	1.83%	95.3%
Horse Creek-Bushnell Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	36552.8	471.54	1.29%	96.6%
Horse Creek-Bushnell Creek	Other	Other	36552.8	1260.66	3.45%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Carey Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	34819.6	12588.46	36.15%	36.2%
Horse Creek-Carey Creek	Western Great Plains Shortgrass Prairie	Grassland	34819.6	9805.20	28.16%	64.3%
Horse Creek-Carey Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	34819.6	5579.09	16.02%	80.3%
Horse Creek-Carey Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	34819.6	1659.54	4.77%	85.1%
Horse Creek-Carey Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	34819.6	746.08	2.14%	87.2%
Horse Creek-Carey Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	34819.6	573.02	1.65%	88.9%

Horse Creek-Carey Creek	Developed-Roads	Developed-Roads	34819.6	508.62	1.46%	90.4%
Horse Creek-Carey Creek	Western Great Plains Floodplain Forest and Woodland	Riparian	34819.6	496.10	1.42%	91.8%
Horse Creek-Carey Creek	Other	Other	34819.6	2863.47	8.22%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Cattail Creek	Western Great Plains Shortgrass Prairie	Grassland	31418.3	21983.77	69.97%	70.0%
Horse Creek-Cattail Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	31418.3	4398.05	14.00%	84.0%
Horse Creek-Cattail Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	31418.3	2167.67	6.90%	90.9%
Horse Creek-Cattail Creek	Western Great Plains Sandhill Grassland	Shrubland	31418.3	775.49	2.47%	93.3%
Horse Creek-Cattail Creek	Developed-Roads	Developed-Roads	31418.3	643.78	2.05%	95.4%
Horse Creek-Cattail Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	31418.3	588.16	1.87%	97.3%
Horse Creek-Cattail Creek	Other	Other	31418.3	861.36	2.74%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Hawk Springs	Western Great Plains Shortgrass Prairie	Grassland	31235.0	14821.78	47.45%	47.5%
Horse Creek-Hawk Springs	Western Cool Temperate Developed Ruderal Grassland	Developed	31235.0	4174.57	13.37%	60.8%
Horse Creek-Hawk Springs	Western Cool Temperate Close Grown Crop	Agricultural	31235.0	3236.69	10.36%	71.2%
Horse Creek-Hawk Springs	Western Cool Temperate Wheat	Agricultural	31235.0	1719.59	5.51%	76.7%
Horse Creek-Hawk Springs	Western Cool Temperate Fallow/Idle Cropland	Agricultural	31235.0	1354.48	4.34%	81.0%
Horse Creek-Hawk Springs	Western Cool Temperate Row Crop	Agricultural	31235.0	1283.37	4.11%	85.1%
Horse Creek-Hawk Springs	Western Great Plains Sandhill Grassland	Shrubland	31235.0	806.80	2.58%	87.7%
Horse Creek-Hawk Springs	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	31235.0	794.70	2.54%	90.3%
Horse Creek-Hawk Springs	Developed-Roads	Developed-Roads	31235.0	790.69	2.53%	92.8%
Horse Creek-Hawk Springs	Western Great Plains Floodplain Herbaceous	Riparian	31235.0	466.06	1.49%	94.3%
Horse Creek-Hawk Springs	Western Cool Temperate Urban Herbaceous	Developed	31235.0	375.97	1.20%	95.5%
Horse Creek-Hawk Springs	Western Great Plains Tallgrass Prairie	Grassland	31235.0	369.00	1.18%	96.7%
Horse Creek-Hawk Springs	Other	Other	31235.0	1041.30	3.33%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Kellehan Creek	Western Great Plains Shortgrass Prairie	Grassland	25010.2	16917.15	67.64%	67.6%
Horse Creek-Kellehan Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	25010.2	1254.39	5.02%	72.7%
Horse Creek-Kellehan Creek	Western Great Plains Sandhill Grassland	Shrubland	25010.2	1142.51	4.57%	77.2%
Horse Creek-Kellehan Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	25010.2	1019.50	4.08%	81.3%
Horse Creek-Kellehan Creek	Western Cool Temperate Close Grown Crop	Agricultural	25010.2	980.79	3.92%	85.2%
Horse Creek-Kellehan Creek	Western Cool Temperate Wheat	Agricultural	25010.2	771.38	3.08%	88.3%
Horse Creek-Kellehan Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	25010.2	548.21	2.19%	90.5%
Horse Creek-Kellehan Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	25010.2	522.42	2.09%	92.6%
Horse Creek-Kellehan Creek	Western Great Plains Floodplain Herbaceous	Riparian	25010.2	435.13	1.74%	94.3%
Horse Creek-Kellehan Creek	Developed-Roads	Developed-Roads	25010.2	357.52	1.43%	95.8%
Horse Creek-Kellehan Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	25010.2	312.58	1.25%	97.0%
Horse Creek-Kellehan Creek	Other	Other	25010.2	748.64	2.99%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Kelley Draw	Western Great Plains Shortgrass Prairie	Grassland	28038.8	20762.08	74.05%	74.0%
Horse Creek-Kelley Draw	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	28038.8	4020.02	14.34%	88.4%
Horse Creek-Kelley Draw	Developed-Roads	Developed-Roads	28038.8	764.37	2.73%	91.1%
Horse Creek-Kelley Draw	Western Cool Temperate Developed Ruderal Grassland	Developed	28038.8	499.73	1.78%	92.9%
Horse Creek-Kelley Draw	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	28038.8	485.89	1.73%	94.6%
Horse Creek-Kelley Draw	Other	Other	28038.8	1506.68	5.37%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**

Horse Creek-La Grange	Western Great Plains Shortgrass Prairie	Grassland	16596.5	9748.86	58.74%	58.7%
Horse Creek-La Grange	Western Cool Temperate Close Grown Crop	Agricultural	16596.5	2276.62	13.72%	72.5%
Horse Creek-La Grange	Western Cool Temperate Developed Ruderal Grassland	Developed	16596.5	2091.80	12.60%	85.1%
Horse Creek-La Grange	Western Great Plains Floodplain Herbaceous	Riparian	16596.5	502.22	3.03%	88.1%
Horse Creek-La Grange	Developed-Roads	Developed-Roads	16596.5	496.36	2.99%	91.1%
Horse Creek-La Grange	Western Cool Temperate Row Crop	Agricultural	16596.5	456.64	2.75%	93.8%
Horse Creek-La Grange	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	16596.5	351.73	2.12%	95.9%
Horse Creek-La Grange	Western Great Plains Sandhill Grassland	Shrubland	16596.5	284.74	1.72%	97.7%
Horse Creek-La Grange	Other	Other	16596.5	387.51	2.33%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Little Willow Reservoir	Western Great Plains Shortgrass Prairie	Grassland	15516.7	8240.29	53.11%	53.1%
Horse Creek-Little Willow Reservoir	Western Cool Temperate Close Grown Crop	Agricultural	15516.7	1445.47	9.32%	62.4%
Horse Creek-Little Willow Reservoir	Western Great Plains Sandhill Grassland	Shrubland	15516.7	1318.77	8.50%	70.9%
Horse Creek-Little Willow Reservoir	Western Great Plains Tallgrass Prairie	Grassland	15516.7	1294.47	8.34%	79.3%
Horse Creek-Little Willow Reservoir	Western Cool Temperate Developed Ruderal Grassland	Developed	15516.7	1142.30	7.36%	86.6%
Horse Creek-Little Willow Reservoir	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	15516.7	460.11	2.97%	89.6%
Horse Creek-Little Willow Reservoir	Western Cool Temperate Row Crop	Agricultural	15516.7	440.74	2.84%	92.4%
Horse Creek-Little Willow Reservoir	Developed-Roads	Developed-Roads	15516.7	348.55	2.25%	94.7%
Horse Creek-Little Willow Reservoir	Western Cool Temperate Wheat	Agricultural	15516.7	281.59	1.81%	96.5%
Horse Creek-Little Willow Reservoir	Western Great Plains Floodplain Forest and Woodland	Riparian	15516.7	194.76	1.26%	97.7%
Horse Creek-Little Willow Reservoir	Other	Other	15516.7	349.67	2.25%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Packer Reservoir	Western Cool Temperate Close Grown Crop	Agricultural	14725.6	4473.78	30.38%	30.4%
Horse Creek-Packer Reservoir	Western Cool Temperate Row Crop	Agricultural	14725.6	3248.07	22.06%	52.4%
Horse Creek-Packer Reservoir	Western Great Plains Shortgrass Prairie	Grassland	14725.6	2175.43	14.77%	67.2%
Horse Creek-Packer Reservoir	Western Cool Temperate Developed Ruderal Grassland	Developed	14725.6	2101.44	14.27%	81.5%
Horse Creek-Packer Reservoir	Western Cool Temperate Wheat	Agricultural	14725.6	899.44	6.11%	87.6%
Horse Creek-Packer Reservoir	Developed-Roads	Developed-Roads	14725.6	468.21	3.18%	90.8%
Horse Creek-Packer Reservoir	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	14725.6	307.68	2.09%	92.9%
Horse Creek-Packer Reservoir	Western Great Plains Sandhill Grassland	Shrubland	14725.6	287.83	1.95%	94.8%
Horse Creek-Packer Reservoir	Open Water	Open Water	14725.6	154.02	1.05%	95.9%
Horse Creek-Packer Reservoir	Other	Other	14725.6	609.72	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 Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Schoolhouse Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	37138.5	13038.03	35.11%	35.1%
Horse Creek-Schoolhouse Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	37138.5	7603.27	20.47%	55.6%
Horse Creek-Schoolhouse Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	37138.5	5656.06	15.23%	70.8%
Horse Creek-Schoolhouse Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	37138.5	2013.02	5.42%	76.2%
Horse Creek-Schoolhouse Creek	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	37138.5	1551.14	4.18%	80.4%
Horse Creek-Schoolhouse Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	37138.5	1082.01	2.91%	83.3%
Horse Creek-Schoolhouse Creek	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Conifer	37138.5	895.99	2.41%	85.7%
Horse Creek-Schoolhouse Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	37138.5	533.65	1.44%	87.2%
Horse Creek-Schoolhouse Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	37138.5	504.07	1.36%	88.5%
Horse Creek-Schoolhouse Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	37138.5	460.45	1.24%	89.8%
Horse Creek-Schoolhouse Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	37138.5	445.27	1.20%	91.0%
Horse Creek-Schoolhouse Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	37138.5	413.22	1.11%	92.1%
Horse Creek-Schoolhouse Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	37138.5	412.13	1.11%	93.2%
Horse Creek-Schoolhouse Creek	Other	Other	37138.5	2530.20	6.81%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**

Horse Creek-Sprager Creek	Western Great Plains Shortgrass Prairie	Grassland	29742.9	24887.40	83.68%	83.7%
Horse Creek-Sprager Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	29742.9	793.90	2.67%	86.3%
Horse Creek-Sprager Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	29742.9	766.89	2.58%	88.9%
Horse Creek-Sprager Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	29742.9	697.67	2.35%	91.3%
Horse Creek-Sprager Creek	Western Great Plains Sandhill Grassland	Shrubland	29742.9	544.17	1.83%	93.1%
Horse Creek-Sprager Creek	Developed-Roads	Developed-Roads	29742.9	536.63	1.80%	94.9%
Horse Creek-Sprager Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	29742.9	466.37	1.57%	96.5%
Horse Creek-Sprager Creek	Western Cool Temperate Close Grown Crop	Agricultural	29742.9	349.70	1.18%	97.6%
Horse Creek-Sprager Creek	Other	Other	29742.9	700.20	2.35%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Horse Creek-Trail Creek	Western Great Plains Shortgrass Prairie	Grassland	29604.3	18554.48	62.67%	62.7%
Horse Creek-Trail Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	29604.3	3213.01	10.85%	73.5%
Horse Creek-Trail Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	29604.3	2875.45	9.71%	83.2%
Horse Creek-Trail Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	29604.3	2293.66	7.75%	91.0%
Horse Creek-Trail Creek	Western Great Plains Sandhill Grassland	Shrubland	29604.3	900.36	3.04%	94.0%
Horse Creek-Trail Creek	Developed-Roads	Developed-Roads	29604.3	543.66	1.84%	95.9%
Horse Creek-Trail Creek	Western Cool Temperate Close Grown Crop	Agricultural	29604.3	350.52	1.18%	97.1%
Horse Creek-Trail Creek	Other	Other	29604.3	873.17	2.95%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Josh Creek	Western Great Plains Shortgrass Prairie	Grassland	22019.1	14826.67	67.34%	67.3%
Josh Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	22019.1	1844.30	8.38%	75.7%
Josh Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	22019.1	1586.61	7.21%	82.9%
Josh Creek	Western Cool Temperate Wheat	Agricultural	22019.1	837.31	3.80%	86.7%
Josh Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	22019.1	625.27	2.84%	89.6%
Josh Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	22019.1	465.89	2.12%	91.7%
Josh Creek	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	22019.1	373.95	1.70%	93.4%
Josh Creek	Barren	Barren	22019.1	338.10	1.54%	94.9%
Josh Creek	Other	Other	22019.1	1121.03	5.09%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Long Canyon-Pumpkin Creek	Western Cool Temperate Wheat	Agricultural	1020.9	475.06	46.53%	46.5%
Long Canyon-Pumpkin Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	1020.9	386.10	37.82%	84.4%
Long Canyon-Pumpkin Creek	Western Great Plains Shortgrass Prairie	Grassland	1020.9	43.01	4.21%	88.6%
Long Canyon-Pumpkin Creek	Western Cool Temperate Close Grown Crop	Agricultural	1020.9	42.98	4.21%	92.8%
Long Canyon-Pumpkin Creek	Developed-Roads	Developed-Roads	1020.9	37.27	3.65%	96.4%
Long Canyon-Pumpkin Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	1020.9	24.00	2.35%	98.8%
Long Canyon-Pumpkin Creek	Other	Other	1020.9	12.50	1.22%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Lower Bear Creek-Horse Creek	Western Great Plains Shortgrass Prairie	Grassland	24094.9	17532.00	72.76%	72.8%
Lower Bear Creek-Horse Creek	Western Cool Temperate Close Grown Crop	Agricultural	24094.9	1528.83	6.35%	79.1%
Lower Bear Creek-Horse Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	24094.9	1378.77	5.72%	84.8%
Lower Bear Creek-Horse Creek	Western Great Plains Sandhill Grassland	Shrubland	24094.9	934.45	3.88%	88.7%
Lower Bear Creek-Horse Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	24094.9	723.25	3.00%	91.7%
Lower Bear Creek-Horse Creek	Developed-Roads	Developed-Roads	24094.9	563.87	2.34%	94.0%
Lower Bear Creek-Horse Creek	Barren	Barren	24094.9	543.12	2.25%	96.3%
Lower Bear Creek-Horse Creek	Western Great Plains Floodplain Herbaceous	Riparian	24094.9	251.39	1.04%	97.3%
Lower Bear Creek-Horse Creek	Other	Other	24094.9	639.23	2.65%	100.0%

Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type Acres	Percent of HUC12	Cumulative Percent
Lower Fox Creek	Western Great Plains Shortgrass Prairie	Grassland	39083.3	31764.40	81.27%	81.3%
Lower Fox Creek	Western Great Plains Sandhill Grassland	Shrubland	39083.3	1657.55	4.24%	85.5%
Lower Fox Creek	Western Cool Temperate Close Grown Crop	Agricultural	39083.3	1432.39	3.66%	89.2%
Lower Fox Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	39083.3	1421.20	3.64%	92.8%
Lower Fox Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	39083.3	1015.54	2.60%	95.4%
Lower Fox Creek	Barren	Barren	39083.3	523.45	1.34%	96.8%
Lower Fox Creek	Developed-Roads	Developed-Roads	39083.3	483.42	1.24%	98.0%
Lower Fox Creek	Other	Other	39083.3	785.35	2.01%	100.0%
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type Acres	Percent of HUC12	Cumulative Percent
Lower Little Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	21835.0	17339.48	79.41%	79.4%
Lower Little Bear Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	21835.0	1150.16	5.27%	84.7%
Lower Little Bear Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	21835.0	701.56	3.21%	87.9%
Lower Little Bear Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	21835.0	621.70	2.85%	90.7%
Lower Little Bear Creek	Western Great Plains Sandhill Grassland	Shrubland	21835.0	487.30	2.23%	93.0%
Lower Little Bear Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	21835.0	476.14	2.18%	95.2%
Lower Little Bear Creek	Developed-Roads	Developed-Roads	21835.0	309.29	1.42%	96.6%
Lower Little Bear Creek	Western Cool Temperate Close Grown Crop	Agricultural	21835.0	259.74	1.19%	97.8%
Lower Little Bear Creek	Other	Other	21835.0	489.62	2.24%	100.0%
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type Acres	Percent of HUC12	Cumulative Percent
Lower Little Horse Creek	Western Great Plains Shortgrass Prairie	Grassland	25141.2	20958.80	83.36%	83.4%
Lower Little Horse Creek	Western Great Plains Floodplain Herbaceous	Riparian	25141.2	711.86	2.83%	86.2%
Lower Little Horse Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	25141.2	482.58	1.92%	88.1%
Lower Little Horse Creek	Western Cool Temperate Close Grown Crop	Agricultural	25141.2	460.76	1.83%	89.9%
Lower Little Horse Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	25141.2	444.10	1.77%	91.7%
Lower Little Horse Creek	Developed-Roads	Developed-Roads	25141.2	402.06	1.60%	93.3%
Lower Little Horse Creek	Western Great Plains Sandhill Grassland	Shrubland	25141.2	318.73	1.27%	94.6%
Lower Little Horse Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	25141.2	292.91	1.17%	95.7%
Lower Little Horse Creek	Other	Other	25141.2	1069.36	4.25%	100.0%
Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type Acres	Percent of HUC12	Cumulative Percent
Lower Lone Tree Creek-Horse Creek	Western Great Plains Shortgrass Prairie	Grassland	23869.0	12527.77	52.49%	52.5%
Lower Lone Tree Creek-Horse Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	23869.0	2957.16	12.39%	64.9%
Lower Lone Tree Creek-Horse Creek	Western Cool Temperate Close Grown Crop	Agricultural	23869.0	1616.26	6.77%	71.6%
Lower Lone Tree Creek-Horse Creek	Western Cool Temperate Row Crop	Agricultural	23869.0	1225.67	5.13%	76.8%
Lower Lone Tree Creek-Horse Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	23869.0	862.93	3.62%	80.4%
Lower Lone Tree Creek-Horse Creek	Western Great Plains Tallgrass Prairie	Grassland	23869.0	742.89	3.11%	83.5%
Lower Lone Tree Creek-Horse Creek	Developed-Roads	Developed-Roads	23869.0	522.86	2.19%	85.7%
Lower Lone Tree Creek-Horse Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	23869.0	429.14	1.80%	87.5%
Lower Lone Tree Creek-Horse Creek	Western Great Plains Sandhill Grassland	Shrubland	23869.0	403.81	1.69%	89.2%
Lower Lone Tree Creek-Horse Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	23869.0	366.41	1.54%	90.7%
Lower Lone Tree Creek-Horse Creek	Western Cool Temperate Wheat	Agricultural	23869.0	357.85	1.50%	92.2%
Lower Lone Tree Creek-Horse Creek	Barren	Barren	23869.0	288.06	1.21%	93.4%
Lower Lone Tree Creek-Horse Creek	Other	Other	23869.0	1568.18	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 Acres	Percent of HUC12	Cumulative Percent
Middle Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	32659.9	26746.45	81.89%	81.9%
Middle Bear Creek	Western Great Plains Sandhill Grassland	Shrubland	32659.9	1228.66	3.76%	85.7%

Middle Bear Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	32659.9	1020.31	3.12%	88.8%
Middle Bear Creek	Developed-Roads	Developed-Roads	32659.9	708.24	2.17%	90.9%
Middle Bear Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	32659.9	586.78	1.80%	92.7%
Middle Bear Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	32659.9	579.05	1.77%	94.5%
Middle Bear Creek	Western Cool Temperate Close Grown Crop	Agricultural	32659.9	525.67	1.61%	96.1%
Middle Bear Creek	Other	Other	32659.9	1264.69	3.87%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Middle Little Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	26838.4	18602.78	69.31%	69.3%
Middle Little Bear Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	26838.4	4416.43	16.46%	85.8%
Middle Little Bear Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	26838.4	1249.87	4.66%	90.4%
Middle Little Bear Creek	Developed-Roads	Developed-Roads	26838.4	649.18	2.42%	92.8%
Middle Little Bear Creek	Western Cool Temperate Close Grown Crop	Agricultural	26838.4	493.24	1.84%	94.7%
Middle Little Bear Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	26838.4	477.29	1.78%	96.5%
Middle Little Bear Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	26838.4	312.02	1.16%	97.6%
Middle Little Bear Creek	Other	Other	26838.4	637.59	2.38%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
North Bear Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	40767.5	30253.91	74.21%	74.2%
North Bear Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	40767.5	3974.99	9.75%	84.0%
North Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	40767.5	1777.29	4.36%	88.3%
North Bear Creek	Western Great Plains Sand Prairie Grassland	Grassland	40767.5	1378.62	3.38%	91.7%
North Bear Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	40767.5	910.33	2.23%	93.9%
North Bear Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	40767.5	687.74	1.69%	95.6%
North Bear Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	40767.5	669.35	1.64%	97.3%
North Bear Creek	Other	Other	40767.5	1115.23	2.74%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
North Fork Horse Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	23464.1	9301.59	39.64%	39.6%
North Fork Horse Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	23464.1	5828.38	24.84%	64.5%
North Fork Horse Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	23464.1	1874.11	7.99%	72.5%
North Fork Horse Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	23464.1	1246.24	5.31%	77.8%
North Fork Horse Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	23464.1	856.78	3.65%	81.4%
North Fork Horse Creek	Western Great Plains Sparsely Vegetated Systems	Sparsely Vegetated	23464.1	826.85	3.52%	85.0%
North Fork Horse Creek	Northern Rocky Mountain Subalpine-Upper Montane Grassland	Grassland	23464.1	382.88	1.63%	86.6%
North Fork Horse Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	23464.1	350.20	1.49%	88.1%
North Fork Horse Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	23464.1	285.52	1.22%	89.3%
North Fork Horse Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	23464.1	278.01	1.18%	90.5%
North Fork Horse Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	23464.1	276.27	1.18%	91.7%
North Fork Horse Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	23464.1	258.46	1.10%	92.8%
North Fork Horse Creek	Rocky Mountain Subalpine/Upper Montane Riparian Shrubland	Riparian	23464.1	243.38	1.04%	93.8%
North Fork Horse Creek	Other	Other	23464.1	1455.43	6.20%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Robb Draw	Western Great Plains Shortgrass Prairie	Grassland	23546.6	11102.05	47.15%	47.1%
Robb Draw	Western Cool Temperate Developed Ruderal Grassland	Developed	23546.6	3189.84	13.55%	60.7%
Robb Draw	Western Cool Temperate Wheat	Agricultural	23546.6	3071.28	13.04%	73.7%
Robb Draw	Western Cool Temperate Fallow/Idle Cropland	Agricultural	23546.6	2162.92	9.19%	82.9%
Robb Draw	Western Cool Temperate Row Crop	Agricultural	23546.6	895.96	3.81%	86.7%
Robb Draw	Western Cool Temperate Close Grown Crop	Agricultural	23546.6	803.12	3.41%	90.1%
Robb Draw	Western Great Plains Sandhill Grassland	Shrubland	23546.6	673.88	2.86%	93.0%
Robb Draw	Developed-Roads	Developed-Roads	23546.6	388.23	1.65%	94.7%

Robb Draw	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	23546.6	377.06	1.60%	96.3%
Robb Draw	Barren	Barren	23546.6	332.57	1.41%	97.7%
Robb Draw	Other	Other	23546.6	549.68	2.33%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Rocky Hollow	Western Great Plains Shortgrass Prairie	Grassland	19674.5	17243.72	87.65%	87.6%
Rocky Hollow	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	19674.5	558.00	2.84%	90.5%
Rocky Hollow	Developed-Roads	Developed-Roads	19674.5	542.88	2.76%	93.2%
Rocky Hollow	Western Great Plains Sandhill Grassland	Shrubland	19674.5	343.23	1.74%	95.0%
Rocky Hollow	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	19674.5	297.20	1.51%	96.5%
Rocky Hollow	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	19674.5	233.47	1.19%	97.7%
Rocky Hollow	Other	Other	19674.5	455.97	2.32%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
South Fork Bear Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	31236.3	16646.09	53.29%	53.3%
South Fork Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	31236.3	7552.98	24.18%	77.5%
South Fork Bear Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	31236.3	2568.75	8.22%	85.7%
South Fork Bear Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	31236.3	835.44	2.67%	88.4%
South Fork Bear Creek	Rocky Mountain Lower Montane-Foothill Shrubland	Shrubland	31236.3	782.89	2.51%	90.9%
South Fork Bear Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	31236.3	675.78	2.16%	93.0%
South Fork Bear Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	31236.3	633.82	2.03%	95.1%
South Fork Bear Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	31236.3	362.39	1.16%	96.2%
South Fork Bear Creek	Other	Other	31236.3	1178.12	3.77%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
South Fork Horse Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	16480.8	6404.12	38.86%	38.9%
South Fork Horse Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	16480.8	3162.41	19.19%	58.0%
South Fork Horse Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	16480.8	2181.16	13.23%	71.3%
South Fork Horse Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	16480.8	1249.77	7.58%	78.9%
South Fork Horse Creek	Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	Shrubland	16480.8	779.63	4.73%	83.6%
South Fork Horse Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	16480.8	620.94	3.77%	87.4%
South Fork Horse Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	16480.8	246.76	1.50%	88.9%
South Fork Horse Creek	Southern Rocky Mountain Ponderosa Pine Savanna	Conifer	16480.8	236.95	1.44%	90.3%
South Fork Horse Creek	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	16480.8	224.01	1.36%	91.7%
South Fork Horse Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	16480.8	201.80	1.22%	92.9%
South Fork Horse Creek	Rocky Mountain Montane Riparian Forest and Woodland	Riparian	16480.8	200.62	1.22%	94.1%
South Fork Horse Creek	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	Conifer	16480.8	171.14	1.04%	95.1%
South Fork Horse Creek	Other	Other	16480.8	801.48	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 Acres**	**Percent of HUC12**	**Cumulative Percent**
Spring Creek-Fox Creek	Western Great Plains Shortgrass Prairie	Grassland	32502.7	13567.33	41.74%	41.7%
Spring Creek-Fox Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	32502.7	4402.80	13.55%	55.3%
Spring Creek-Fox Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	32502.7	3311.14	10.19%	65.5%
Spring Creek-Fox Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	32502.7	3239.33	9.97%	75.4%
Spring Creek-Fox Creek	Western Cool Temperate Wheat	Agricultural	32502.7	2702.76	8.32%	83.8%
Spring Creek-Fox Creek	Western Great Plains Sand Prairie Grassland	Grassland	32502.7	1401.95	4.31%	88.1%
Spring Creek-Fox Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	32502.7	669.64	2.06%	90.1%
Spring Creek-Fox Creek	Developed-Roads	Developed-Roads	32502.7	668.92	2.06%	92.2%
Spring Creek-Fox Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	32502.7	611.99	1.88%	94.1%
Spring Creek-Fox Creek	Western Cool Temperate Close Grown Crop	Agricultural	32502.7	541.07	1.66%	95.7%
Spring Creek-Fox Creek	Other	Other	32502.7	1385.81	4.26%	100.0%

Hydrologic Unit Code (HUC12) Name	Existing Vegetation Type	Physiognomy (form/morphological structure of vegetation)	Hydrologic Unit Code (HUC12) Acres	Existing Vegetation Type Acres	Percent of HUC12	Cumulative Percent
Tromely Gulch-Dry Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	15252.5	6000.13	39.34%	39.3%
Tromely Gulch-Dry Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	15252.5	2929.59	19.21%	58.5%
Tromely Gulch-Dry Creek	Western Great Plains Shortgrass Prairie	Grassland	15252.5	1789.86	11.73%	70.3%
Tromely Gulch-Dry Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	15252.5	967.79	6.35%	76.6%
Tromely Gulch-Dry Creek	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	Grassland	15252.5	956.26	6.27%	82.9%
Tromely Gulch-Dry Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	15252.5	725.96	4.76%	87.7%
Tromely Gulch-Dry Creek	Rocky Mountain Subalpine-Montane Mesic Meadow	Grassland	15252.5	207.03	1.36%	89.0%
Tromely Gulch-Dry Creek	Developed-Roads	Developed-Roads	15252.5	186.00	1.22%	90.2%
Tromely Gulch-Dry Creek	Other	Other	15252.5	1489.86	9.77%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Bear Creek-Middle Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	29131.6	20060.47	68.86%	68.9%
Upper Bear Creek-Middle Bear Creek	Western Great Plains Sand Prairie Grassland	Grassland	29131.6	4249.33	14.59%	83.4%
Upper Bear Creek-Middle Bear Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	29131.6	2020.18	6.93%	90.4%
Upper Bear Creek-Middle Bear Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	29131.6	624.83	2.14%	92.5%
Upper Bear Creek-Middle Bear Creek	Introduced Upland Vegetation-Annual Grassland	Exotic Herbaceous	29131.6	403.61	1.39%	93.9%
Upper Bear Creek-Middle Bear Creek	Other	Other	29131.6	1773.20	6.09%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Bull Canyon	Western Cool Temperate Wheat	Agricultural	685.5	207.14	30.22%	30.2%
Upper Bull Canyon	Western Great Plains Shortgrass Prairie	Grassland	685.5	206.31	30.10%	60.3%
Upper Bull Canyon	Western Cool Temperate Fallow/Idle Cropland	Agricultural	685.5	153.26	22.36%	82.7%
Upper Bull Canyon	Western Cool Temperate Developed Ruderal Grassland	Developed	685.5	81.88	11.94%	94.6%
Upper Bull Canyon	Developed-Roads	Developed-Roads	685.5	16.24	2.37%	97.0%
Upper Bull Canyon	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	685.5	10.77	1.57%	98.6%
Upper Bull Canyon	Other	Other	685.5	9.86	1.44%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Fox Creek	Western Great Plains Shortgrass Prairie	Grassland	27068.4	21991.44	81.24%	81.2%
Upper Fox Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	27068.4	990.40	3.66%	84.9%
Upper Fox Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	27068.4	805.05	2.97%	87.9%
Upper Fox Creek	Western Great Plains Sand Prairie Grassland	Grassland	27068.4	579.98	2.14%	90.0%
Upper Fox Creek	Western Cool Temperate Close Grown Crop	Agricultural	27068.4	524.64	1.94%	92.0%
Upper Fox Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	27068.4	365.82	1.35%	93.3%
Upper Fox Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	27068.4	352.36	1.30%	94.6%
Upper Fox Creek	Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	27068.4	341.40	1.26%	95.9%
Upper Fox Creek	Other	Other	27068.4	1117.32	4.13%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Little Bear Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	21638.5	7790.96	36.01%	36.0%
Upper Little Bear Creek	Western Great Plains Shortgrass Prairie	Grassland	21638.5	5420.90	25.05%	61.1%
Upper Little Bear Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	21638.5	3391.06	15.67%	76.7%
Upper Little Bear Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	21638.5	3199.68	14.79%	91.5%
Upper Little Bear Creek	Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	21638.5	709.77	3.28%	94.8%
Upper Little Bear Creek	Inter-Mountain Basins Curl-leaf Mountain Mahogany Shrubland	Shrubland	21638.5	377.17	1.74%	96.5%
Upper Little Bear Creek	Other	Other	21638.5	748.97	3.46%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Little Horse Creek	Western Great Plains Shortgrass Prairie	Grassland	25173.2	20686.10	82.18%	82.2%

Upper Little Horse Creek	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	Shrubland	25173.2	2042.42	8.11%	90.3%
Upper Little Horse Creek	Western Great Plains Sandhill Grassland	Shrubland	25173.2	699.81	2.78%	93.1%
Upper Little Horse Creek	Western Cool Temperate Wheat	Agricultural	25173.2	306.62	1.22%	94.3%
Upper Little Horse Creek	Inter-Mountain Basins Semi-Desert Shrub-Steppe	Shrubland	25173.2	265.37	1.05%	95.3%
Upper Little Horse Creek	Other	Other	25173.2	1172.90	4.66%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Lone Tree Creek-Lower Lone Tree Creek	Western Great Plains Shortgrass Prairie	Grassland	21197.2	14976.51	70.65%	70.7%
Upper Lone Tree Creek-Lower Lone Tree Creek	Western Great Plains Sandhill Grassland	Shrubland	21197.2	1498.80	7.07%	77.7%
Upper Lone Tree Creek-Lower Lone Tree Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	21197.2	1358.98	6.41%	84.1%
Upper Lone Tree Creek-Lower Lone Tree Creek	Introduced Upland Vegetation-Perennial Grassland and Forbland	Exotic Herbaceous	21197.2	829.60	3.91%	88.0%
Upper Lone Tree Creek-Lower Lone Tree Creek	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	21197.2	533.09	2.51%	90.6%
Upper Lone Tree Creek-Lower Lone Tree Creek	Developed-Roads	Developed-Roads	21197.2	443.27	2.09%	92.7%
Upper Lone Tree Creek-Lower Lone Tree Creek	Southern Rocky Mountain Ponderosa Pine Woodland	Conifer	21197.2	270.49	1.28%	93.9%
Upper Lone Tree Creek-Lower Lone Tree Creek	Barren	Barren	21197.2	237.53	1.12%	95.1%
Upper Lone Tree Creek-Lower Lone Tree Creek	Other	Other	21197.2	1048.96	4.95%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
Upper Pumpkin Creek	Western Great Plains Shortgrass Prairie	Grassland	306.2	294.85	96.29%	96.3%
Upper Pumpkin Creek	Western Great Plains Sandhill Grassland	Shrubland	306.2	3.64	1.19%	97.5%
Upper Pumpkin Creek	Other	Other	306.2	7.72	2.52%	100.0%
Hydrologic Unit Code (HUC12) Name	**Existing Vegetation Type**	**Physiognomy (form/morphological structure of vegetation)**	**Hydrologic Unit Code (HUC12) Acres**	**Existing Vegetation Type Acres**	**Percent of HUC12**	**Cumulative Percent**
YBO Creek	Western Great Plains Shortgrass Prairie	Grassland	31985.3	18806.72	58.80%	58.8%
YBO Creek	Western Cool Temperate Developed Ruderal Grassland	Developed	31985.3	4411.62	13.79%	72.6%
YBO Creek	Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	31985.3	2213.44	6.92%	79.5%
YBO Creek	Northwestern Great Plains Mixedgrass Prairie	Grassland	31985.3	1604.04	5.01%	84.5%
YBO Creek	Western Cool Temperate Wheat	Agricultural	31985.3	696.03	2.18%	86.7%
YBO Creek	Western Great Plains Sand Prairie Grassland	Grassland	31985.3	681.81	2.13%	88.8%
YBO Creek	Western Cool Temperate Fallow/Idle Cropland	Agricultural	31985.3	456.18	1.43%	90.3%
YBO Creek	Barren	Barren	31985.3	409.54	1.28%	91.5%
YBO Creek	Western Cool Temperate Developed Ruderal Shrubland	Developed	31985.3	398.46	1.25%	92.8%
YBO Creek	Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna	Conifer	31985.3	343.22	1.07%	93.9%
YBO Creek	Western Cool Temperate Undeveloped Ruderal Shrubland	Developed	31985.3	328.92	1.03%	94.9%
YBO Creek	Western Cool Temperate Undeveloped Ruderal Grassland	Developed	31985.3	320.19	1.00%	95.9%
YBO Creek	Other	Other	31985.3	1315.16	4.11%	100.0%

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
Conifers								
limber pine	Pinus flexilis		Sensitive			G4	S4	Species of Potential Concern (SOPC)
Flowering Plants								
Andean prairie clover	Dalea cylindriceps					G3G4	S2	Species of Concern (SOC)
autumn willow	Salix serissima			USFS-R2		G5	S1	Species of Concern (SOC)
bristlystalked sedge	Carex leptalea					G5	S3	
broadleaf arrowhead	Sagittaria latifolia					G5	S1	Species of Concern (SOC)
brownplume wirelettuce	Stephanomeria pauciflora					G5	S1	Species of Concern (SOC)
Colorado butterfly plant	Oenothera coloradensis					G3	S2	Species of Concern (SOC)
Colorado butterfly plant	Oenothera coloradensis ssp. coloradensis	Listed Threatened (LT)				G3T2	S2	Species of Concern (SOC)
Colorado tansyaster	Xanthisma coloradoense			USFS-R2		G3	S2	Species of Concern (SOC)
common hackberry	Celtis occidentalis					G5	S1	Species of Concern (SOC)
dainty rockcress	Boechera gracilenta					G4?Q	S1	Species of Concern (SOC)
disk waterhyssop	Bacopa rotundifolia					G5	S1	Species of Concern (SOC)
dropleaf buckwheat	Eriogonum exilifolium			USFS-R2		G3	S2	Species of Concern (SOC)
dwarf spikerush	Eleocharis coloradoensis					GNR	S1	Species of Concern (SOC)
Engelmann's milkweed	Asclepias engelmanniana					G5	S1	Species of Concern (SOC)
foothill milkvetch	Astragalus tridactylicus					G4	S2	Species of Potential Concern (SOPC)
grassyslope sedge	Carex oreocharis					G3	S2	Species of Concern (SOC)
great blue lobelia	Lobelia siphilitica					G5	S1	Species of Concern (SOC)
great blue lobelia	Lobelia siphilitica var. ludoviciana					G5T5?	S1	Species of Concern (SOC)
lanceleaf blazing star	Liatris lancifolia					G4	S1	Species of Concern (SOC)
Laramie chickensage	Artemisia simplex		Sensitive			G2	S2	Species of Concern (SOC)
Laramie columbine	Aquilegia laramiensis		Sensitive	USFS-R2		G2G3	S2S3	Species of Concern (SOC)
leechleaf blazingstar	Mentzelia sinuata					G3	S2	Species of Concern (SOC)
lesser bladderwort	Utricularia minor			USFS-R2		G5	S3	Species of Potential Concern (SOPC)
marsh felwort	Lomatogonium rotatum					G5	S2	Species of Concern (SOC)
matted grama	Bouteloua simplex					G5	S1	Species of Concern (SOC)
mealy goosefoot	Chenopodium incanum var. incanum					G5T5	S1	Species of Concern (SOC)
narrowleaf Indian breadroot	Pediomelum linearifolium					G4?	S1	Species of Concern (SOC)
pale blue-eyed grass	Sisyrinchium pallidum					G3	S2S3	Species of Potential Concern (SOPC)
persistent sepal yellowcress	Rorippa calycina		Sensitive			G3	S3	Species of Potential Concern (SOPC)
pony beebalm	Monarda pectinata					G5	S1	Species of Concern (SOC)
prairie dodder	Cuscuta plattensis	Not Warranted for Listing (NW)		USFS-R2		G1Q	S1	Species of Concern (SOC)
Rocky Mountain bulrush	Schoenoplectus saximontanus					G5	S1	Species of Concern (SOC)
Rocky Mountain phacelia	Phacelia denticulata					G3	S2	Species of Concern (SOC)
sageleaf willow	Salix candida			USFS-R2		G5	S2S3	Species of Concern (SOC)
sand milkweed	Asclepias arenaria					G5?	S1	Species of Concern (SOC)
showy prairie-gentian	Eustoma grandiflorum					G5	S1	Species of Concern (SOC)
silky prairie clover	Dalea villosa var. villosa					G5T5	S1	Species of Concern (SOC)
slender flatsedge	Cyperus bipartitus					G5	S1	Species of Concern (SOC)
smooth goosefoot	Chenopodium subglabrum					G3G4	S3	
spotted evening primrose	Oenothera canescens					G4G5	S1	Species of Concern (SOC)

tapertip flatsedge	Cyperus acuminatus					G5	S1	Species of Concern (SOC)
teal lovegrass	Eragrostis hypnoides					G5	S1	Species of Concern (SOC)
Ute lady's tresses	Spiranthes diluvialis	Listed Threatened (LT)				G2G3	S1S2	Species of Concern (SOC)
Vasey's rush	Juncus vaseyi					G5	S1	Species of Concern (SOC)
Ward's false goldenweed	Oonopsis wardii					G3	S3	Species of Potential Concern (SOPC)
western sedge	Carex occidentalis					G4	S1	Species of Concern (SOC)
white phacelia	Phacelia alba					G4G5	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
Amphibians								
Eastern Clade Western Toad	Anaxyrus boreas - Eastern Clade	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS1(Aa)	G4T2T3	S1	Species of Concern (SOC)
Northern Leopard Frog	Lithobates pipiens	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Plains Spadefoot	Spea bombifrons				NSS4(Bc)	G5	S4	Species of Concern (SOC)
Southern Rockies Wood Frog	Lithobates sylvaticus - Southern Rockies			USFS-R2	NSS2(Ba)	G5T3Q	S1	Species of Concern (SOC)
Western Tiger Salamander	Ambystoma mavortium				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Western Toad	Anaxyrus boreas		Sensitive	USFS-R2, USFS-R4	NSS1(Aa)	G4	S1	Species of Concern (SOC)
Wood Frog	Lithobates sylvaticus			USFS-R2	NSS2(Ba)	G5	S1	Species of Concern (SOC)
Birds								
American Avocet	Recurvirostra americana					G5	S3B	Species of Potential Concern (SOPC)
American Bittern	Botaurus lentiginosus			USFS-R2	NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
American Dipper	Cinclus mexicanus					G5	S4	Species of Potential Concern (SOPC)
American Kestrel	Falco sparverius				NSS4(Bc)	G5	S5	
American Pipit	Anthus rubescens				NSS4(Bc)	G5	S2	
American Three-toed Woodpecker	Picoides dorsalis			USFS-R4		G5	S3	Species of Concern (SOC)
American White Pelican	Pelecanus erythrorhynchos				NSS4(Bc)	G4	S3S4	Species of Concern (SOC)
Ash-throated Flycatcher	Myiarchus cinerascens				NSS3(Bb)	G5	S1S2	Species of Potential Concern (SOPC)
Baird's Sparrow	Ammodramus bairdii	Not Warranted for Listing (NW)	Sensitive		NSS4(Bc)	G4	S1	Species of Concern (SOC)
Bald Eagle	Haliaeetus leucocephalus	Delisted, formally monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G5	S4BS5N	Species of Concern (SOC)
Barn Owl	Tyto alba					G5	S2	Species of Potential Concern (SOPC)
Bewick's Wren	Thryomanes bewickii				NSS4(Bc)	G5	S2	
Black Rosy-Finch	Leucosticte atrata				NSSU(U)	G4	S1BS2N	Species of Concern (SOC)
Black Tern	Chlidonias niger			USFS-R2	NSS3(Bb)	G4	S1	Species of Concern (SOC)
Black-billed Cuckoo	Coccyzus erythropthalmus				NSS4(Bc)	G5	S2S3	Species of Concern (SOC)
Black-crowned Night-Heron	Nycticorax nycticorax				NSS3(Bb)	G5	S2S3	Species of Potential Concern (SOPC)
Black-necked Stilt	Himantopus mexicanus					G5	S3B	Species of Potential Concern (SOPC)
Black-throated Gray Warbler	Setophaga nigrescens				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Blue Grosbeak	Passerina caerulea				NSS4(Bc)	G5	S1	Species of Potential Concern (SOPC)
Blue-gray Gnatcatcher	Polioptila caerulea				NSS4(Bc)	G5	S3S4	
Bobolink	Dolichonyx oryzivorus				NSS4(Bc)	G5	S2S3	Species of Concern (SOC)
Boreal Owl	Aegolius funereus			USFS-R2, USFS-R4	NSS3(Bb)	G5	S2	Species of Concern (SOC)
Brewer's Sparrow	Spizella breweri		Sensitive	USFS-R2	NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Brown-capped Rosy-Finch	Leucosticte australis				NSSU(U)	G4	S1	Species of Concern (SOC)
Bufflehead	Bucephala albeola					G5	S2B	Species of Potential Concern (SOPC)
Burrowing Owl	Athene cunicularia		Sensitive	USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
California Gull	Larus californicus					G5	S2B	Species of Potential Concern (SOPC)
Calliope Hummingbird	Selasphorus calliope				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Canyon Wren	Catherpes mexicanus				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Caspian Tern	Hydroprogne caspia				NSS3(Bb)	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)	G5	S1S2	
Chestnut-collared Longspur	Calcarius ornatus			USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Chimney Swift	Chaetura pelagica					G5	S3B	Species of Potential Concern (SOPC)
Clark's Grebe	Aechmophorus clarkii				NSSU(U)	G5	S2S3	Species of Concern (SOC)

Clark's Nutcracker	Nucifraga columbiana				NSS4(Bc)	G5	S3S4	
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)	G5	S1BS3N	Species of Concern (SOC)
Common Nighthawk	Chordeiles minor				NSS4(Bc)	G5	S5	
Common Tern	Sterna hirundo					G5	S1	Species of Potential Concern (SOPC)
Common Yellowthroat	Geothlypis trichas				NSS4(Bc)	G5	S5	
Dark-eyed Junco	Junco hyemalis					G5	S5BS5N	Species of Concern (SOC)
Dickcissel	Spiza americana				NSSU(U)	G5	S1	Species of Potential Concern (SOPC)
Eastern Bluebird	Sialia sialis					G5	S2	Species of Potential Concern (SOPC)
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)	G4	S4S5BS3N	Species of Concern (SOC)
Forster's Tern	Sterna forsteri				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Franklin's Gull	Leucophaeus pipixcan				NSSU(U)	G4G5	S1	
Golden Eagle	Aquila chrysaetos				NSS4(Bc)	G5	S5BS4S5N	Species of Potential Concern (SOPC)
Golden-crowned Kinglet	Regulus satrapa					G5	S3BS4N	Species of Potential Concern (SOPC)
Grasshopper Sparrow	Ammodramus savannarum			USFS-R2	NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Gray-headed Junco	Junco hyemalis caniceps					G5T5	S5BS5N	Species of Concern (SOC)
Great Blue Heron	Ardea herodias				NSS4(Bc)	G5	S4	
Greater Sage-Grouse	Centrocercus urophasianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G3G4	S4	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)	G4	S3	Species of Concern (SOC)
Loggerhead Shrike	Lanius ludovicianus		Sensitive	USFS-R2	NSS4(Bc)	G4	S4S5	Species of Concern (SOC)
Long-billed Curlew	Numenius americanus		Sensitive	USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
MacGillivray's Warbler	Geothlypis tolmiei				NSS4(Bc)	G5	S4	
McCown's Longspur	Rhynchophanes mccownii			USFS-R2	NSS4(Bc)	G4	S3	Species of Concern (SOC)
Merlin	Falco columbarius				NSSU(U)	G5	S4	Species of Potential Concern (SOPC)
Mountain Plover	Charadrius montanus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSSU(U)	G3	S3	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)	G5	S2S3BS3N	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)
Oregon Junco	Junco hyemalis oreganus					G5T5	S5BS5N	Species of Concern (SOC)
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)	G4	S2BS2S3N	Species of Concern (SOC)
Pink-sided Junco	Junco hyemalis mearnsi					G5T5	S5BS5N	Species of Concern (SOC)
Piping Plover	Charadrius melodus	Listed Threatened (LT)				G3	SNA	Species of Potential Concern (SOPC)
Purple Martin	Progne subis				NSSU(U)	G5	S1	
Pygmy Nuthatch	Sitta pygmaea				NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Red Crossbill	Loxia curvirostra				NSS4(Bc)	G5	S5	
Red-eyed Vireo	Vireo olivaceus				NSS4(Bc)	G5	S2	Species of Potential Concern (SOPC)
Red-headed Woodpecker	Melanerpes erythrocephalus				NSS4(Bc)	G5	S2S3	
Red-necked Phalarope	Phalaropus lobatus					G4G5	S3N	Species of Potential Concern (SOPC)
Ring-billed Gull	Larus delawarensis					G5	S2	Species of Potential Concern (SOPC)
Ring-necked Duck	Aythya collaris					G5	S4B	Species of Potential Concern (SOPC)

Rose-breasted Grosbeak	Pheucticus ludovicianus					G5	S1	Species of Potential Concern (SOPC)
Rufous Hummingbird	Selasphorus rufus				NSS4(Bc)	G5	S3	
Sage Thrasher	Oreoscoptes montanus		Sensitive		NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Sagebrush Sparrow	Artemisiospiza nevadensis		Sensitive	USFS-R2	NSS4(Bc)	G5	S3S4	Species of Concern (SOC)
Sandhill Crane	Antigone canadensis					G5	S3BS5N	Species of Potential Concern (SOPC)
Short-eared Owl	Asio flammeus				NSS4(Bc)	G5	S1S2	Species of Concern (SOC)
Slate-colored Junco	Junco hyemalis hyemalis					G5T5	S5BS5N	Species of Concern (SOC)
Snowy Egret	Egretta thula				NSS3(Bb)	G5	S1S2	Species of Potential Concern (SOPC)
Sprague's Pipit	Anthus spragueii	Not Warranted for Listing (NW)				G4	SNA	Species of Potential Concern (SOPC)
Swainson's Hawk	Buteo swainsoni				NSSU(U)	G5	S5	
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)	G4	S3	Species of Concern (SOC)
Tundra Swan	Cygnus columbianus					G5	S2N	Species of Potential Concern (SOPC)
Upland Sandpiper	Bartramia longicauda				NSSU(U)	G5	S4S5	
Virginia Rail	Rallus limicola				NSSU(U)	G5	S2S4	Species of Potential Concern (SOPC)
Virginia's Warbler	Oreothlypis virginiae				NSSU(U)	G5	S1	Species of Concern (SOC)
Western Grebe	Aechmophorus occidentalis				NSSU(U)	G5	S3S4	
White-faced Ibis	Plegadis chihi		Sensitive		NSS3(Bb)	G5	S1	Species of Concern (SOC)
White-winged Crossbill	Loxia leucoptera					G5	S2	Species of Potential Concern (SOPC)
White-winged Junco	Junco hyemalis aikeni					G5T4	S3BS3N	Species of Concern (SOC)
Whooping Crane	Grus americana	Listed Endangered (LE), and Endangered - Nonessential Experimental Population (LEXN)				G1	SH	Species of Concern (SOC)
Williamson's Sapsucker	Sphyrapicus thyroideus				NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Willow Flycatcher	Empidonax traillii				NSS3(Bb)	G5	S5	
Woodhouse's Scrub-Jay	Aphelocoma woodhouseii				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Yellow-billed Cuckoo	Coccyzus americanus		Sensitive	USFS-R2, USFS-R4	NSSU(U)	G5	S1	Species of Concern (SOC)
Crustaceans								
Calico/Papershell Crayfish	Orconectes immunis				NSS4(Bc)	G5	SNR	
Devil Crayfish	Cambarus diogenes				NSSU(U)	G5	S3	Species of Concern (SOC)
Circumpolar Fairy Shrimp	Branchinecta paludosa				NSSU(U)	G5	S4	Species of Concern (SOC)
Constricted Fairy Shrimp	Branchinecta constricta				NSSU(U)	G2	S4	Species of Concern (SOC)
Couse tadpole shrimp	Lepidurus couesii				NSSU(U)	G4	S3	Species of Concern (SOC)
Greater Plains Fairy Shrimp	Streptocephalus texanus				NSSU(U)	G5	SNR	Species of Concern (SOC)
Longtail Tadpole Shrimp	Triops longicaudatus				NSSU(U)	G5	S4	Species of Concern (SOC)
Pocket Pouch Fairy Shrimp	Branchinecta lateralis				NSSU(U)	G4	S5	Species of Concern (SOC)
Rock Pool Fairy Shrimp	Branchinecta packardi				NSSU(U)	G5	SNR	Species of Concern (SOC)
Spineynose Clam Shrimp	Leptestheria compleximanus				NSSU(U)	G5	SNR	Species of Concern (SOC)
Versatile Fairy Shrimp	Branchinecta lindahli				NSSU(U)	G5	S4	Species of Concern (SOC)
Fish								
Bigmouth Shiner	Notropis dorsalis				NSS4(Cb)	G5	S5	
Brassy Minnow	Hybognathus hankinsoni				NSS4(Bc)	G5	S5	
Common Shiner	Luxilus cornutus				NSS4(Bc)	G5	S3S4	Species of Potential Concern (SOPC)
Cutthroat Trout	Oncorhynchus clarkii					G4	S2S3	Species of Concern (SOC)
Greenback Cutthroat Trout	Oncorhynchus clarkii stomias	Listed Threatened (LT)				G4T2T3	SX	Species of Concern (SOC)
Iowa Darter	Etheostoma exile				NSS3(Bb)	G5	S3S4	Species of Potential Concern (SOPC)
Northern Plains Killifish	Fundulus kansae				NSS3(Bb)	G5	S5	
Orangethroat Darter	Etheostoma spectabile				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Plains Topminnow	Fundulus sciadicus	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb)	G4	S3?	Species of Potential Concern (SOPC)

Suckermouth Minnow	Phenacobius mirabilis				NSS2(Ab)	G5	S2	Species of Concern (SOC)
Insects								
A Mason Bee	Osmia tanneri					G3G5	SH	Species of Concern (SOC)
Ottoe Skipper	Hesperia ottoe			USFS-R2		G3G4	S3	Species of Concern (SOC)
Regal Fritillary	Speyeria idalia	Petition Under Review (UR)		USFS-R2		G3	S3	Species of Concern (SOC)
Snow Scorpionfly	Boreus bomari					GNR	S4	Species of Concern (SOC)
Tawny Crescent	Phyciodes batesii					G4	SNR	Species of Concern (SOC)
Mammals								
American Pika	Ochotona princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5	S2	Species of Concern (SOC)
American Pygmy Shrew	Sorex hoyi			USFS-R2	NSSU(U)	G5	S1	
Bighorn Sheep	Ovis canadensis			USFS-R2, USFS-R4	NSS4(Bc)	G4	S2S3	Species of Potential Concern (SOPC)
Black-tailed Prairie Dog	Cynomys ludovicianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S2S3	Species of Concern (SOC)
Canada Lynx	Lynx canadensis	Listed Threatened (LT)			NSS1(Aa)	G5	S1	Species of Concern (SOC)
Dwarf Shrew	Sorex nanus				NSS3(Bb)	G4	S4S5	Species of Potential Concern (SOPC)
Eastern Cottontail	Sylvilagus floridanus					G5	S3	Species of Potential Concern (SOPC)
Eastern Mole	Scalopus aquaticus					G5	S2	Species of Potential Concern (SOPC)
Eastern Red Bat	Lasiurus borealis				NSS4(Bc)	G5	S3	
Eastern Spotted Skunk	Spilogale putorius				NSS3(Bb)	G4	S3S4	Species of Potential Concern (SOPC)
Fringed Myotis	Myotis thysanodes		Sensitive	USFS-R2	NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
Hispid Pocket Mouse	Chaetodipus hispidus				NSSU(U)	G5	S1S3	
Hoary Bat	Lasiurus cinereus			USFS-R2		G5	S4	Species of Potential Concern (SOPC)
Least Weasel	Mustela nivalis				NSSU(U)	G5	S1S2	Species of Potential Concern (SOPC)
Little Brown Myotis	Myotis lucifugus	Petition Under Review (UR)			NSS3(Bb)	G3	S5	Species of Potential Concern (SOPC)
Long-eared Myotis	Myotis evotis		Sensitive		NSS4(Cb)	G5	S4S5	Species of Potential Concern (SOPC)
Long-legged Myotis	Myotis volans				NSS4(Cb)	G5	S5	Species of Potential Concern (SOPC)
Meadow Jumping Mouse	Zapus hudsonius				NSS4(Bc)	G5	S3	Species of Concern (SOC)
Moose	Alces americanus				NSS4(Bc)	G5	S4	
North American Wolverine	Gulo gulo luscus	Proposed Threatened (WPT)			NSS3(Bb)	G4T4	S1S2	
Northern River Otter	Lontra canadensis	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Northern Rocky Mountain Pika	Ochotona princeps princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5TNR	S2	Species of Concern (SOC)
Olive-backed Pocket Mouse	Perognathus fasciatus				NSS4(Cb)	G5	S3S5	Species of Potential Concern (SOPC)
Pacific Marten	Martes caurina	Not Warranted for Listing (NW)		USFS-R2		G4G5	S3	Species of Potential Concern (SOPC)
Pallid Bat	Antrozous pallidus				NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Plains Harvest Mouse	Reithrodontomys montanus				NSS3(Bb)	G5	S3S5	
Plains Pocket Mouse	Perognathus flavescens				NSSU(U)	G5	S2S3	
Plains Spotted Skunk	Spilogale putorius interrupta	Petition Under Review (UR)			NSS3(Bb)	G4T4	S3S4	Species of Potential Concern (SOPC)
Preble's Meadow Jumping Mouse	Zapus hudsonius preblei	Listed Threatened (LT)	Sensitive		NSS3(Bb)	G5T2	S1	Species of Concern (SOC)
Ringtail	Bassariscus astutus				NSSU(U)	G5	S1S2	Species of Potential Concern (SOPC)
Sagebrush Vole	Lemmiscus curtatus				NSS4(Cb)	G5	S4	
Sand Hills Pocket Gopher	Geomys lutescens				NSS3(Bb)	G5	S1S3	
Silky Pocket Mouse	Perognathus flavus				NSSU(U)	G5	S2S4	
Silver-haired Bat	Lasionycteris noctivagans					G5	S3B	Species of Potential Concern (SOPC)
Southern Rocky Mountain Pygmy Shrew	Sorex hoyi montanus			USFS-R2	NSSU(U)	G5T2T3	S1	Species of Concern (SOC)
Southern Rocky Mountain Uinta Chipmunk	Tamias umbrinus montanus				NSS4(Bc)	G5TNR	S2S5	Species of Potential Concern (SOPC)
Spotted Ground Squirrel	Xerospermophilus spilosoma				NSS4(Bc)	G5	S2S5	
Swift Fox	Vulpes velox	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	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)	G3G4	S2BS1N	Species of Concern (SOC)

Uinta Chipmunk	Tamias umbrinus				NSS4(Bc)	G5	S2S5	Species of Potential Concern (SOPC)
Western Small-footed Myotis	Myotis ciliolabrum				NSS4(Cb)	G5	S4	Species of Potential Concern (SOPC)
Western Spotted Skunk	Spilogale gracilis				NSSU(U)	G5	S3S4	
White-tailed Prairie Dog	Cynomys leucurus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S2S3	Species of Concern (SOC)
Wolverine	Gulo gulo				NSS3(Bb)	G4	S1S2	
Wyoming Ground Squirrel	Urocitellus elegans					G5	S3S4	Species of Potential Concern (SOPC)
Mollusks								
Cylindrical Papershell	Anodontoides ferussacianus				NSS2(Ab)	G5	S3	Species of Concern (SOC)
Ash Gyro	Gyraulus parvus				NSSU(U)	G5	S4	Species of Concern (SOC)
Forest Disc	Discus whitneyi				NSSU(U)	G5	SNR	
Marsh Rams-horn	Planorbella trivolvis				NSSU(U)	G5	S4	Species of Concern (SOC)
Pewter Physa	Physa acuta				NSSU(U)	G5Q	S4	Species of Concern (SOC)
Prairie Fossaria	Fossaria bulimoides				NSSU(U)	G5	SNR	
Quick Gloss	Zonitoides arboreus				NSSU(U)	G5	SNR	
Subalpine Mountainsnail	Oreohelix subrudis				NSSU(U)	G5	SNR	Species of Concern (SOC)
Tadpole Physa	Physa gyrina				NSSU(U)	G5	S4	Species of Concern (SOC)
Reptiles								
Baur's Short-horned Lizard	Phrynosoma hernandesi bauri				NSS4(Bc)	G5TNR	SNR	
Bullsnake	Pituophis catenifer sayi					G5T5	S4	Species of Potential Concern (SOPC)
Common Gartersnake	Thamnophis sirtalis				NSSU(U)	G5	S5	Species of Potential Concern (SOPC)
Common Lesser Earless Lizard	Holbrookia maculata					G5	S2	Species of Concern (SOC)
Eastern Spiny Softshell	Apalone spinifera spinifera				NSS2(Ba)	G5T5	S4	Species of Potential Concern (SOPC)
Eastern Yellow-bellied Racer	Coluber constrictor flaviventris					G5T5	S4	Species of Potential Concern (SOPC)
Gophersnake	Pituophis catenifer					G5	S4	Species of Potential Concern (SOPC)
Great Plains Earless Lizard	Holbrookia maculata maculata				NSSU(U)	G5TNR	S2	Species of Concern (SOC)
Greater Short-horned Lizard	Phrynosoma hernandesi				NSS4(Bc)	G5	S4	
Many-lined Skink	Plestiodon multivirgatus					G5	S2	Species of Concern (SOC)
Northern Many-lined Skink	Plestiodon multivirgatus multivirgatus				NSSU(U)	G5T5	S1	Species of Concern (SOC)
Ornate Box Turtle	Terrapene ornata				NSSU(U)	G5	S1	Species of Concern (SOC)
Plains Black-headed Snake	Tantilla nigriceps				NSSU(U)	G5	SNR	Species of Concern (SOC)
Plains Box Turtle	Terrapene ornata ornata				NSSU(U)	G5T5	S1	Species of Concern (SOC)
Plains Gartersnake	Thamnophis radix				NSSU(U)	G5	S5	Species of Potential Concern (SOPC)
Plains Hog-nosed Snake	Heterodon nasicus				NSSU(U)	G5	S4	
Plains Short-horned Lizard	Phrynosoma hernandesi brevirostris				NSS4(Bc)	G5TNR	SNR	
Prairie Lizard	Sceloporus consobrinus				NSSU(U)	G5	S1	Species of Concern (SOC)
Prairie Racerunner	Aspidoscelis sexlineata viridis				NSSU(U)	G5T5	S2	Species of Concern (SOC)
Prairie Rattlesnake	Crotalus viridis				NSS4(Bc)	G5	S5	
Red-sided Gartersnake	Thamnophis sirtalis parietalis				NSSU(U)	G5T5TNR	S5	Species of Potential Concern (SOPC)
Six-lined Racerunner	Aspidoscelis sexlineata					G5	S2	Species of Concern (SOC)
Smooth Greensnake	Opheodrys vernalis				NSS3(Bb)	G5	S2	Species of Concern (SOC)
Spiny Softshell	Apalone spinifera					G5	S4	Species of Potential Concern (SOPC)
Valley Gartersnake	Thamnophis sirtalis fitchi				NSSU(U)	G5TNR	S2	Species of Potential Concern (SOPC)
Western Milksnake	Lampropeltis gentilis				NSS3(Bb)	G5	S3	Species of Potential Concern (SOPC)
Western Painted Turtle	Chrysemys picta bellii				NSS4(Bc)	G5T5	S4	

APPENDIX 4F

STOCK RESERVOIR EVALUATION

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
1	Pond/Reservoir	SEO Reservoir File	MANFULL RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.5025	-104.30499	Lower Little Horse Creek	N/A	018N	062W	27
2	Pond/Reservoir	SEO Reservoir File	MCLAUGHLIN NO. 2 RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.45704	-105.23213	North Fork Horse Creek	N/A	017N	070W	9
3	Pond/Reservoir	SEO Reservoir File	PETSCH RESERVOIR	Wet in 2004, 2012	Yes	Functional	Private	41.50198	-104.215	Horse Creek-Kellehan Creek	N/A	018N	061W	29
4	Pond/Reservoir	SEO Reservoir File	SWEET RESERVOIR	Berm evident, but dry in 2004, 2012, 2017	Potential	Potential	Private	41.52023	-104.94754	South Fork Bear Creek	N/A	018N	068W	24
5	Pond/Reservoir	SEO Reservoir File	MCCAN RESERVOIR	Berm evident, but dry in 2004, 2012, 2017	Potential	Potential	Private	41.51538	-104.94933	South Fork Bear Creek	N/A	018N	068W	24
6	Pond/Reservoir	SEO Reservoir File	NIMMO NO. 2 RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	Private	41.46337	-105.10487	Upper Little Bear Creek	N/A	017N	069W	10
7	Pond/Reservoir	SEO Reservoir File	NIMMO NO. 3 RESERVOIR	Berm evident and wet in 2004	Potential	Potential	Private	41.46467	-105.14397	Upper Little Bear Creek	N/A	017N	069W	8
8	Pond/Reservoir	SEO Reservoir File	MCKECHNIE RESERVOIR NO. 1	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.39587	-105.34717	Horse Creek-Schoolhouse Creek	N/A	017N	071W	33
9	Pond/Reservoir	SEO Reservoir File	MCKECHNIE RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.41717	-105.35472	Horse Creek-Schoolhouse Creek	N/A	017N	071W	28
10	Pond/Reservoir	SEO Reservoir File	DONAHUE RESERVOIR	Wet in 2012, 2017	Yes	Functional	Private	41.49341	-104.38797	Upper Little Horse Creek	N/A	018N	063W	26
11	Pond/Reservoir	SEO Reservoir File	DONAHUE POND NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.49589	-104.3779	Upper Little Horse Creek	N/A	018N	063W	25
12	Pond/Reservoir	SEO Reservoir File	DONAHUE POND NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.49615	-104.37831	Upper Little Horse Creek	N/A	018N	063W	25
13	Pond/Reservoir	SEO Reservoir File	BROWN NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.42211	-105.41892	Horse Creek-Schoolhouse Creek	N/A	017N	072W	25
14	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 1 RESERVOIR	Berm evident, but dry in 2004, 2012, 2017	Potential	Potential	Private	41.50192	-105.0565	South Fork Bear Creek	N/A	018N	068W	30
15	Pond/Reservoir	SEO Reservoir File	CARROLL NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.40231	-105.36649	Horse Creek-Schoolhouse Creek	N/A	017N	071W	32
16	Pond/Reservoir	SEO Reservoir File	CARROLL NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.40141	-105.36964	Horse Creek-Schoolhouse Creek	N/A	017N	071W	32
17	Pond/Reservoir	SEO Reservoir File	CARROLL NO. 3 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.40169	-105.37722	Horse Creek-Schoolhouse Creek	N/A	017N	071W	32
18	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 2 RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.57701	-105.04099	North Bear Creek	N/A	019N	068W	31
19	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 5 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.56671	-105.05876	North Bear Creek	N/A	018N	069W	1
20	Pond/Reservoir	SEO Reservoir File	ENL. R P ALLEN NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.56781	-105.06058	North Bear Creek	N/A	018N	069W	1
21	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 3 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.57468	-105.05658	North Bear Creek	N/A	019N	068W	31
22	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 1 RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.57449	-105.04562	North Bear Creek	N/A	019N	068W	31
23	Pond/Reservoir	SEO Reservoir File	STILES' NUMBER ONE RESERVOIR	no SEO Stock Use	No	N/A	Private	41.44105	-105.39951	North Fork Horse Creek	N/A	017N	071W	18
24	Pond/Reservoir	SEO Reservoir File	INDIAN HILL RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.55432	-104.74464	Middle Little Bear Creek	N/A	018N	066W	2
25	Pond/Reservoir	SEO Reservoir File	CASH'S HOME RESERVOIR	no SEO Stock Use	No	N/A	Private	41.44684	-105.43909	North Fork Horse Creek	N/A	017N	072W	14
26	Pond/Reservoir	SEO Reservoir File	HIRSIG NO. 4 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.58516	-105.01353	North Bear Creek	N/A	019N	068W	28
27	Pond/Reservoir	SEO Reservoir File	NFHC NO. 7 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45822	-105.2277	North Fork Horse Creek	N/A	017N	070W	10
28	Pond/Reservoir	SEO Reservoir File	NFHC NO. 8 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45821	-105.22769	North Fork Horse Creek	N/A	017N	070W	10
29	Pond/Reservoir	SEO Reservoir File	NFHC NO. 9 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45823	-105.22771	North Fork Horse Creek	N/A	017N	070W	10
30	Pond/Reservoir	SEO Reservoir File	NFHC NO. 10 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45464	-105.22775	North Fork Horse Creek	N/A	017N	070W	10
31	Pond/Reservoir	SEO Reservoir File	NFHC NO. 11 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45463	-105.22775	North Fork Horse Creek	N/A	017N	070W	10
32	Pond/Reservoir	SEO Reservoir File	NFHC NO. 12 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45462	-105.22775	North Fork Horse Creek	N/A	017N	070W	10
33	Pond/Reservoir	SEO Reservoir File	NFHC NO. 13 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45464	-105.22775	North Fork Horse Creek	N/A	017N	070W	10
34	Pond/Reservoir	SEO Reservoir File	NFHC #14 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45465	-105.22775	North Fork Horse Creek	N/A	017N	070W	10
35	Pond/Reservoir	SEO Reservoir File	NFHC NO. 15 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45462	-105.223	North Fork Horse Creek	N/A	017N	070W	10
36	Pond/Reservoir	SEO Reservoir File	NFHC NO. 16 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.22298	North Fork Horse Creek	N/A	017N	070W	10
37	Pond/Reservoir	SEO Reservoir File	NFHC NO. 17 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.22299	North Fork Horse Creek	N/A	017N	070W	10
38	Pond/Reservoir	SEO Reservoir File	NFHC NO. 18 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.22299	North Fork Horse Creek	N/A	017N	070W	10
39	Pond/Reservoir	SEO Reservoir File	NFHC NO. 19 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.22299	North Fork Horse Creek	N/A	017N	070W	10
40	Pond/Reservoir	SEO Reservoir File	NFHC NO. 20 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.4546	-105.21821	North Fork Horse Creek	N/A	017N	070W	10
41	Pond/Reservoir	SEO Reservoir File	NFHC NO. 21 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45459	-105.21822	North Fork Horse Creek	N/A	017N	070W	10
42	Pond/Reservoir	SEO Reservoir File	NFHC NO. 22 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.4546	-105.21822	North Fork Horse Creek	N/A	017N	070W	10
43	Pond/Reservoir	SEO Reservoir File	NFHC NO. 23 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.21822	North Fork Horse Creek	N/A	017N	070W	10
44	Pond/Reservoir	SEO Reservoir File	NFHC NO. 24 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.21822	North Fork Horse Creek	N/A	017N	070W	10
45	Pond/Reservoir	SEO Reservoir File	NFHC NO. 25 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45461	-105.21822	North Fork Horse Creek	N/A	017N	070W	10
46	Pond/Reservoir	SEO Reservoir File	NFHC NO. 26 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45361	-105.21834	North Fork Horse Creek	N/A	017N	070W	10
47	Pond/Reservoir	SEO Reservoir File	NFHC NO. 27 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45408	-105.21577	North Fork Horse Creek	N/A	017N	070W	10
48	Pond/Reservoir	SEO Reservoir File	NFHC NO. 28 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45415	-105.21404	North Fork Horse Creek	N/A	017N	070W	10
49	Pond/Reservoir	SEO Reservoir File	NFHC NO. 29 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45365	-105.21439	North Fork Horse Creek	N/A	017N	070W	10
50	Pond/Reservoir	SEO Reservoir File	NFHC NO. 30 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45393	-105.21394	North Fork Horse Creek	N/A	017N	070W	10
51	Pond/Reservoir	SEO Reservoir File	NFHC NO. 31 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45415	-105.21405	North Fork Horse Creek	N/A	017N	070W	10
52	Pond/Reservoir	SEO Reservoir File	NFHC NO. 32 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.45404	-105.21231	North Fork Horse Creek	N/A	017N	070W	10
53	Pond/Reservoir	SEO Reservoir File	J H D NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.46126	-104.61689	Horse Creek-Cattail Creek	N/A	017N	065W	11
54	Pond/Reservoir	SEO Reservoir File	BUSHNELL RESERVOIR	no SEO Stock Use	No	N/A	Private	41.51822	-104.1527	Horse Creek-Bushnell Creek	N/A	018N	061W	23
55	Pond/Reservoir	SEO Reservoir File	CAREY COMPANY NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.46736	-104.80589	Horse Creek-Kelley Draw	N/A	017N	066W	5
56	Pond/Reservoir	SEO Reservoir File	KIRKBRIDE RESERVOIR	no SEO Stock Use	No	N/A	Private	41.50095	-104.59386	Horse Creek-Cattail Creek	N/A	018N	064W	30
57	Pond/Reservoir	SEO Reservoir File	EVANS POND RESERVOIR	no SEO Stock Use	No	N/A	Private	41.770211	-104.274181	Horse Creek-Hawk Springs	N/A	021N	062W	23
58	Pond/Reservoir	SEO Reservoir File	DRY CREEK DIVERSION DAM RESERVOIR	Wet in 2012, 2015	Yes	Functional	Bureau of Land Management	41.85145	-104.14058	Dry Creek	TABLE MOUNTAIN 2	022N	061W	25
59	Pond/Reservoir	SEO Reservoir File	EAST RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.82675	-104.516111	YBO Creek	N/A	021N	064W	2

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
60	Pond/Reservoir	SEO Reservoir File	CANYON VIEW RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.836806	-104.522222	YBO Creek	N/A	022N	064W	34
61	Pond/Reservoir	SEO Reservoir File	WEST RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.826972	-104.525694	YBO Creek	N/A	021N	064W	3
62	Pond/Reservoir	SEO Reservoir File	DUCK POND	no SEO Stock Use	No	N/A	Private	41.86064	-104.30068	Goshen Hole Reservoir	N/A	022N	062W	22
63	Pond/Reservoir	SEO Reservoir File	SANDERS	May be wet in 2015, but dry in 2012, 2017	Potential	Potential	Private	41.65463	-104.2063	Horse Creek-La Grange	N/A	020N	061W	33
64	Pond/Reservoir	SEO Reservoir File	JOHNSON	No visible reservoir	No	Non-Functional	Private	41.847306	-104.271694	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	26
65	Pond/Reservoir	SEO Reservoir File	GOSHEN NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.86528	-104.31261	Goshen Hole Reservoir	N/A	022N	062W	21
66	Pond/Reservoir	SEO Reservoir File	GREASEWOOD RESERVOIR	no SEO Stock Use	No	N/A	Private	41.87757	-104.33596	Goshen Hole Reservoir	N/A	022N	062W	17
67	Pond/Reservoir	SEO Reservoir File	RIGGS RESERVOIR	no SEO Stock Use	No	N/A	Private	41.66475	-104.2396	Horse Creek-Hawk Springs	N/A	020N	061W	31
68	Pond/Reservoir	SEO Reservoir File	DUNN RESERVOIR	no SEO Stock Use	No	N/A	Private	41.83218	-104.27283	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	35
69	Pond/Reservoir	SEO Reservoir File	MCMILLEN RESERVOIR	no SEO Stock Use	No	N/A	Private	41.76439	-104.18242	Hawk Springs Reservoir	N/A	021N	061W	27
70	Pond/Reservoir	SEO Reservoir File	ENL. GOSHEN NOS. 1 AND 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.86011	-104.30431	Goshen Hole Reservoir	N/A	022N	062W	22
71	Pond/Reservoir	SEO Reservoir File	MCMILLEN RESERVOIR NO. 2	No visible reservoir	No	Non-Functional	Private	41.76171	-104.18194	Hawk Springs Reservoir	N/A	021N	061W	27
72	Pond/Reservoir	SEO Reservoir File	MARLATT RESERVOIR	no SEO Stock Use	No	N/A	Private	41.89463	-104.2828	Goshen Hole Reservoir	N/A	022N	062W	11
73	Pond/Reservoir	SEO Reservoir File	MCMILLEN RESERVOIR NO. 3	no SEO Stock Use	No	N/A	Private	41.76915	-104.18027	Hawk Springs Reservoir	N/A	021N	061W	27
74	Pond/Reservoir	SEO Reservoir File	LITTLE WILLOW RESERVOIR	no SEO Stock Use	No	N/A	Private	41.85594	-104.25161	Horse Creek-Little Willow Reservoir	N/A	022N	062W	25
75	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Bureau of Land Management	41.86178	-104.14833	Dry Creek	TABLE MOUNTAIN 3	022N	061W	24
76	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Bureau of Land Management	41.86352	-104.12829	Dry Creek	TABLE MOUNTAIN 1	022N	060W	19
77	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN NO. 5 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.87108	-104.13438	Horse Creek-Packer Reservoir	N/A	022N	061W	13
78	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN RESERVOIR NO. 8	no SEO Stock Use	No	N/A	Bureau of Land Management	41.87709	-104.12368	Horse Creek-Packer Reservoir	TABLE MOUNTAIN 1	022N	060W	18
79	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN RESERVOIR NO. 4	no SEO Stock Use	No	N/A	Bureau of Land Management	41.86776	-104.12971	Horse Creek-Packer Reservoir	TABLE MOUNTAIN 1	022N	060W	19
80	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN NO. 3 RESERVOIR	no SEO Stock Use	No	N/A	Bureau of Land Management	41.85459	-104.13617	Dry Creek	TABLE MOUNTAIN 2	022N	061W	25
81	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN RESERVOIR NO. 6	no SEO Stock Use	No	N/A	Bureau of Land Management	41.86458	-104.13569	Dry Creek	TABLE MOUNTAIN 3	022N	061W	24
82	Pond/Reservoir	SEO Reservoir File	TABLE MOUNTAIN RESERVOIR NO. 7	no SEO Stock Use	No	N/A	Bureau of Land Management	41.87379	-104.12487	Horse Creek-Packer Reservoir	TABLE MOUNTAIN 1	022N	060W	18
83	Pond/Reservoir	SEO Reservoir File	KAUFMAN NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.7625	-104.07536	Robb Draw	N/A	021N	060W	28
84	Pond/Reservoir	SEO Reservoir File	SOUTHWELL FISH POND RESERVOIR	no SEO Stock Use	No	N/A	Private	41.83141	-104.0903	Dry Creek	N/A	022N	060W	33
85	Pond/Reservoir	SEO Reservoir File	BEAVER CREEK RESERVOIR	no SEO Stock Use	No	N/A	Private	41.63253	-104.38865	Middle Bear Creek	N/A	019N	063W	11
86	Pond/Reservoir	SEO Reservoir File	LANE CANYON RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.85521	-104.6027	YBO Creek	CEDAR CANYON	022N	065W	25
87	Pond/Reservoir	SEO Reservoir File	HAWK SPRINGS RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.71508	-104.19617	Hawk Springs Reservoir	N/A	020N	061W	9
88	Pond/Reservoir	SEO Reservoir File	SPRINGER WILDLIFE MANAGEMENT UNIT RESERVOIR	no SEO Stock Use	No	N/A	State	41.8672	-104.28825	Goshen Hole Reservoir	N/A	022N	062W	22
89	Pond/Reservoir	SEO Reservoir File	ENL. MCMILLEN NO. 2	no SEO Stock Use	No	N/A	Private	41.760261	-104.183669	Hawk Springs Reservoir	N/A	021N	061W	27
90	Pond/Reservoir	SEO Reservoir File	DRUMMOND NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.89467	-104.28356	Goshen Hole Reservoir	N/A	022N	062W	11
91	Pond/Reservoir	SEO Reservoir File	BAUMGARTNER RESERVOIR	no SEO Stock Use	No	N/A	Private	41.84446	-104.32171	Goshen Hole Reservoir	N/A	022N	062W	28
92	Pond/Reservoir	SEO Reservoir File	SINNARD RESERVOIR	no SEO Stock Use	No	N/A	Private	41.80754	-104.34644	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	7
93	Pond/Reservoir	SEO Reservoir File	SINNARD WETLAND RESERVOIR	no SEO Stock Use	No	N/A	Private	41.810486	-104.345172	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	7
94	Pond/Reservoir	SEO Reservoir File	MARTIN RESERVOIR	Wet in 2015	Potential	Potential	Private	41.857492	-104.325558	Goshen Hole Reservoir	N/A	022N	062W	20
95	Pond/Reservoir	SEO Reservoir File	DAYSPRING RANCH LLC WETLAND NO. 1	no SEO Stock Use	No	N/A	Private	41.85006	-104.32789	Goshen Hole Reservoir	N/A	022N	062W	29
96	Pond/Reservoir	SEO Reservoir File	DAYSPRING RANCH LLC WETLAND NO. 2	no SEO Stock Use	No	N/A	Private	41.84889	-104.33886	Goshen Hole Reservoir	N/A	022N	062W	29
97	Pond/Reservoir	SEO Reservoir File	DAYSPRING RANCH LLC WETLAND NO. 3	no SEO Stock Use	No	N/A	Private	41.84344	-104.34317	Goshen Hole Reservoir	N/A	022N	062W	29
98	Pond/Reservoir	SEO Reservoir File	DAYSPRING RANCH LLC WETLAND NO. 4	no SEO Stock Use	No	N/A	Private	41.84333	-104.33439	Goshen Hole Reservoir	N/A	022N	062W	29
99	Pond/Reservoir	SEO Reservoir File	ZIMMERER NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.89747	-104.07847	Horse Creek-Packer Reservoir	N/A	022N	060W	9
100	Pond/Reservoir	SEO Reservoir File	ZIMMERER POND NO. 2 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.89733	-104.08597	Horse Creek-Packer Reservoir	N/A	022N	060W	9
101	Pond/Reservoir	SEO Reservoir File	ENL BAUMGARTNER STOCK WATER NO 1 RESERVOIR	Wet in 2012, 2017	Yes	Functional	Private	41.84578	-104.31321	Goshen Hole Reservoir	N/A	022N	062W	28
102	Pond/Reservoir	SEO Reservoir File	WELLS FAMILY NO. 1	no SEO Stock Use	No	N/A	Private	41.92933	-104.11181	Horse Creek-Packer Reservoir	N/A	023N	060W	30
103	Pond/Reservoir	SEO Reservoir File	WELLS FAMILY NO. 2	no SEO Stock Use	No	N/A	Private	41.92986	-104.11336	Horse Creek-Packer Reservoir	N/A	023N	060W	30
104	Pond/Reservoir	SEO Reservoir File	ALPS WETLAND RESERVOIR	no SEO Stock Use	No	N/A	Private	41.9082	-104.2474	Goshen Hole Reservoir	N/A	022N	062W	1
105	Pond/Reservoir	SEO Reservoir File	WASHBURN WRP EXCAVATED POND D	no SEO Stock Use	No	N/A	Private	41.88837	-104.33801	Goshen Hole Reservoir	N/A	022N	062W	8
106	Pond/Reservoir	SEO Reservoir File	PRESTON POND NO. 2	no SEO Stock Use	No	N/A	Private	41.85204	-104.37995	Josh Creek	N/A	022N	063W	25
107	Pond/Reservoir	SEO Reservoir File	PRESTON POND NO. 3	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.85961	-104.37031	Josh Creek	N/A	022N	063W	24
108	Pond/Reservoir	SEO Reservoir File	WASHBURN WRP RESERVOIR	no SEO Stock Use	No	N/A	Private	41.88478	-104.34111	Goshen Hole Reservoir	N/A	022N	062W	17
109	Pond/Reservoir	SEO Reservoir File	WASHBURN WRP EXCAVATED PONDS A,B,C, AND E RESERVOIR	no SEO Stock Use	No	N/A	Private	41.88518	-104.34272	Goshen Hole Reservoir	N/A	022N	062W	17
110	Pond/Reservoir	SEO Reservoir File	RICHARD PRESTON NO. 1 RESERVOIR	Wet in 2015	Potential	Potential	Private	41.86512	-104.36594	Josh Creek	N/A	022N	063W	24
111	Pond/Reservoir	SEO Reservoir File	SHOVELER RESERVOIR	no SEO Stock Use	No	N/A	Private	41.8407	-104.335	Goshen Hole Reservoir	N/A	022N	062W	32
112	Pond/Reservoir	SEO Reservoir File	AVOCET RESERVOIR	no SEO Stock Use	No	N/A	Private	41.8401	-104.3422	Goshen Hole Reservoir	N/A	022N	062W	32
113	Pond/Reservoir	SEO Reservoir File	PAFFORD RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.849769	-104.348079	Goshen Hole Reservoir	N/A	022N	062W	30
114	Pond/Reservoir	SEO Reservoir File	BAKER BROS ENLARGEMENT RESERVOIR	no SEO Stock Use	No	N/A	Private	41.85	-104.344	Goshen Hole Reservoir	N/A	022N	062W	29
115	Pond/Reservoir	SEO Reservoir File	BAKER BROS RESERVOIR	no SEO Stock Use	No	N/A	Private	41.754357	-104.230813	Horse Creek-Hawk Springs	N/A	021N	061W	31
116	Pond/Reservoir	SEO Reservoir File	YODER RESERVOIR	no SEO Stock Use	No	N/A	Private	41.75655	-104.23942	Horse Creek-Hawk Springs	N/A	021N	061W	30
117	Pond/Reservoir	SEO Reservoir File	HUGHES RESERVOIR	no SEO Stock Use	No	N/A	Private	41.82569	-104.27351	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	2
118	Pond/Reservoir	SEO Reservoir File	MID WILLOW RESERVOIR	no SEO Stock Use	No	N/A	Private	41.78599	-104.24012	Horse Creek-Hawk Springs	N/A	021N	061W	18

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
119	Pond/Reservoir	SEO Reservoir File	SHERARD NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.65349	-104.1914	Horse Creek-La Grange	N/A	020N	061W	33
120	Pond/Reservoir	SEO Reservoir File	SHERARD RESERVOIR	no SEO Stock Use	No	N/A	Private	41.66051	-104.19609	Horse Creek-La Grange	N/A	020N	061W	33
121	Pond/Reservoir	SEO Reservoir File	STEMLER RESERVOIR	no SEO Stock Use	No	N/A	Private	41.63144	-104.16225	Horse Creek-La Grange	N/A	019N	061W	11
122	Pond/Reservoir	SEO Reservoir File	BUNN RESERVOIR	no SEO Stock Use	No	N/A	Private	41.66886	-104.32994	Lower Fox Creek	N/A	020N	062W	29
123	Pond/Reservoir	SEO Reservoir File	MICHAEL RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.890769	-104.16335	Horse Creek-Little Willow Reservoir	N/A	022N	061W	11
124	Pond/Reservoir	SEO Reservoir File	PETERS NO. 1 RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.89555	-104.0531	Horse Creek-Packer Reservoir	N/A	022N	060W	10
125	Pond/Reservoir	SEO Reservoir File	GOSHEN HOLE RESERVOIR	no SEO Stock Use	No	N/A	Private	41.893731	-104.282259	Goshen Hole Reservoir	N/A	022N	062W	11
126	Pond/Reservoir	SEO Reservoir File	VANCE RESERVOIR	no SEO Stock Use	No	N/A	Private	41.79006	-104.23962	Horse Creek-Hawk Springs	N/A	021N	061W	18
127	Pond/Reservoir	SEO Reservoir File	BABBITT NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.64725	-104.23993	Lower Bear Creek-Horse Creek	N/A	019N	061W	6
128	Pond/Reservoir	SEO Reservoir File	HUBB RESERVOIR	no SEO Stock Use	No	N/A	Private	41.65345	-104.21083	Horse Creek-La Grange	N/A	020N	061W	32
129	Pond/Reservoir	SEO Reservoir File	66 PASTURES RESERVOIR	no SEO Stock Use	No	N/A	Private	41.66228	-104.11963	Hawk Springs Reservoir	N/A	020N	060W	31
130	Pond/Reservoir	SEO Reservoir File	CROWN NO. 1 RESERVOIR	no SEO Stock Use	No	N/A	Private	41.61717	-104.13807	Horse Creek-La Grange	N/A	019N	061W	13
131	Pond/Reservoir	SEO Stock Reservoir File	H. T. LEWIS NO. 2 STOCK RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	State	41.439369	-104.785536	Horse Creek-Kelley Draw	N/A	017N	066W	16
132	Pond/Reservoir	SEO Stock Reservoir File	RABOU NO. 1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.45289	-104.11398	Horse Creek-Bushnell Creek	N/A	017N	060W	7
133	Pond/Reservoir	SEO Stock Reservoir File	RABOU NO. 3 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.46037	-104.13407	Horse Creek-Bushnell Creek	N/A	017N	061W	12
134	Pond/Reservoir	SEO Stock Reservoir File	INDIAN WOMAN STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.474836	-104.230025	Horse Creek-Kellehan Creek	N/A	017N	061W	6
135	Pond/Reservoir	SEO Stock Reservoir File	RABOU SOUTH PIT STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.460247	-104.123297	Horse Creek-Bushnell Creek	N/A	017N	060W	7
136	Pond/Reservoir	SEO Stock Reservoir File	RABOU WEST PIT STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.467861	-104.132572	Horse Creek-Bushnell Creek	N/A	017N	061W	1
137	Pond/Reservoir	SEO Stock Reservoir File	RABOU NORTH PIT STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.467264	-104.126672	Horse Creek-Bushnell Creek	N/A	017N	060W	6
138	Pond/Reservoir	SEO Stock Reservoir File	RABOU LOWER STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.49	-104.124167	Horse Creek-Bushnell Creek	N/A	018N	060W	31
139	Pond/Reservoir	SEO Stock Reservoir File	H. T. LEWIS NO. 4 STOCK RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	State	41.4395	-104.839558	Horse Creek-Kelley Draw	N/A	017N	067W	13
140	Pond/Reservoir	SEO Stock Reservoir File	H. T. LEWIS NO. 5 STOCK RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	State	41.445711	-104.858875	Horse Creek-Kelley Draw	N/A	017N	067W	14
141	Pond/Reservoir	SEO Stock Reservoir File	LEWIS NO. 8 STOCK RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	State	41.441858	-104.898358	Horse Creek-Kelley Draw	N/A	017N	067W	16
142	Pond/Reservoir	SEO Stock Reservoir File	NIMMO NO 8 STOCK RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.435544	-104.941522	Horse Creek-Carey Creek	N/A	017N	067W	19
143	Pond/Reservoir	SEO Stock Reservoir File	JUNIOR STOCK RESERVOIR	Wet in 2015, 2017	Yes	Functional	Private	41.394392	-105.32205	Horse Creek-Schoolhouse Creek	N/A	016N	071W	2
144	Pond/Reservoir	SEO Stock Reservoir File	P K STOCK RESERVOIR	Wet in 2012	Potential	Potential	Private	41.55761	-104.92416	Harry Dayton Ranch	N/A	018N	067W	6
145	Pond/Reservoir	SEO Stock Reservoir File	HARRY #1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.43722	-105.39149	North Fork Horse Creek	N/A	017N	071W	19
146	Pond/Reservoir	SEO Stock Reservoir File	SNOW NO. 1 STOCK RESERVOIR	Wet in 2012, 2017	Yes	Functional	Private	41.58911	-104.84254	South Fork Bear Creek	N/A	019N	067W	25
147	Pond/Reservoir	SEO Stock Reservoir File	HIRSIG NO. 2 STOCK RESERVOIR	Wet in 2004, 2017	Yes	Functional	Private	41.56695	-105.0504	North Bear Creek	N/A	018N	068W	6
148	Pond/Reservoir	SEO Stock Reservoir File	BROWN #3 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.43729	-105.4343	North Fork Horse Creek	N/A	017N	072W	23
149	Pond/Reservoir	SEO Stock Reservoir File	BROWN #7 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.44329	-105.41481	North Fork Horse Creek	N/A	017N	072W	13
150	Pond/Reservoir	SEO Stock Reservoir File	BROWN #4 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.43594	-105.40385	North Fork Horse Creek	N/A	017N	072W	24
151	Pond/Reservoir	SEO Stock Reservoir File	BROWN #2 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	State	41.4151	-105.43915	Horse Creek-Schoolhouse Creek	N/A	017N	072W	26
152	Pond/Reservoir	SEO Stock Reservoir File	DEREEMER NO. 3 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.41059	-105.11745	Horse Creek-Carey Creek	N/A	017N	069W	28
153	Pond/Reservoir	SEO Stock Reservoir File	DEREEMER #2 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.44788	-105.15096	Horse Creek-Carey Creek	N/A	017N	069W	17
154	Pond/Reservoir	SEO Stock Reservoir File	DEREEMER #1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.43229	-105.09849	Horse Creek-Carey Creek	N/A	017N	069W	22
155	Pond/Reservoir	SEO Stock Reservoir File	DEREEMER NO. 4 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.40695	-105.12705	Horse Creek-Carey Creek	N/A	017N	069W	33
156	Pond/Reservoir	SEO Stock Reservoir File	DEREEMER NO. 5 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.40695	-105.12705	Horse Creek-Carey Creek	N/A	017N	069W	33
157	Pond/Reservoir	SEO Stock Reservoir File	PRESTON STOCK RESERVOIR	No visible reservoir	No	Non-Functional	State	41.5707	-104.86312	South Fork Bear Creek	N/A	019N	067W	35
158	Pond/Reservoir	SEO Stock Reservoir File	PETE KAMP STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.45647	-105.4606	North Fork Horse Creek	N/A	017N	072W	10
159	Pond/Reservoir	SEO Stock Reservoir File	NIMMO NO. 9 STOCK RESERVOIR	Wet in 2004, 2012, 2017	Yes	Functional	Private	41.536222	-104.993997	South Fork Bear Creek	N/A	018N	068W	15
160	Pond/Reservoir	SEO Stock Reservoir File	H.T. LEWIS NO. 6 STOCK RESERVOIR	Berm evident but wet in 2004, 2012, 2017	Potential	Potential	Private	41.463194	-104.773889	Horse Creek-Kelley Draw	N/A	017N	066W	9
161	Pond/Reservoir	SEO Stock Reservoir File	H.T. LEWIS NO. 3 STOCK RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	Private	41.443472	-104.803472	Horse Creek-Kelley Draw	N/A	017N	066W	17
162	Pond/Reservoir	SEO Stock Reservoir File	H.T. LEWIS NO. 7 STOCK RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	Private	41.478333	-104.849667	Horse Creek-Kelley Draw	N/A	017N	067W	2
163	Pond/Reservoir	SEO Stock Reservoir File	H. T. LEWIS NO. 1 STOCK RESERVOIR	Berm evident but dry in 2004, 2012, 2017	Potential	Potential	Private	41.4747	-104.8774	Horse Creek-Kelley Draw	N/A	017N	067W	3
164	Pond/Reservoir	SEO Stock Reservoir File	SANFORD NO 1 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.7907	-104.2608	Horse Creek-Hawk Springs	N/A	021N	062W	13
165	Pond/Reservoir	SEO Stock Reservoir File	66 MOUNTAIN STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.6934	-104.167036	Hawk Springs Reservoir	N/A	020N	061W	23
166	Pond/Reservoir	SEO Stock Reservoir File	KAMIS NO 1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.657131	-104.301864	Lower Bear Creek-Horse Creek	N/A	020N	062W	34
167	Pond/Reservoir	SEO Stock Reservoir File	GBK STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.894772	-104.312844	Goshen Hole Reservoir	N/A	022N	062W	9
168	Pond/Reservoir	SEO Stock Reservoir File	PRZYMUS STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.909278	-104.308039	Goshen Hole Reservoir	N/A	022N	062W	4
169	Pond/Reservoir	SEO Stock Reservoir File	JOYCE 1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.892536	-104.307331	Goshen Hole Reservoir	N/A	022N	062W	9
170	Pond/Reservoir	SEO Stock Reservoir File	JOYCE 2 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.890961	-104.306014	Goshen Hole Reservoir	N/A	022N	062W	9
171	Pond/Reservoir	SEO Stock Reservoir File	WOLSKI STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.854833	-104.293256	Goshen Hole Reservoir	N/A	022N	062W	27
172	Pond/Reservoir	SEO Stock Reservoir File	DUCKLING STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.838108	-104.335881	Goshen Hole Reservoir	N/A	022N	062W	32
173	Pond/Reservoir	SEO Stock Reservoir File	GOSLING STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.8395	-104.3363	Goshen Hole Reservoir	N/A	022N	062W	32
174	Pond/Reservoir	SEO Stock Reservoir File	WARD NO 2 STOCK RESERVOIR	Dry in 2012, 2015, 2017	No	Non-Functional	Private	41.653792	-104.23515	Lower Bear Creek-Horse Creek	N/A	020N	061W	31
175	Pond/Reservoir	SEO Stock Reservoir File	LOVERCHECK NO 2 STOCK RESERVOIR	Berm evident but dry in 2012, 2015, 2017	Potential	Potential	Private	41.670367	-104.107872	Hawk Springs Reservoir	N/A	020N	060W	29
176	Pond/Reservoir	SEO Stock Reservoir File	LONE TREE CREEK NO 1 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.851111	-104.268869	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	26
177	Pond/Reservoir	SEO Stock Reservoir File	WING SHOOTER NO 1 STOCK RESERVOIR	Wet in 2015, 2017	Yes	Functional	Private	41.848747	-104.117636	Dry Creek	N/A	022N	060W	30

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
178	Pond/Reservoir	SEO Stock Reservoir File	MIHAN NO. 3 STOCK RESERVOIR	Berm evident, but dry in 2012, 2015, 2017	Potential	Potential	Private	41.719464	-104.077956	Robb Draw	N/A	020N	060W	9
179	Pond/Reservoir	SEO Stock Reservoir File	MIHAN NO. 4 STOCK RESERVOIR	Berm evident, but dry in 2012, 2015, 2017	Potential	Potential	Private	41.7451	-104.073467	Robb Draw	N/A	021N	060W	33
180	Pond/Reservoir	SEO Stock Reservoir File	STEMLER	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.65862	-104.20475	Horse Creek-La Grange	N/A	020N	061W	33
181	Pond/Reservoir	SEO Stock Reservoir File	ZAVORKA DRAW	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.7765	-104.25889	Horse Creek-Hawk Springs	N/A	021N	062W	24
182	Pond/Reservoir	SEO Stock Reservoir File	GOMME NO. 1 STOCK RESERVOIR	Wet in 2015	Potential	Potential	Private	41.70046	-104.28322	Horse Creek-Hawk Springs	N/A	020N	062W	14
183	Pond/Reservoir	SEO Stock Reservoir File	MIHAN NO. 6 STOCK RESERVOIR	Wet in 2015, 2017	Yes	Functional	Private	41.760033	-104.155314	Hawk Springs Reservoir	N/A	021N	061W	26
184	Pond/Reservoir	SEO Stock Reservoir File	DAN PHINNEY NO. 1 STOCK RESERVOIR	Berm evident but dry in 2012, 2015, 2017	Potential	Potential	Private	41.722611	-104.100308	Robb Draw	WALKER CANYON	020N	060W	8
185	Pond/Reservoir	SEO Stock Reservoir File	OTTO NO. 1 STOCK RESERVOIR	Berm evident but dry in 2012, 2015, 2017	No	Non-Functional	Private	41.802139	-104.439153	Josh Creek	N/A	021N	063W	9
186	Pond/Reservoir	SEO Stock Reservoir File	SMITH NUMBER ONE STOCK RESERVOIR	No visible reserovir	No	Non-Functional	Private	41.804731	-104.47745	Josh Creek	N/A	021N	063W	7
187	Pond/Reservoir	SEO Stock Reservoir File	BEN TROUT NO. 1 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.732628	-104.185261	Hawk Springs Reservoir	N/A	020N	061W	3
188	Pond/Reservoir	SEO Stock Reservoir File	PAUL HARRIS NO. 1 STOCK RESERVOIR	Wet in 2015, 2017	Yes	Functional	Private	41.780658	-104.107217	Robb Draw	N/A	021N	060W	20
189	Pond/Reservoir	SEO Stock Reservoir File	MAGNUS LARSON STOCK RESERVOIR	Berm evident, maybe breached?Dry 2012, 2015, 2017	No	Non-Functional	Private	41.73481	-104.16741	Hawk Springs Reservoir	N/A	020N	061W	2
190	Pond/Reservoir	SEO Stock Reservoir File	KNAPP STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.73367	-104.35054	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	020N	062W	6
191	Pond/Reservoir	SEO Stock Reservoir File	WOODFORD STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.74611	-104.41008	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	063W	34
192	Pond/Reservoir	SEO Stock Reservoir File	SPRING STOCK RESERVOIR	Dry in 2012, 2015, 2017	No	Non-Functional	Private	41.67963	-104.08683	Craton Draw	N/A	020N	060W	28
193	Pond/Reservoir	SEO Stock Reservoir File	SIMON D. STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.76703	-104.06965	Robb Draw	N/A	021N	060W	27
194	Pond/Reservoir	SEO Stock Reservoir File	MCCOMPSEY SPRING STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.71894	-104.06037	Robb Draw	N/A	020N	060W	10
195	Pond/Reservoir	SEO Stock Reservoir File	CLYDE YEIK NO. 1 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.8499	-104.41799	Josh Creek	N/A	022N	063W	27
196	Pond/Reservoir	SEO Stock Reservoir File	WARD NO. 1 STOCK RESERVOIR	Berm evident, but dry in 2012, 2015, 2017	Potential	Potential	State	41.67793	-104.25418	Horse Creek-Hawk Springs	N/A	020N	062W	25
197	Pond/Reservoir	SEO Stock Reservoir File	HARRIS NO. 2 STOCK RESERVOIR	Berm evident, but only wet in 2015	Potential	Potential	Private	41.77526	-104.10195	Robb Draw	N/A	021N	060W	20
198	Pond/Reservoir	SEO Stock Reservoir File	DAVIS DAM STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.73771	-104.18838	Hawk Springs Reservoir	N/A	020N	061W	3
199	Pond/Reservoir	SEO Stock Reservoir File	BAUMGARTNER PROPERTIES NO. 1 STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.83726	-104.27695	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	35
200	Pond/Reservoir	SEO Stock Reservoir File	SPRINGER MEADOWS STOCK RESERVOIR	Wet in 2012, 2015, 2017	Yes	Functional	Private	41.853	-104.268	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	26
201	Pond/Reservoir	SEO Stock Reservoir File	CARVEY NO. 1 STOCK RESERVOIR	No visible reservoir	No	Non-Functional	Private	41.754053	-104.230625	Horse Creek-Hawk Springs	N/A	021N	061W	31
202	Pond/Reservoir	SEO Reservoir File	ENL. VANCE RESERVOIR	no SEO Stock Use	No	N/A	Private	41.78774	-104.23987	Horse Creek-Hawk Springs	N/A	021N	061W	18
203	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.444063	-105.411053	North Fork Horse Creek	N/A	017N	072W	13
204	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.445008	-105.406726	North Fork Horse Creek	N/A	017N	072W	13
205	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	41.303171	-105.428859	Horse Creek-Schoolhouse Creek	N/A	015N	072W	2
206	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Forest Service	41.296739	-105.420986	Horse Creek-Schoolhouse Creek	N/A	015N	072W	1
207	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.324468	-105.423812	Horse Creek-Schoolhouse Creek	N/A	016N	072W	25
208	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.337619	-105.41714	Horse Creek-Schoolhouse Creek	N/A	016N	072W	24
209	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.437739	-105.437213	North Fork Horse Creek	N/A	017N	072W	23
210	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.43746	-105.395164	North Fork Horse Creek	N/A	017N	071W	19
211	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.415251	-105.382455	Horse Creek-Schoolhouse Creek	N/A	017N	071W	29
212	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.416117	-105.380028	Horse Creek-Schoolhouse Creek	N/A	017N	071W	29
213	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.417048	-105.375095	Horse Creek-Schoolhouse Creek	N/A	017N	071W	29
214	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.367604	-105.335214	South Fork Horse Creek	N/A	016N	071W	10
219	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.63373	-104.770854	Upper Bear Creek-Middle Bear Creek	N/A	019N	066W	9
253	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	State	41.697746	-104.66562	Upper Fox Creek	N/A	020N	065W	16
272	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.91202	-104.064496	Horse Creek-Packer Reservoir	N/A	022N	060W	3
273	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.864106	-104.089034	Horse Creek-Packer Reservoir	N/A	022N	060W	21
274	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.833732	-104.083865	Dry Creek Drain	N/A	022N	060W	33
275	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.831698	-104.076034	Dry Creek Drain	N/A	022N	060W	33
276	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.830595	-104.071237	Dry Creek Drain	N/A	022N	060W	34
277	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.831409	-104.085677	Dry Creek	N/A	022N	060W	33
278	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.813467	-104.055141	Dry Creek Drain	N/A	021N	060W	3
279	Pond/Reservoir	ACE		Wet in 2012, 2015	Yes	Functional	Private	41.814794	-104.056555	Dry Creek Drain	N/A	021N	060W	3
281	Pond/Reservoir	ACE		Berm evident, dry in 2012, 2015, 2017	Yes	Functional	State	41.795379	-104.086589	Robb Draw	N/A	021N	060W	16
282	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.767966	-104.076316	Robb Draw	N/A	021N	060W	28
283	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.779929	-104.092583	Robb Draw	N/A	021N	060W	20
284	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.753588	-104.071363	Robb Draw	N/A	021N	060W	34
289	Pond/Reservoir	ACE		Wet in 2012, 2015	Yes	Functional	Private	41.716485	-104.071376	Robb Draw	N/A	020N	060W	10
300	Pond/Reservoir	ACE		Wet in 2012, 2015	Yes	Functional	Private	41.663342	-104.0626	Craton Draw	N/A	020N	060W	34
305	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.621095	-104.056835	Craton Draw	N/A	019N	060W	15
330	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.665835	-104.128584	Hawk Springs Reservoir	N/A	020N	060W	31
334	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.685882	-104.113745	Hawk Springs Reservoir	N/A	020N	060W	19
338	Pond/Reservoir	ACE		Berm evident, but dry in 2012, 2015, 2017	Potential	Potential	Private	41.730731	-104.109618	Robb Draw	WALKER CANYON	020N	060W	5
339	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.751665	-104.101573	Robb Draw	N/A	021N	060W	32
340	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.768315	-104.100281	Robb Draw	N/A	021N	060W	29

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
342	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.765857	-104.106443	Robb Draw	N/A	021N	060W	29
344	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.774622	-104.10109	Robb Draw	N/A	021N	060W	20
346	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.784181	-104.11019	Robb Draw	N/A	021N	060W	17
347	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.785406	-104.109552	Robb Draw	N/A	021N	060W	17
348	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.787308	-104.128585	Robb Draw	N/A	021N	060W	18
349	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.788742	-104.099315	Robb Draw	N/A	021N	060W	17
350	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.794216	-104.105776	Robb Draw	N/A	021N	060W	17
351	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.797763	-104.091175	Robb Draw	N/A	021N	060W	9
352	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.800393	-104.09575	Robb Draw	N/A	021N	060W	8
353	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	Private	41.805755	-104.102061	Robb Draw	N/A	021N	060W	8
354	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.825294	-104.090744	Robb Draw	N/A	021N	060W	4
355	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.827708	-104.095873	Robb Draw	N/A	022N	060W	32
356	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.836	-104.108144	Dry Creek	N/A	022N	060W	32
357	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843566	-104.117383	Dry Creek	TABLE MOUNTAIN 2	022N	060W	30
358	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.845902	-104.117555	Dry Creek	N/A	022N	060W	30
359	Pond/Reservoir	ACE		Berm evident, but only wet in 2012	Potential	Potential	Private	41.86698	-104.097787	Horse Creek-Packer Reservoir	N/A	022N	060W	20
360	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.922256	-104.125812	Horse Creek-Packer Reservoir	N/A	023N	060W	31
363	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.892536	-104.164421	Horse Creek-Little Willow Reservoir	N/A	022N	061W	11
364	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.880636	-104.157227	Horse Creek-Little Willow Reservoir	HORSE CREEK 2	022N	061W	14
365	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Bureau of Land Management	41.857599	-104.147274	Dry Creek	TABLE MOUNTAIN 3	022N	061W	24
366	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.853377	-104.159644	Dry Creek	N/A	022N	061W	26
367	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.850067	-104.167881	Dry Creek	N/A	022N	061W	26
368	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.85315	-104.150804	Dry Creek	N/A	022N	061W	26
374	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.805519	-104.166514	Dry Creek	N/A	021N	061W	11
376	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.789469	-104.170889	Dry Creek	N/A	021N	061W	15
378	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.78276	-104.175371	Dry Creek	N/A	021N	061W	22
379	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.780407	-104.13121	Robb Draw	N/A	021N	061W	24
383	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.773643	-104.170158	Hawk Springs Reservoir	N/A	021N	061W	22
387	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.736058	-104.169017	Hawk Springs Reservoir	N/A	020N	061W	2
394	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.694303	-104.166381	Hawk Springs Reservoir	N/A	020N	061W	23
412	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.628546	-104.1861	Horse Creek-La Grange	N/A	019N	061W	10
414	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.637668	-104.192844	Horse Creek-La Grange	N/A	019N	061W	4
415	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.639712	-104.18807	Horse Creek-La Grange	N/A	019N	061W	3
416	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.640312	-104.18935	Horse Creek-La Grange	N/A	019N	061W	4
417	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.637967	-104.188932	Horse Creek-La Grange	N/A	019N	061W	4
420	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.655926	-104.206951	Horse Creek-La Grange	N/A	020N	061W	33
421	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.655964	-104.20552	Horse Creek-La Grange	N/A	020N	061W	33
422	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.666626	-104.198507	Horse Creek-La Grange	N/A	020N	061W	28
423	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.66691	-104.196196	Horse Creek-La Grange	N/A	020N	061W	28
424	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.673116	-104.198588	Horse Creek-La Grange	N/A	020N	061W	28
432	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.703276	-104.221072	Horse Creek-Hawk Springs	N/A	020N	061W	17
433	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.72829	-104.175311	Hawk Springs Reservoir	N/A	020N	061W	3
434	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.739655	-104.178797	Hawk Springs Reservoir	N/A	020N	061W	3
435	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.745671	-104.203689	Horse Creek-Hawk Springs	N/A	021N	061W	33
436	Pond/Reservoir	ACE		Wet in 2012, 2015	Yes	Functional	Private	41.744319	-104.187496	Hawk Springs Reservoir	N/A	021N	061W	34
440	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.774076	-104.181786	Hawk Springs Reservoir	N/A	021N	061W	22
444	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.799618	-104.207588	Dry Creek	N/A	021N	061W	9
459	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.880551	-104.182278	Horse Creek-Little Willow Reservoir	N/A	022N	061W	15
460	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.886527	-104.187184	Horse Creek-Little Willow Reservoir	N/A	022N	061W	10
461	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.888523	-104.185229	Horse Creek-Little Willow Reservoir	N/A	022N	061W	10
462	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.891438	-104.1871	Horse Creek-Little Willow Reservoir	N/A	022N	061W	10
463	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.895533	-104.19347	Horse Creek-Little Willow Reservoir	N/A	022N	061W	9
464	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.926644	-104.190217	Goshen Hole Reservoir	N/A	023N	061W	33
465	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.923899	-104.219962	Goshen Hole Reservoir	N/A	023N	061W	32
466	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.91506	-104.235765	Goshen Hole Reservoir	N/A	023N	061W	31
467	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.912981	-104.238141	Goshen Hole Reservoir	N/A	022N	061W	6
468	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.901932	-104.251454	Goshen Hole Reservoir	N/A	022N	062W	1
472	Pond/Reservoir	ACE		Wet in 2012, 2015	Yes	Functional	Private	41.871434	-104.209201	Horse Creek-Little Willow Reservoir	N/A	022N	061W	17
498	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.763005	-104.236507	Horse Creek-Hawk Springs	N/A	021N	061W	30

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
499	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.755123	-104.230289	Horse Creek-Hawk Springs	N/A	021N	061W	30
501	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.759413	-104.237393	Horse Creek-Hawk Springs	N/A	021N	061W	30
507	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.71032	-104.218523	Horse Creek-Hawk Springs	N/A	020N	061W	8
508	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.708603	-104.219665	Horse Creek-Hawk Springs	N/A	020N	061W	17
516	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.640044	-104.219366	Lower Bear Creek-Horse Creek	N/A	019N	061W	5
529	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.584177	-104.274159	Fourmile Draw	N/A	019N	062W	26
530	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.58403	-104.27856	Fourmile Draw	N/A	019N	062W	26
532	Pond/Reservoir	ACE		Berm evident but dry in 2012, 2015, 2017	Potential	Potential	State	41.57328	-104.248316	Fourmile Draw	N/A	019N	062W	36
533	Pond/Reservoir	ACE		Berm evident, but dry in 2012, 2015, 2017	Potential	Potential	State	41.573472	-104.247007	Fourmile Draw	N/A	019N	062W	36
540	Pond/Reservoir	ACE		Berm evident but dry in 2012, 2015, 2017	Potential	Potential	Private	41.636558	-104.237726	Lower Bear Creek-Horse Creek	N/A	019N	061W	7
550	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.722436	-104.267061	Horse Creek-Hawk Springs	N/A	020N	062W	11
552	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.768443	-104.26059	Horse Creek-Hawk Springs	N/A	021N	062W	25
554	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.762589	-104.265099	Horse Creek-Hawk Springs	N/A	021N	062W	25
555	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.780969	-104.260209	Horse Creek-Hawk Springs	N/A	021N	062W	24
556	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.780488	-104.259552	Horse Creek-Hawk Springs	N/A	021N	062W	24
557	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.784766	-104.27542	Horse Creek-Hawk Springs	N/A	021N	062W	14
558	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.793308	-104.257176	Horse Creek-Hawk Springs	N/A	021N	062W	13
559	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.785463	-104.254152	Horse Creek-Hawk Springs	N/A	021N	062W	13
560	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.794644	-104.272883	Horse Creek-Hawk Springs	N/A	021N	062W	14
561	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.792494	-104.268345	Horse Creek-Hawk Springs	N/A	021N	062W	14
562	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.797879	-104.256649	Horse Creek-Hawk Springs	N/A	021N	062W	13
563	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.807827	-104.254565	Horse Creek-Hawk Springs	N/A	021N	062W	12
564	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.810667	-104.276211	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	11
565	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.815797	-104.267309	Horse Creek-Hawk Springs	N/A	021N	062W	2
566	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	State	41.816763	-104.278986	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	2
567	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.827097	-104.273206	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	2
568	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.823674	-104.277654	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	2
569	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	Private	41.825555	-104.2656	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	1
570	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.830214	-104.272628	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	35
571	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.83622	-104.254012	Horse Creek-Hawk Springs	N/A	022N	062W	36
572	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.838647	-104.272034	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	35
573	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.840342	-104.261095	Horse Creek-Hawk Springs	N/A	022N	062W	36
574	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.845356	-104.282017	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	26
575	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.847035	-104.265483	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	25
576	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843925	-104.271091	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	26
577	Pond/Reservoir	ACE		Berm evident but only wet in 2015	Potential	Potential	Private	41.866288	-104.257247	Horse Creek-Little Willow Reservoir	N/A	022N	062W	24
578	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.866517	-104.26441	Horse Creek-Little Willow Reservoir	N/A	022N	062W	24
579	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.857439	-104.267144	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	23
580	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.876305	-104.272553	Horse Creek-Little Willow Reservoir	N/A	022N	062W	14
581	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.882672	-104.253636	Horse Creek-Little Willow Reservoir	N/A	022N	062W	13
582	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	Private	41.887198	-104.245074	Horse Creek-Little Willow Reservoir	N/A	022N	061W	7
584	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.897139	-104.272129	Goshen Hole Reservoir	N/A	022N	062W	11
585	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.907829	-104.279586	Goshen Hole Reservoir	N/A	022N	062W	2
586	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.909651	-104.276686	Goshen Hole Reservoir	N/A	022N	062W	2
587	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.911155	-104.273844	Goshen Hole Reservoir	N/A	022N	062W	2
588	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.912897	-104.273506	Goshen Hole Reservoir	N/A	022N	062W	2
589	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.912736	-104.270598	Goshen Hole Reservoir	N/A	022N	062W	2
590	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.914047	-104.272918	Goshen Hole Reservoir	N/A	022N	062W	2
591	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.912247	-104.282818	Goshen Hole Reservoir	N/A	022N	062W	2
592	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.903082	-104.285087	Goshen Hole Reservoir	N/A	022N	062W	2
593	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.903042	-104.278102	Goshen Hole Reservoir	N/A	022N	062W	2
594	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.910075	-104.274272	Goshen Hole Reservoir	N/A	022N	062W	2
595	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.911656	-104.28496	Goshen Hole Reservoir	N/A	022N	062W	2
596	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.909845	-104.265871	Goshen Hole Reservoir	N/A	022N	062W	1
597	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.910541	-104.268012	Goshen Hole Reservoir	N/A	022N	062W	2
598	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.914847	-104.272835	Goshen Hole Reservoir	N/A	023N	062W	35
599	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.916839	-104.26706	Goshen Hole Reservoir	N/A	023N	062W	35
600	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.916736	-104.265872	Goshen Hole Reservoir	N/A	023N	062W	36
601	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.916055	-104.264572	Goshen Hole Reservoir	N/A	023N	062W	36

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
602	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.916858	-104.258773	Goshen Hole Reservoir	N/A	023N	062W	36
603	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.922181	-104.251728	Goshen Hole Reservoir	N/A	023N	062W	36
606	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.927489	-104.279826	Goshen Hole Reservoir	N/A	023N	062W	35
607	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.921331	-104.266975	Goshen Hole Reservoir	N/A	023N	062W	35
608	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.927021	-104.259263	Goshen Hole Reservoir	N/A	023N	062W	36
609	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.926735	-104.255676	Goshen Hole Reservoir	N/A	023N	062W	36
612	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.92074	-104.306744	Goshen Hole Reservoir	N/A	023N	062W	33
613	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.921085	-104.291697	Goshen Hole Reservoir	N/A	023N	062W	34
614	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.921112	-104.290289	Goshen Hole Reservoir	N/A	023N	062W	34
615	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.921075	-104.288969	Goshen Hole Reservoir	N/A	023N	062W	34
616	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.900787	-104.294261	Goshen Hole Reservoir	N/A	022N	062W	3
617	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.901493	-104.291255	Goshen Hole Reservoir	N/A	022N	062W	3
618	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.90143	-104.288767	Goshen Hole Reservoir	N/A	022N	062W	3
619	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.886328	-104.292218	Goshen Hole Reservoir	N/A	022N	062W	10
620	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.89638	-104.292757	Goshen Hole Reservoir	N/A	022N	062W	10
621	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.898105	-104.28736	Goshen Hole Reservoir	N/A	022N	062W	10
622	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.89572	-104.296936	Goshen Hole Reservoir	N/A	022N	062W	10
623	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.885325	-104.317183	Goshen Hole Reservoir	N/A	022N	062W	16
624	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.884765	-104.316096	Goshen Hole Reservoir	N/A	022N	062W	16
628	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	State	41.873062	-104.305939	Goshen Hole Reservoir	N/A	022N	062W	16
629	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.872634	-104.303658	Goshen Hole Reservoir	N/A	022N	062W	15
630	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	State	41.857512	-104.287751	Goshen Hole Reservoir	N/A	022N	062W	22
631	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.862818	-104.294301	Goshen Hole Reservoir	N/A	022N	062W	22
632	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	State	41.863301	-104.291602	Goshen Hole Reservoir	N/A	022N	062W	22
633	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.853271	-104.291086	Goshen Hole Reservoir	N/A	022N	062W	27
634	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.851836	-104.3096	Goshen Hole Reservoir	N/A	022N	062W	28
635	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.844211	-104.290926	Lower Lone Tree Creek-Horse Creek	N/A	022N	062W	27
636	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.852249	-104.31144	Goshen Hole Reservoir	N/A	022N	062W	28
637	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.851052	-104.31204	Goshen Hole Reservoir	N/A	022N	062W	28
638	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.847993	-104.31472	Goshen Hole Reservoir	N/A	022N	062W	28
640	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.819493	-104.292155	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	3
641	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.813385	-104.303942	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	3
642	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.818144	-104.301092	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	3
643	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.821112	-104.29608	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	3
644	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.816923	-104.309406	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	4
645	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.816316	-104.310439	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	4
646	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.816286	-104.312479	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	4
647	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.82049	-104.315057	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	4
648	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.808413	-104.313475	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	9
649	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.812166	-104.311643	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	9
650	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.805108	-104.305524	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	9
651	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.809327	-104.294956	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
652	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.807822	-104.287134	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
653	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.803735	-104.297118	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
654	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.803366	-104.294511	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
655	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.802556	-104.301998	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
656	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.799104	-104.303785	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	10
658	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	State	41.792042	-104.316868	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	16
660	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.789989	-104.288901	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	15
661	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.794269	-104.294235	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	15
662	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.779471	-104.322343	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	21
665	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.78017	-104.293605	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	22
667	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.764942	-104.326069	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	29
668	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.765243	-104.323851	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	28
674	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.729055	-104.308804	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	020N	062W	4
685	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	Private	41.668327	-104.293268	Lower Bear Creek-Horse Creek	N/A	020N	062W	27
686	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.656412	-104.302035	Lower Bear Creek-Horse Creek	N/A	020N	062W	34
697	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.58241	-104.32064	Fourmile Draw	N/A	019N	062W	28
698	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.583018	-104.295674	Fourmile Draw	N/A	019N	062W	27

ACE ID	Improvement Type	Source	Name	ACE_Notes	Water Source	Condition	Land_Owner	Lat	Long	HUC 12 Name	Allotment	T	R	S
699	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.584013	-104.324545	Fourmile Draw	N/A	019N	062W	28
715	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.691808	-104.358068	Lower Bear Creek-Horse Creek	N/A	020N	062W	19
722	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.739989	-104.332036	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	020N	062W	5
725	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.754677	-104.332062	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	32
726	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.750248	-104.329204	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	32
730	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.759432	-104.331274	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	29
731	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.761007	-104.325268	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	29
732	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.769853	-104.325408	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	20
733	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.76915	-104.324966	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	29
734	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.774853	-104.326549	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	20
735	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.77661	-104.325641	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	20
737	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.782889	-104.339485	Upper Lone Tree Creek-Lower Lone Tree Creek	N/A	021N	062W	20
739	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.811766	-104.326002	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	8
740	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.812945	-104.340544	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	8
741	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.81386	-104.34296	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	5
742	Pond/Reservoir	ACE		Wet in 2012, 2017	Yes	Functional	Private	41.820258	-104.339399	Lower Lone Tree Creek-Horse Creek	N/A	021N	062W	5
743	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.838438	-104.337715	Goshen Hole Reservoir	N/A	022N	062W	32
744	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.840544	-104.337905	Goshen Hole Reservoir	N/A	022N	062W	32
745	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.842184	-104.334421	Goshen Hole Reservoir	N/A	022N	062W	32
746	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.843221	-104.333292	Goshen Hole Reservoir	N/A	022N	062W	29
747	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.854825	-104.343745	Goshen Hole Reservoir	N/A	022N	062W	29
748	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.857747	-104.347417	Goshen Hole Reservoir	N/A	022N	062W	19
749	Pond/Reservoir	ACE		Wet in 2012, 2015, 2017	Yes	Functional	Private	41.864913	-104.352917	Goshen Hole Reservoir	N/A	022N	062W	19
750	Pond/Reservoir	ACE		Wet in 2015	Potential	Potential	Private	41.867838	-104.359544	Josh Creek	N/A	022N	062W	19
751	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.870626	-104.362041	Josh Creek	N/A	022N	062W	19
752	Pond/Reservoir	ACE		Wet in 2017	Potential	Potential	Private	41.87763	-104.328556	Goshen Hole Reservoir	N/A	022N	062W	17
753	Pond/Reservoir	ACE		Wet in 2015, 2017	Yes	Functional	Private	41.88317	-104.343256	Goshen Hole Reservoir	N/A	022N	062W	17

APPENDIX 4G

PLANT COMMUNITY DESCRIPTIONS

United States Department of Agriculture Natural Resources Conservation Service Ecological Site Description

Section I: Ecological Site Characteristics

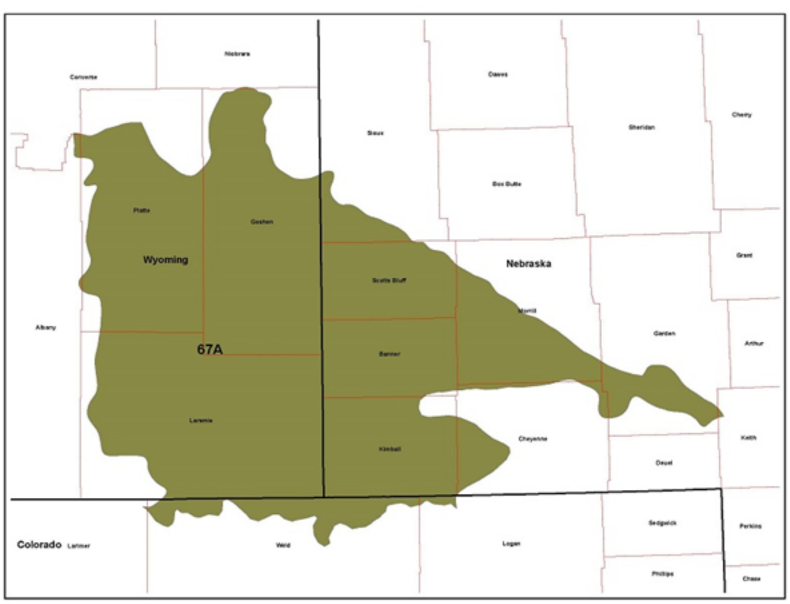
Ecological Site Identification and Concept

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.

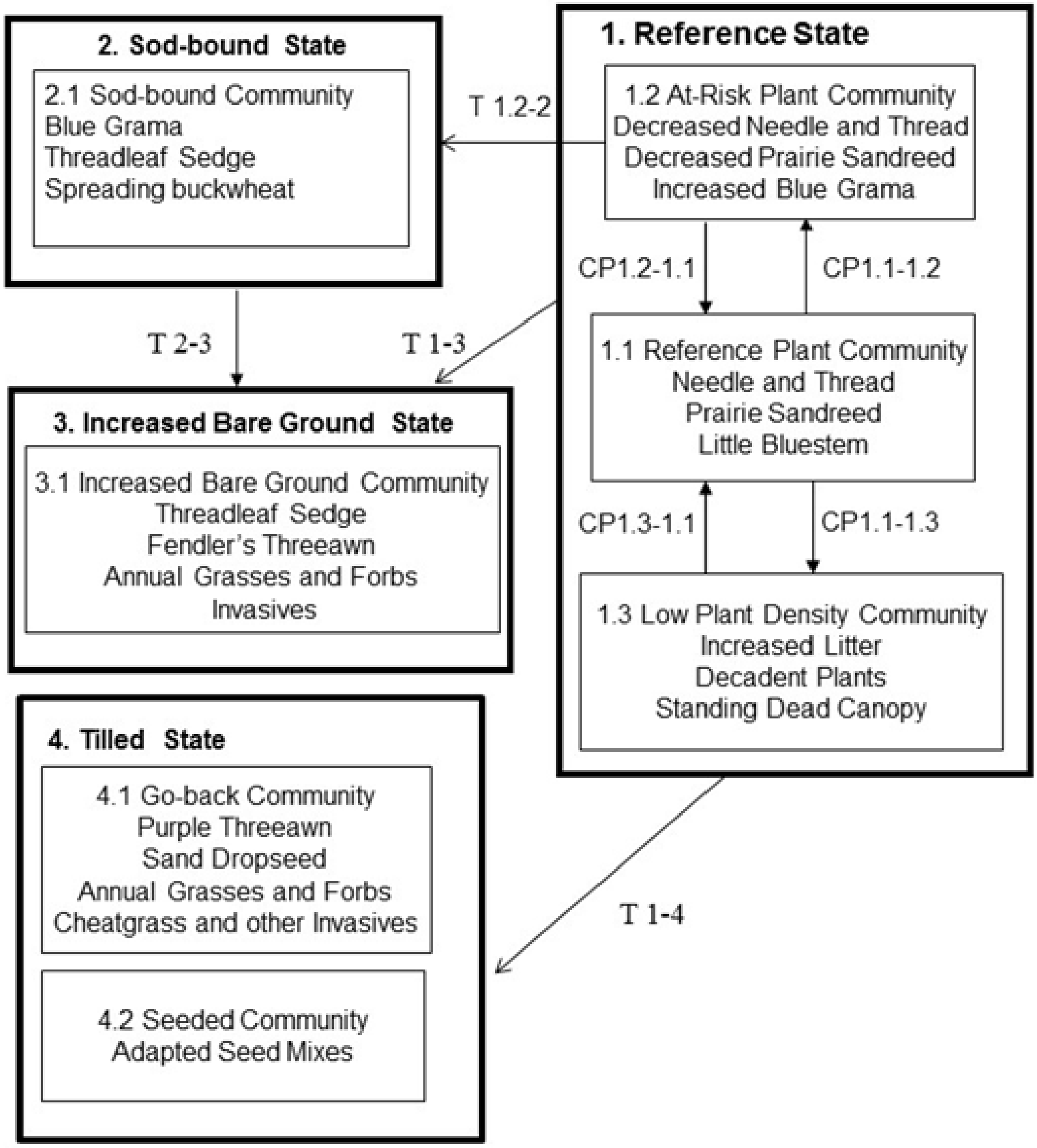
Recurrent drought has historically impacted the vegetation of this region. Changes in species composition and production, will vary depending upon the duration and severity of the drought cycle, and prior grazing management.

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 midgrasses 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.

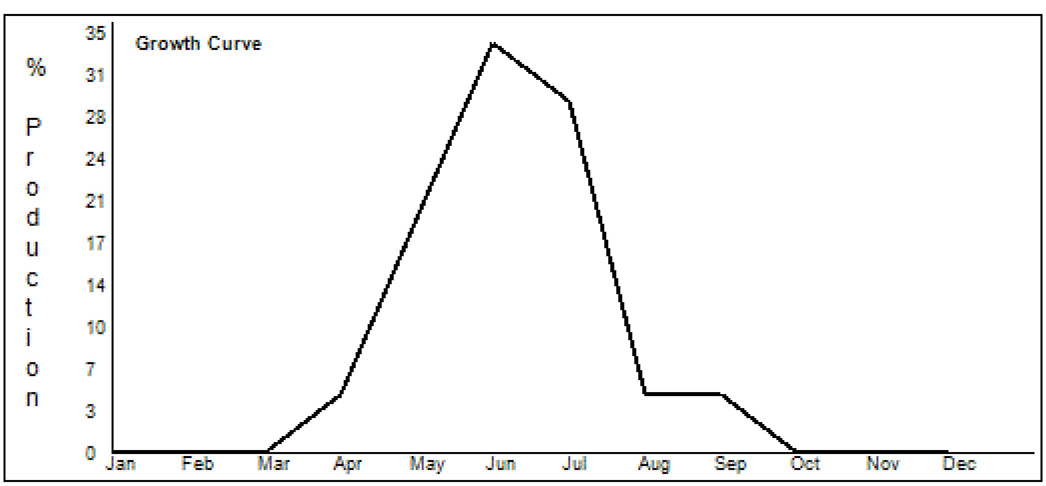
Transitions or pathways leading to other plant communities are as follows:

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.

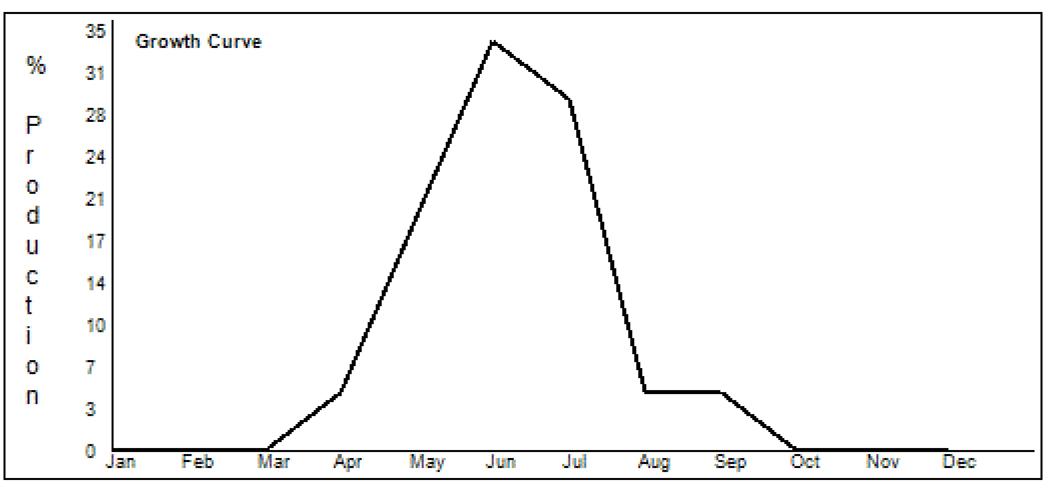
Soil erosion hazard has increased due to the increase of bare ground. Runoff is typically high and infiltration is low. All ecological functions are impaired. Desertification is advanced.

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.

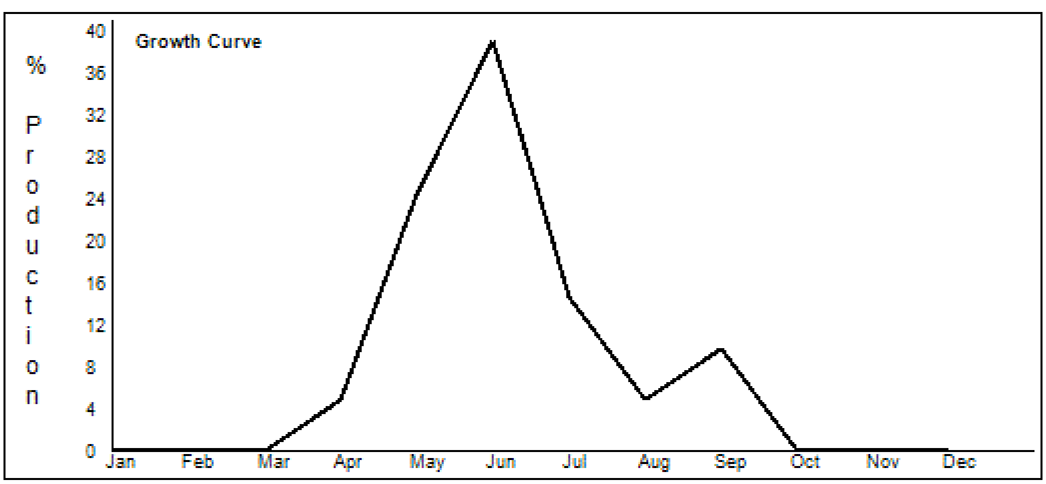
Go-back land evolves through several plant communities beginning with an early annual plant community, which initiates the revegetation process. Plants such as Russian thistle, kochia, sixweeks fescue, cheatgrass, and other annuals begin to establish. These plants give some protection from erosion and 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)

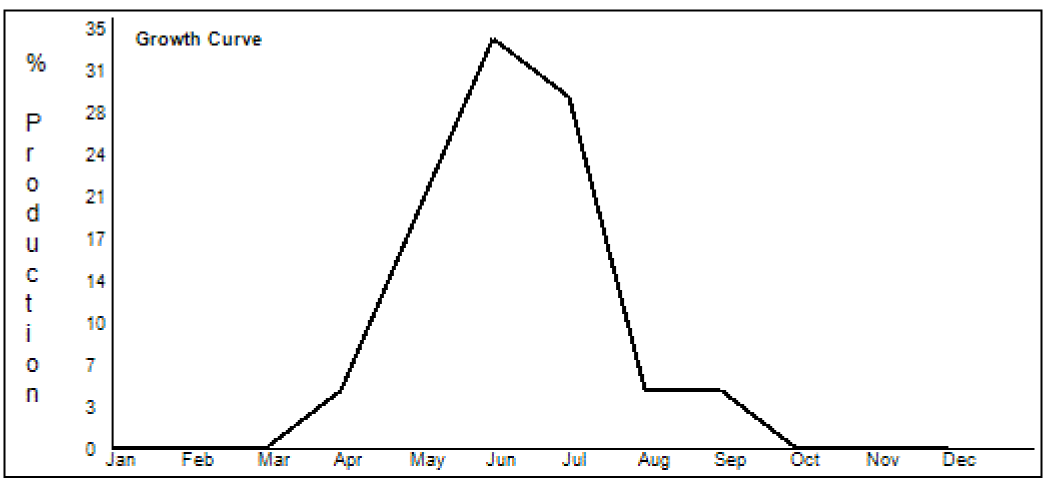
Group	Group name	Common name	Symbol	Scientific name	Low	High
16	-15"-17"				0	225
		Shrub (>.5m)	2SHRUB		0	75
		silver sagebrush	ARCA13	*Artemisia cana*	0	30
		sand sagebrush	ARFI2	*Artemisia filifolia*	0	30
		fringed sagewort	ARFR4	*Artemisia frigida*	0	30
		fourwing saltbush	ATCA2	*Atriplex canescens*	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.

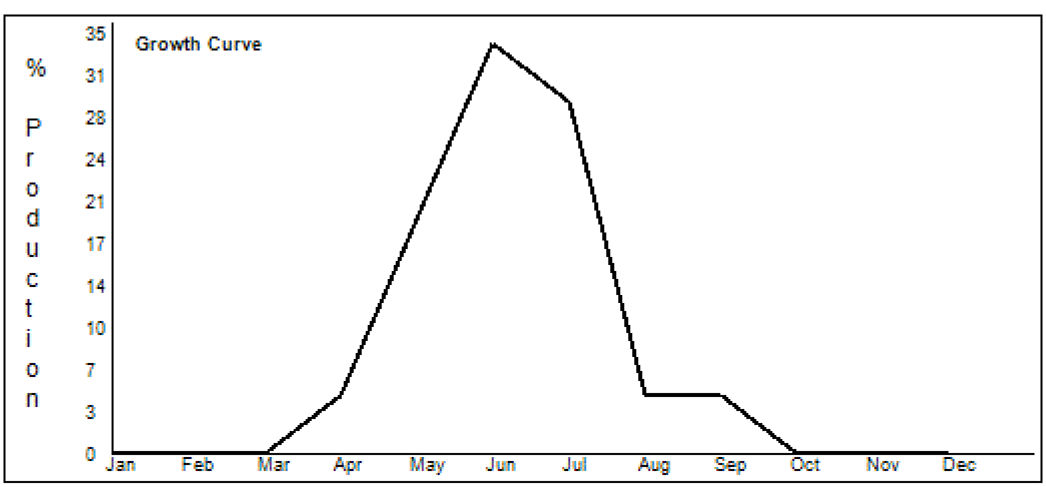
Nearly all plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management.

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.

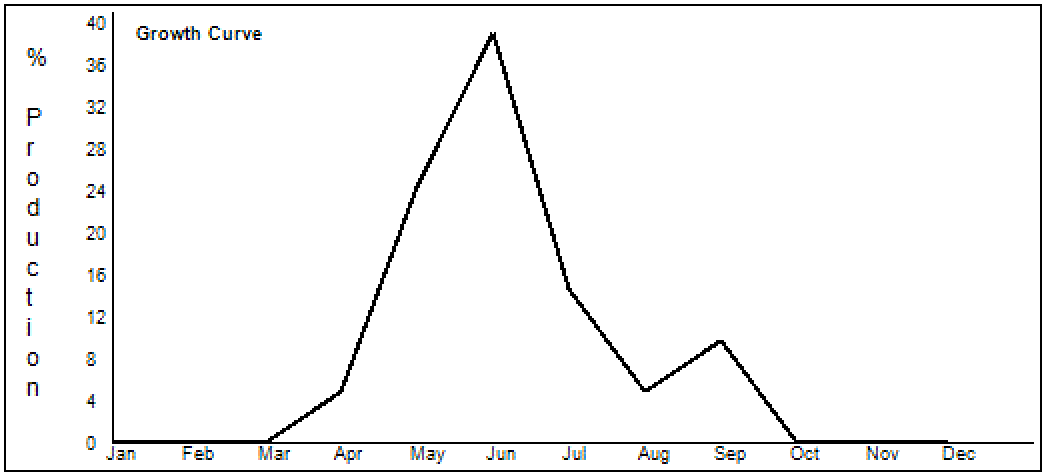
In the 15 to 17” PZ, the total annual production (air-dry weight) is about 1,000 pounds per acre during an average year, but it can range from about 650 pounds per acre in unfavorable years to about 1,350 pounds per acre in above average years.

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
40
36
32
28
24
20
16
12
8
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

<u>Section I: Ecological Site Characteristics</u>

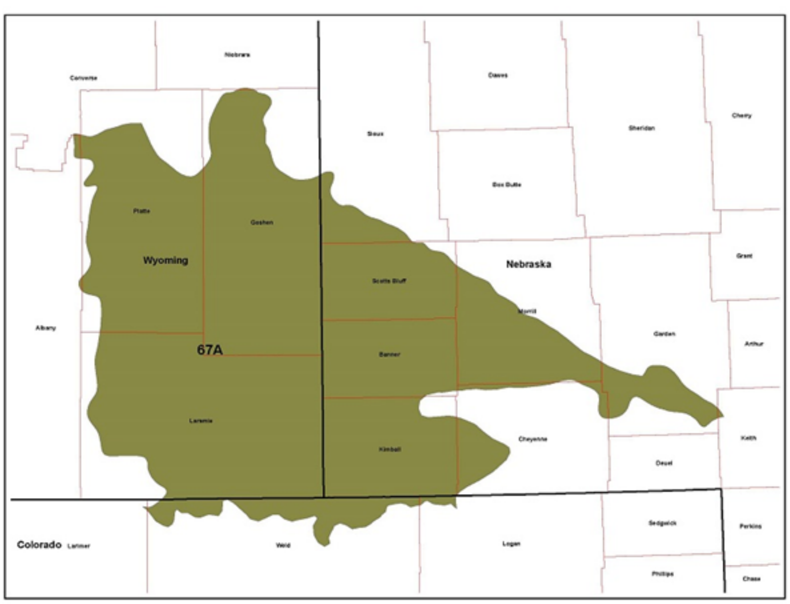
Ecological Site Identification and Concept

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) 12-17” PZ

/ *Hesperostipa comata* - *Pascopyrum smithii*
(/ needle and thread - western wheatgrass)
Site type: Rangeland
Site ID: R067AY122WY
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.
The elevations in MLRA 67A range from approximately 3,300 to 6,200 feet. The average annual precipitation in this area 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 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 Loamy 12-17” PZ site occurs on nearly level to gentle slopes on dissected plains or uplands. It is a warm- and cool-season codominant, 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 Loamy 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), cool-season mid- rhizomatous grasses (western wheatgrass and streambank, also known as thickspike wheatgrass), and warm-season shortgrass (blue grama). Secondary grasses and grass-likes include prairie Junegrass, alkali (Sandberg) bluegrass, and threadleaf sedge. Green needlegrass is found in greater abundance, in 15-17” precipitation zones, and on finer-textured soils. A minor component of forbs and shrubs are also present. The Sod-bound State is characterized by warm-season shortgrass (blue grama and/or buffalograss) and grasslikes (threadleaf sedge). The Increased Bare Ground State is characterized by annual grasses (sixweeks fescue), forbs (curlycup gumweed, hairy false goldenaster, and annuals), and shrubs (fringed sagewort, 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. Due to the moderately deep to deep loamy soils, and gentle slopes, this site is subject to conversion to cropland, especially in higher precipitation areas.

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 hairy goldenaster, fringed sagewort, 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.

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. The mid-grasses and palatable forbs have been eliminated. The dominant species are blue grama, threadleaf sedge, and/or buffalograss. These species have developed into a sod-bound condition occurring in localized colonies exhibiting a mosaic appearance. Perennial threeawn species such as Fendler's threeawn, have increased. Forbs such as scarlet globemallow, wild onion, death camas, slim-flower scurfpea, and skeletonplant remain. Forbs and shrubs that continue to increase are Cuman ragweed (western ragweed), hairy false goldenaster, fringed sagewort, and pricklypear. 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 700 pounds per acre during an average year, but it can range from about 500 pounds per acre in unfavorable years to about 900 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.

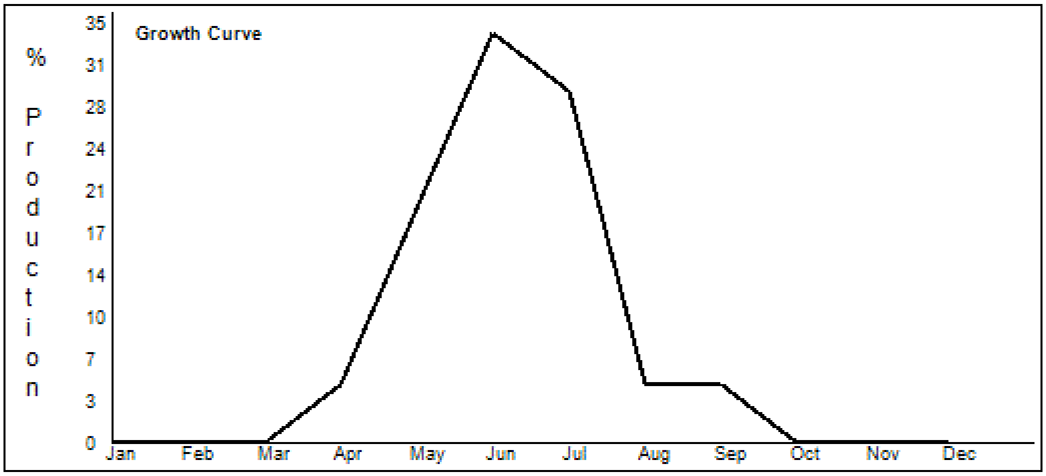
Transitions or pathways leading to other plant communities are as follows:

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 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 threeawn. Annuals such as sixweeks fescue, Russian thistle, kochia and cheatgrass have increased or invaded. The dominant forbs include curlycup gumweed, green sagewort, and hairy goldenaster. Broom snakeweed and pricklypear are increasing.

In the 12 to 14“ precipitation zone (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 700 pounds per acre during an average year, but it can range from about 450 pounds per acre in unfavorable years to about 950 pounds per acre in above average years.

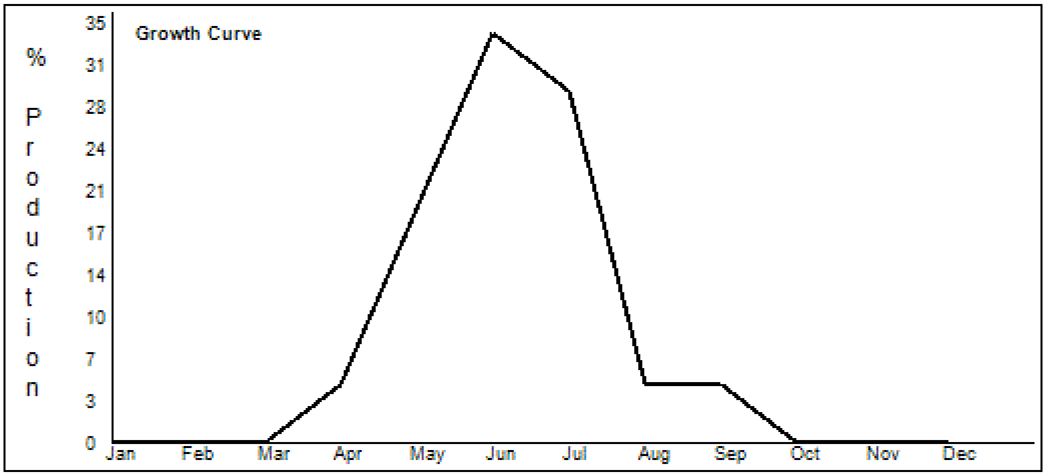
The hazard of soil erosion has increased due to the increase of bare ground. Runoff is typically high and infiltration is low. All ecological functions are impaired. Desertification is advanced.

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 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, and other annuals begin to establish. These plants give some protection from erosion and start to build minor levels of soil organic matter. This early annual plant community lasts for two to several years. Purple threeawn, sand dropseed, and several other early perennials can dominate the plant community for five to eight years or more. Buffalograss establishes next and dominates for many years. Eventually western wheatgrass, blue grama, and other native plants become re-established. 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 ecological site may evolve depending on severity of soil erosion and parent material.

Reference Plant Community

This is the interpretive plant community for this site. It is well adapted to the Northern Great Plains climate. 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 75-90 percent grasses and grass-likes, 5-15 percent forbs, and 5-10 percent woody plants.

In the western portion of the MLRA, the plant community is predominately cool-season midgrasses, with a significant component of warm-season midgrasses. In the eastern portion of the MLRA, the plant community is predominantly warm-season with a significant cool-season component. The major grasses/grass-likes include needle and thread, blue grama, and rhizomatous wheatgrasses such as western wheatgrass. Secondary grasses include prairie Junegrass, streambank (thickspike) wheatgrass, alkali (Sandberg) bluegrass, green needlegrass and buffalograss. A variety of forbs and half-shrubs also occur, as shown in the Species Composition List. Shrubs are not abundant. 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 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"				390	520
		needle and thread	HECO26	*Hesperostipa comata*	325	390
		green needlegrass	NAVI4	*Nassella viridula*	65	130
2	-12"-14"				260	325
		streambank wheatgrass	ELLA3	*Elymus lanceolatus*	0	130
		western wheatgrass	PASM	*Pascopyrum smithii*	260	325
3	-12"-14"				130	195
		blue grama	BOGR2	*Bouteloua gracilis*	130	195
4	-12"-14"				65	130
		little bluestem	SCSC	*Schizachyrium scoparium*	0	26
5	-12"-14"				130	195
		Graminoid (grass or grass-like)	2GRAM		0	65
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	65
		threeawn	ARIST	*Aristida*	0	26
		sideoats grama	BOCU	*Bouteloua curtipendula*	0	65
		buffalograss	BUDA	*Buchloe dactyloides*	0	65
		threadleaf sedge	CAFI	*Carex filifolia*	0	65
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	65
		alkali bluegrass	POSE	*Poa secunda*	0	65

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
6	-12"-14"				65	195

		Forb, perennial	2FP		0	65
		textile onion	ALTE	Allium textile	0	26
		Cuman ragweed	AMPS	Ambrosia psilostachya	0	26
		field sagewort	ARCA12	Artemisia campestris	0	26
		cudweed sagewort	ARLU	Artemisia ludoviciana	0	26
		milkvetch	ASTRA	Astragalus	0	26
		white prairie clover	DACA7	Dalea candida	0	26
		purple prairie clover	DAPU5	Dalea purpurea	0	26
		larkspur	DELPH	Delphinium	0	26
		blacksamson echinacea	ECAN2	Echinacea angustifolia	0	26
		sanddune wallflower	ERCA14	Erysimum capitatum	0	26
		buckwheat	ERIOG	Eriogonum	0	26
		scarlet beeblossom	GACO5	Gaura coccinea	0	26
		hairy false goldenaster	HEVI4	Heterotheca villosa	0	26
		dotted blazing star	LIPU	Liatris punctata	0	26
		biscuitroot	LOMAT	Lomatium	0	26
		Indian breadroot	PEDIO2	Pediomelum	0	26
		beardtongue	PENST	Penstemon	0	26
		woolly Indianwheat	PLPA2	Plantago patagonica	0	26
		slimflower scurfpea	PSTE5	Psoralidium tenuiflorum	0	26
		prairie coneflower	RACO3	Ratibida columnifera	0	26
		scarlet globemallow	SPCO	Sphaeralcea coccinea	0	26
		American vetch	VIAM	Vicia americana	0	26
		meadow deathcamas	ZIVE	Zigadenus venenosus	0	26

Shrub/Vine

					Annual Production (pounds per acre)	
Group	Group name	Common name	Symbol	Scientific name	Low	High
7 -12"-14"					65	130
		Shrub (>.5m)	2SHRUB		0	65
		silver sagebrush	ARCA13	Artemisia cana	0	26
		fringed sagewort	ARFR4	Artemisia frigida	0	26
		big sagebrush	ARTR2	Artemisia tridentata	0	65
		fourwing saltbush	ATCA2	Atriplex canescens	0	26
		Douglas rabbitbrush	CHVI8	Chrysothamnus viscidiflorus	0	26
		rubber rabbitbrush	ERNA10	Ericameria nauseosa	0	26
		broom snakeweed	GUSA2	Gutierrezia sarothrae	0	26
		winterfat	KRLA2	Krascheninnikovia lanata	0	65
		plains pricklypear	OPPO	Opuntia polyacantha	0	26
		prairie rose	ROAR3	Rosa arkansana	0	26

Grass/Grasslike

					Annual Production (pounds per acre)	
Group	Group name	Common name	Symbol	Scientific name	Low	High
8 -15"-17"					450	600
		needle and thread	HECO26	Hesperostipa comata	375	450
		green needlegrass	NAVI4	Nassella viridula	75	150
9 -15"-17"					300	375
		streambank	ELLA3	Elymus lanceolatus	0	150

		wheatgrass				
		western wheatgrass	PASM	*Pascopyrum smithii*	300	375
10	-15"-17"				150	225
		blue grama	BOGR2	*Bouteloua gracilis*	150	225
11	-15"-17"				75	150
		little bluestem	SCSC	*Schizachyrium scoparium*	0	30
12	-15"-17"				150	225
		Graminoid (grass or grass-like)	2GRAM		0	75
		Indian ricegrass	ACHY	*Achnatherum hymenoides*	0	75
		threeawn	ARIST	*Aristida*	0	30
		sideoats grama	BOCU	*Bouteloua curtipendula*	0	75
		buffalograss	BUDA	*Buchloe dactyloides*	0	75
		threadleaf sedge	CAFI	*Carex filifolia*	0	75
		prairie Junegrass	KOMA	*Koeleria macrantha*	0	75
		alkali bluegrass	POSE	*Poa secunda*	0	75

Forb

Group	Group name	Common name	Symbol	Scientific name	Annual Production (pounds per acre) Low	High
13	-15"-17"				75	225
		Forb, perennial	2FP		0	75
		textile onion	ALTE	*Allium textile*	0	30
		Cuman ragweed	AMPS	*Ambrosia psilostachya*	0	30
		field sagewort	ARCA12	*Artemisia campestris*	0	30
		cudweed sagewort	ARLU	*Artemisia ludoviciana*	0	30
		milkvetch	ASTRA	*Astragalus*	0	30
		white prairie clover	DACA7	*Dalea candida*	0	30
		purple prairie clover	DAPU5	*Dalea purpurea*	0	30
		larkspur	DELPH	*Delphinium*	0	30
		blacksamson echinacea	ECAN2	*Echinacea angustifolia*	0	30
		sanddune wallflower	ERCA14	*Erysimum capitatum*	0	30
		buckwheat	ERIOG	*Eriogonum*	0	30
		scarlet beeblossom	GACO5	*Gaura coccinea*	0	30
		hairy false goldenaster	HEVI4	*Heterotheca villosa*	0	30
		dotted blazing star	LIPU	*Liatris punctata*	0	30
		biscuitroot	LOMAT	*Lomatium*	0	30
		Indian breadroot	PEDIO2	*Pediomelum*	0	30
		beardtongue	PENST	*Penstemon*	0	30
		woolly Indianwheat	PLPA2	*Plantago patagonica*	0	30
		slimflower scurfpea	PSTE5	*Psoralidium tenuiflorum*	0	30
		prairie coneflower	RACO3	*Ratibida columnifera*	0	30
		scarlet globemallow	SPCO	*Sphaeralcea coccinea*	0	30
		American vetch	VIAM	*Vicia americana*	0	30
		meadow deathcamas	ZIVE	*Zigadenus venenosus*	0	30

Shrub/Vine Annual Production

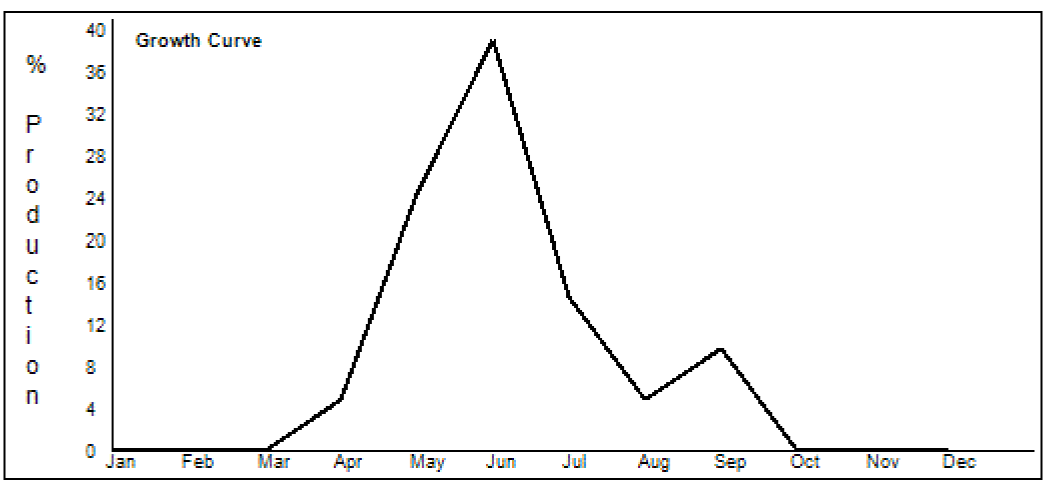
Group	Group name	Common name	Symbol	Scientific name	Low (pounds per acre)	High (pounds per acre)
14	-15"-17"				75	150
		Shrub (>.5m)	2SHRUB		0	75
		fringed sagewort	ARFR4	*Artemisia frigida*	0	30
		big sagebrush	ARTR2	*Artemisia tridentata*	0	75
		fourwing saltbush	ATCA2	*Atriplex canescens*	0	30
		Douglas rabbitbrush	CHVI8	*Chrysothamnus viscidiflorus*	0	8
		rubber rabbitbrush	ERNA10	*Ericameria nauseosa*	0	30
		broom snakeweed	GUSA2	*Gutierrezia sarothrae*	0	30
		winterfat	KRLA2	*Krascheninnikovia lanata*	0	75
		plains pricklypear	OPPO	*Opuntia polyacantha*	0	30
		prairie rose	ROAR3	*Rosa arkansana*	0	30

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



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. Portions of the Loamy Plains have been converted to cropland in some areas.

At-Risk Plant Community

This plant community developed with frequent and severe defoliation without adequate recovery opportunity during the growing season. Grazing-tolerant species such as blue grama and threadleaf sedge have noticeably increased. Needle and thread may initially increase or decrease depending on the season of grazing use. Green needlegrass is nearly absent. Prairie clover species and other palatable forbs such as dotted gayfeather and penstemon are present in reduced amounts. Hairy false goldenaster, slimflower scurfpea, fringed sagewort, and broom snakeweed have increased.

In the 12 to 14“ precipitation zones, 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“ precipitation zones, 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.

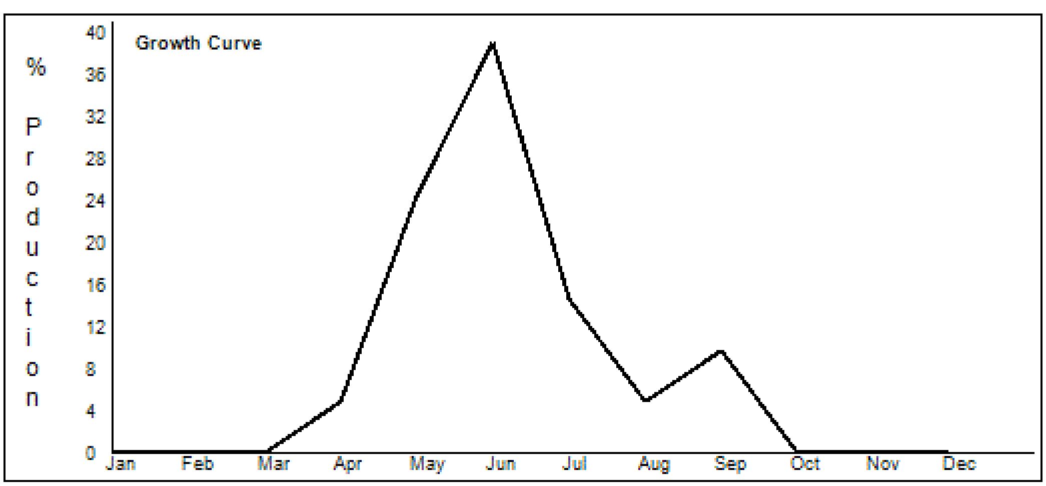
Nearly all plant species typically found in the Reference Plant Community are present and will respond to changes in grazing management.

Plant Growth Curve

Growth curve number:	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



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. Noxious weeds such as Canada thistle, leafy spurge, and Dalmatian toadflax may invade, if a seed source is readily available. 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“ precipitation zone (PZ), the total annual production (air-dry weight) is about 1,200 pounds per acre during an average year, but it can range from about 800 pounds per acre in unfavorable years to about 1,600 pounds per acre in above average years.

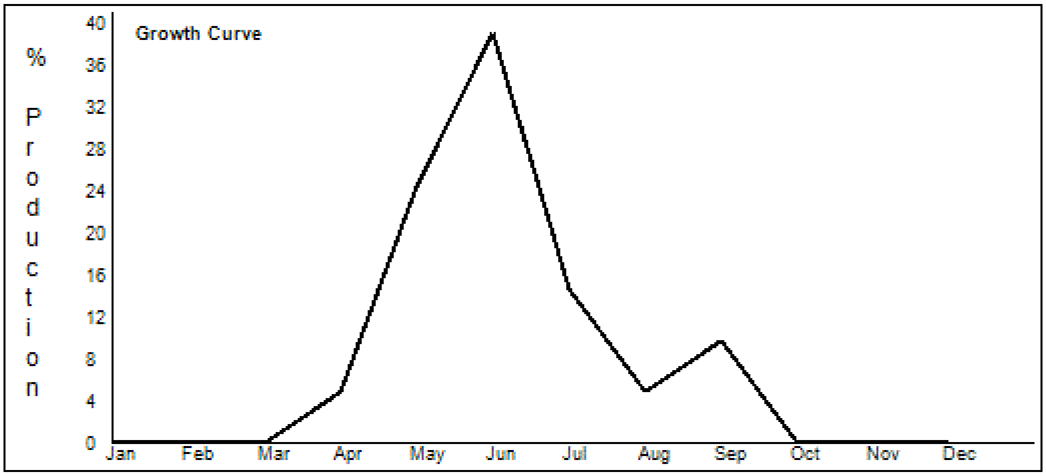
In the 15 to 17” PZ, the total annual production (air-dry weight) is about 1,400 pounds per acre during an average year, but it can range from about 950 pounds per acre in unfavorable years to about 1,850 pounds per acre in above average years.

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
40
36
32
28
24
20
16
12
8
4
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

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)

Label	Lowham Hydrologic Region	Precipitation Gage (for Wet/Dry Estimation)	Area (sq mi)	Mean Annual Precipitation (In)			Annual Runoff (cfs)			Acre-Ft/year/sq mile			Notes
				Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	Normal (PRISM)	Dry	Wet	
1 - Craton Draw	Plains Region	La Grange	33.24	17.274	11.44	22.40	1.36	0.83	1.85	29.883	18.301	40.713	Partial area, HUC 12 clipped to watershed boundary
2 - Dry Creek	Plains Region	Yoder 4 SW	26.29	15.689	10.16	18.70	0.99	0.59	1.22	27.411	16.344	33.780	
3 - Dry Creek Drain	Plains Region	Yoder 4 SW	10.67	15.630	10.16	18.70	0.44	0.27	0.55	30.405	18.211	37.638	Partial area, HUC 12 clipped to watershed boundary
4 - Fourmile Draw	Plains Region	La Grange	25.44	16.457	11.44	22.40	1.02	0.66	1.47	29.129	18.897	42.041	
5 - Goshen Hole Reservoir	Plains Region	Yoder 4 SW	55.14	15.600	10.16	18.70	1.88	1.13	2.33	24.911	14.954	30.907	
6 - Harry Dayton Ranch	Plains Region	Phillips	19.39	16.280	10.27	20.86	0.79	0.46	1.06	29.710	17.172	39.905	
7 - Hawk Springs Reservoir	Plains Region	La Grange	37.46	16.542	11.44	22.40	1.44	0.93	2.06	27.979	18.040	40.134	
8 - Horse Creek-Bushnell Creek	Plains Region	La Grange	57.11	17.232	11.44	22.40	2.18	1.34	2.99	27.924	17.150	38.153	Partial area, HUC 12 clipped to watershed boundary
9 - Horse Creek-Carey Creek	Plains Region	Phillips	54.41	16.181	10.27	20.86	1.94	1.13	2.63	26.061	15.172	35.257	
10 - Horse Creek-Cattail Creek	Plains Region	Phillips	49.09	16.327	10.27	20.86	1.79	1.03	2.40	26.668	15.360	35.695	
11 - Horse Creek-Hawk Springs	Plains Region	La Grange	48.80	16.199	11.44	22.40	1.77	1.17	2.60	26.437	17.476	38.880	
12 - Horse Creek-Kellehan Creek	Plains Region	La Grange	39.08	16.988	11.44	22.40	1.54	0.96	2.14	28.733	17.949	39.931	
13 - Horse Creek-Kelley Draw	Plains Region	Phillips	43.81	16.038	10.27	20.86	1.59	0.93	2.17	26.466	15.571	36.186	
14 - Horse Creek-La Grange	Plains Region	La Grange	25.93	16.877	11.44	22.40	1.06	0.67	1.49	29.947	18.854	41.945	
15 - Horse Creek-Little Willow Reservoir	Plains Region	Yoder 4 SW	24.24	15.677	10.16	18.70	0.92	0.55	1.13	27.654	16.504	34.110	
16 - Horse Creek-Packer Reservoir	Plains Region	Yoder 4 SW	23.01	15.446	10.16	18.70	0.86	0.52	1.08	27.341	16.608	34.325	Partial area, HUC 12 clipped to watershed boundary
17 - Horse Creek-Schoolhouse Creek	Plains Region	Phillips	58.03	19.629	10.27	20.86	2.59	1.20	2.78	32.542	15.055	34.986	
18 - Horse Creek-Sprager Creek	Plains Region	Phillips	46.47	16.424	10.27	20.86	1.72	0.98	2.29	27.033	15.461	35.930	
19 - Horse Creek-Trail Creek	Plains Region	Phillips	46.26	16.161	10.27	20.86	1.68	0.98	2.28	26.535	15.470	35.951	
20 - Josh Creek	Plains Region	Yoder 4 SW	34.40	15.696	10.16	18.70	1.25	0.75	1.54	26.554	15.825	32.707	
21 - Long Canyon-Pumpkin Creek	Plains Region	La Grange	1.60	17.697	11.44	22.40	0.10	0.06	0.13	44.256	26.333	58.584	Partial area, HUC 12 clipped to watershed boundary
22 - Lower Bear Creek-Horse Creek	Plains Region	La Grange	37.65	16.207	11.44	22.40	1.41	0.93	2.07	27.290	18.029	40.110	
23 - Lower Fox Creek	Plains Region	Phillips	61.07	15.730	10.27	20.86	2.08	1.25	2.91	24.852	14.963	34.772	
24 - Lower Little Bear Creek	Plains Region	Phillips	34.12	16.214	10.27	20.86	1.29	0.75	1.74	27.628	16.046	37.288	
25 - Lower Little Horse Creek	Plains Region	La Grange	39.28	16.903	11.44	22.40	1.54	0.97	2.15	28.544	17.938	39.905	
26 - Lower Lone Tree Creek-Horse Creek	Plains Region	Yoder 4 SW	37.30	15.811	10.16	18.70	1.36	0.80	1.65	26.528	15.673	32.392	
27 - Middle Bear Creek	Plains Region	Phillips	51.03	15.945	10.27	20.86	1.80	1.07	2.48	25.806	15.289	35.529	
28 - Middle Little Bear Creek	Plains Region	Phillips	41.94	16.232	10.27	20.86	1.55	0.90	2.09	26.988	15.653	36.376	
29 - North Bear Creek	Plains Region	Phillips	63.70	16.329	10.27	20.86	2.26	1.30	3.02	25.850	14.887	34.596	
30 - North Fork Horse Creek	Plains Region	Phillips	36.66	18.178	10.27	20.86	1.58	0.80	1.86	31.382	15.908	36.967	
31 - Robb Draw	Plains Region	La Grange	36.79	16.253	11.44	22.40	1.38	0.91	2.03	27.458	18.079	40.221	Partial area, HUC 12 clipped to watershed boundary
32 - Rocky Hollow	Plains Region	Phillips	30.74	16.201	10.27	20.86	1.18	0.68	1.59	27.949	16.247	37.757	
33 - South Fork Bear Creek	Plains Region	Phillips	48.81	16.204	10.27	20.86	1.77	1.03	2.39	26.446	15.371	35.720	
34 - South Fork Horse Creek	Plains Region	Phillips	25.75	18.677	10.27	20.86	1.19	0.59	1.36	33.815	16.596	38.568	
35 - Spring Creek-Fox Creek	Plains Region	Phillips	50.79	16.309	10.27	20.86	1.85	1.06	2.47	26.524	15.298	35.550	
36 - Tromely Gulch-Dry Creek	Plains Region	Phillips	23.83	16.969	10.27	20.86	0.99	0.55	1.27	30.448	16.751	38.928	
37 - Upper Bear Creek-Middle Bear Creek	Plains Region	Phillips	45.52	16.322	10.27	20.86	1.68	0.97	2.25	26.900	15.500	36.020	
38 - Upper Bull Canyon	Plains Region	La Grange	1.08	17.598	11.44	22.40	0.07	0.04	0.09	46.117	27.623	61.453	Partial area, HUC 12 clipped to watershed boundary
39 - Upper Fox Creek	Plains Region	Phillips	42.29	16.273	10.27	20.86	1.57	0.91	2.11	27.042	15.637	36.339	
40 - Upper Little Bear Creek	Plains Region	Phillips	33.81	16.247	10.27	20.86	1.28	0.74	1.73	27.725	16.063	37.328	
41 - Upper Little Horse Creek	Plains Region	La Grange	39.33	16.998	11.44	22.40	1.55	0.97	2.15	28.731	17.935	39.899	
42 - Upper Lone Tree Creek-Lower Lone Tree Creek	Plains Region	Phillips	33.12	15.778	10.27	20.86	1.22	0.73	1.70	26.841	16.103	37.421	
43 - Upper Pumpkin Creek	Plains Region	La Grange	0.48	16.732	11.44	22.40	0.03	0.02	0.04	47.842	30.430	67.697	Partial area, HUC 12 clipped to watershed boundary
44 - YBO Creek	Plains Region	Yoder 4 SW	49.98	15.884	10.16	18.70	1.76	1.04	2.14	25.753	15.132	31.274	

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 3: Eastern Basins and Eastern Plains Region			Region 4: Eastern Mountains Region			
	A	B	C	A	B	C	D
1.5 yr	1.12	0.401	3.01	4.27	0.518	1.42	-0.435
2 yr	2.28	0.402	2.9	6.26	0.506	1.33	-0.315
2.33 yr	3.1	0.403	2.84	7.27	0.503	1.3	-0.262
5 yr	10.1	0.407	2.6	12.2	0.506	1.19	-0.048
10 yr	21.9	0.410	2.44	16.9	0.518	1.12	0.107
25 yr	48.8	0.416	2.27	23.5	0.536	1.05	0.283
50 yr	80.9	0.423	2.16	29.1	0.549	1.01	0.403
100 yr	127	0.432	2.05	35.3	0.562	0.963	0.517
200 yr	193	0.441	1.94	42.2	0.573	0.922	0.626
500 yr	323	0.454	1.80	52.5	0.585	0.873	0.766

Equation for Region 3: Eastern Basins and Eastern Plains Region (Miller, 2003)

$$\boxed{Q = A \cdot [AREA^{B}] \cdot [SOIL^{C}]}$$

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)

Equation for Region 4: Eastern Mountains Region (Miller, 2003)

$$\boxed{Q = A \cdot [AREA^{B}] \cdot [MAR^{C}] \cdot [LAT - 40]^{D}}$$

Q = peak discharge (cfs), AREA = total drainage area (sq mi), MAR = mean March precipitation (in), LAT = latitude of basin outlet
A, B, C, and D are coefficients that vary with recurrance interval (see table)

HUC12 Basin Name	Region	Area (sq mi)	Soil Index	Mean March Precip (in)	Latitude	Peak flows in cfs for various return periods										NOTES
						1.5 yr	2 yr	2.33 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr	
1 - Craton Draw	3	33.24	2.01	1.13		37.30	70.56	92.33	258.02	505.65	1021.96	1607.97	2412.62	3504.28	5566.67	Partial area, HUC 12 clipped to watershed boundary
2 - Dry Creek	3	26.29	1.65	0.98		18.68	36.10	47.80	139.96	282.93	590.62	948.25	1451.12	2149.71	3500.45	
3 - Dry Creek Drain	3	10.67	1.93	0.94		21.00	39.86	52.22	146.66	288.25	582.51	913.23	1362.18	1966.93	3095.79	Partial area, HUC 12 clipped to watershed boundary
4 - Fourmile Draw	3	25.44	2.09	1.05		37.49	70.62	92.18	255.02	496.39	995.30	1556.67	2320.48	3348.56	5273.18	
5 - Goshen Hole Reservoir	3	55.14	1.94	0.98		40.87	77.68	101.92	287.94	568.50	1159.75	1838.71	2782.73	4076.88	6552.87	
6 - Harry Dayton Ranch	3	19.39	2.29	1.09		44.27	82.53	107.10	289.56	554.99	1093.85	1690.47	2488.62	3546.57	5494.52	
7 - Hawk Springs Reservoir	3	37.46	1.92	1.07		34.28	65.18	85.53	241.66	477.09	972.15	1538.28	2321.73	3392.24	5430.34	
8 - Horse Creek-Bushnell Creek	3	57.11	2.41	1.15		79.76	148.01	191.69	514.09	980.40	1927.86	2984.99	4412.16	6313.33	9847.83	Partial area, HUC 12 clipped to watershed boundary
9 - Horse Creek-Carey Creek	4	54.41	2.17	1.12	41.45	33.87	48.98	57.13	103.75	158.44	250.74	340.41	451.34	584.37	798.96	
10 - Horse Creek-Cattail Creek	3	49.09	2.15	1.00		53.27	100.08	130.48	359.43	697.74	1397.61	2188.96	3271.89	4734.33	7488.84	
11 - Horse Creek-Hawk Springs	3	48.80	1.91	1.04		37.28	70.95	93.16	263.97	522.18	1067.08	1693.00	2563.44	3757.40	6041.89	
12 - Horse Creek-Kellehan Creek	3	39.08	2.45	1.11		72.59	134.36	173.75	463.12	879.48	1719.84	2650.24	3895.74	5543.63	8581.52	
13 - Horse Creek-Kelley Draw	3	43.81	1.94	1.01		37.60	71.43	93.68	264.24	521.09	1061.03	1678.95	2534.86	3704.85	5934.66	
14 - Horse Creek-La Grange	3	25.93	1.99	1.10		32.58	61.70	80.77	226.14	443.68	897.18	1411.01	2115.13	3069.33	4868.09	
15 - Horse Creek-Little Willow Reservoir	3	24.24	1.85	0.98		25.57	48.81	64.16	182.69	362.50	741.68	1175.12	1774.37	2593.61	4151.33	
16 - Horse Creek-Packer Reservoir	3	23.01	1.99	0.92		31.09	58.87	77.05	215.59	422.81	854.32	1342.43	2010.08	2913.64	4613.75	Partial area, HUC 12 clipped to watershed boundary
17 - Horse Creek-Schoolhouse Creek	4	58.03	3.56	1.26	41.42	41.86	59.72	69.32	123.77	187.06	292.95	395.28	520.52	669.79	908.77	
18 - Horse Creek-Sprager Creek	3	46.47	2.22	1.02		57.79	108.16	140.72	384.36	741.92	1476.96	2303.63	3428.61	4939.93	7771.01	
19 - Horse Creek-Trail Creek	3	46.26	2.02	0.98		43.12	81.57	106.75	298.40	584.96	1183.75	1865.97	2806.78	4087.04	6516.51	
20 - Josh Creek	3	34.40	2.09	0.96		42.82	80.65	105.27	291.32	567.21	1138.59	1783.77	2665.09	3854.63	6090.62	
21 - Long Canyon-Pumpkin Creek	3	1.60	2.30	1.23		16.60	30.85	39.92	106.70	202.77	393.29	596.88	858.61	1195.63	1791.68	Partial area, HUC 12 clipped to watershed boundary
22 - Lower Bear Creek-Horse Creek	3	37.65	2.13	1.00		46.88	88.12	114.91	316.74	615.08	1231.55	1926.80	2875.40	4153.92	6554.61	
23 - Lower Fox Creek	3	61.07	2.36	0.91		77.20	143.58	186.18	501.83	960.25	1895.35	2942.43	4361.34	6257.95	9797.01	
24 - Lower Little Bear Creek	3	34.12	2.28	0.98		55.04	102.69	133.37	361.65	694.66	1374.47	2133.28	3157.56	4524.33	7063.97	
25 - Lower Little Horse Creek	3	39.28	2.50	1.11		77.31	142.78	184.41	489.17	925.96	1804.58	2774.74	4069.88	5778.83	8920.90	
26 - Lower Lone Tree Creek-Horse Creek	3	37.30	1.93	1.01		34.64	65.83	86.36	243.76	480.92	979.27	1548.82	2336.50	3412.18	5458.86	
27 - Middle Bear Creek	3	51.03	2.33	0.89		69.48	129.36	167.83	453.23	868.32	1715.28	2662.76	3945.24	5658.66	8851.86	
28 - Middle Little Bear Creek	3	41.94	2.28	1.00		60.05	112.06	145.54	394.85	758.72	1502.71	2335.30	3462.44	4969.59	7778.39	
29 - North Bear Creek	3	63.70	2.26	1.11		68.55	128.14	166.61	454.04	875.21	1741.23	2717.40	4049.37	5841.42	9207.89	
30 - North Fork Horse Creek	4	36.66	3.43	1.26	41.42	32.68	46.91	54.53	97.31	146.34	227.41	305.10	399.51	511.63	690.60	
31 - Robb Draw	3	36.79	2.10	1.00		44.06	82.99	108.33	299.82	583.82	1172.29	1837.32	2746.58	3974.65	6285.25	Partial area, HUC 12 clipped to watershed boundary
32 - Rocky Hollow	3	30.74	2.32	0.94		55.36	103.12	133.77	361.22	691.87	1364.40	2112.42	3118.31	4456.12	6932.65	
33 - South Fork Bear Creek	3	48.81	2.25	1.09		60.74	113.56	147.67	402.44	775.71	1542.05	2403.32	3574.61	5146.88	8090.38	
34 - South Fork Horse Creek	4	25.75	3.62	1.28	41.42	28.03	40.31	46.88	83.32	124.52	191.88	255.94	333.14	424.47	569.69	
35 - Spring Creek-Fox Creek	3	50.79	2.47	1.05		82.31	152.28	196.89	524.50	995.73	1947.96	3005.01	4424.34	6305.94	9785.49	
36 - Tromely Gulch-Dry Creek	4	23.83	3.09	1.21	41.42	24.97	36.11	42.08	75.22	112.74	174.17	232.60	303.24	386.92	520.23	
37 - Upper Bear Creek-Middle Bear Creek	3	45.52	2.48	1.04		79.47	146.98	189.98	505.50	958.90	1873.74	2887.36	4245.55	6043.19	9360.55	

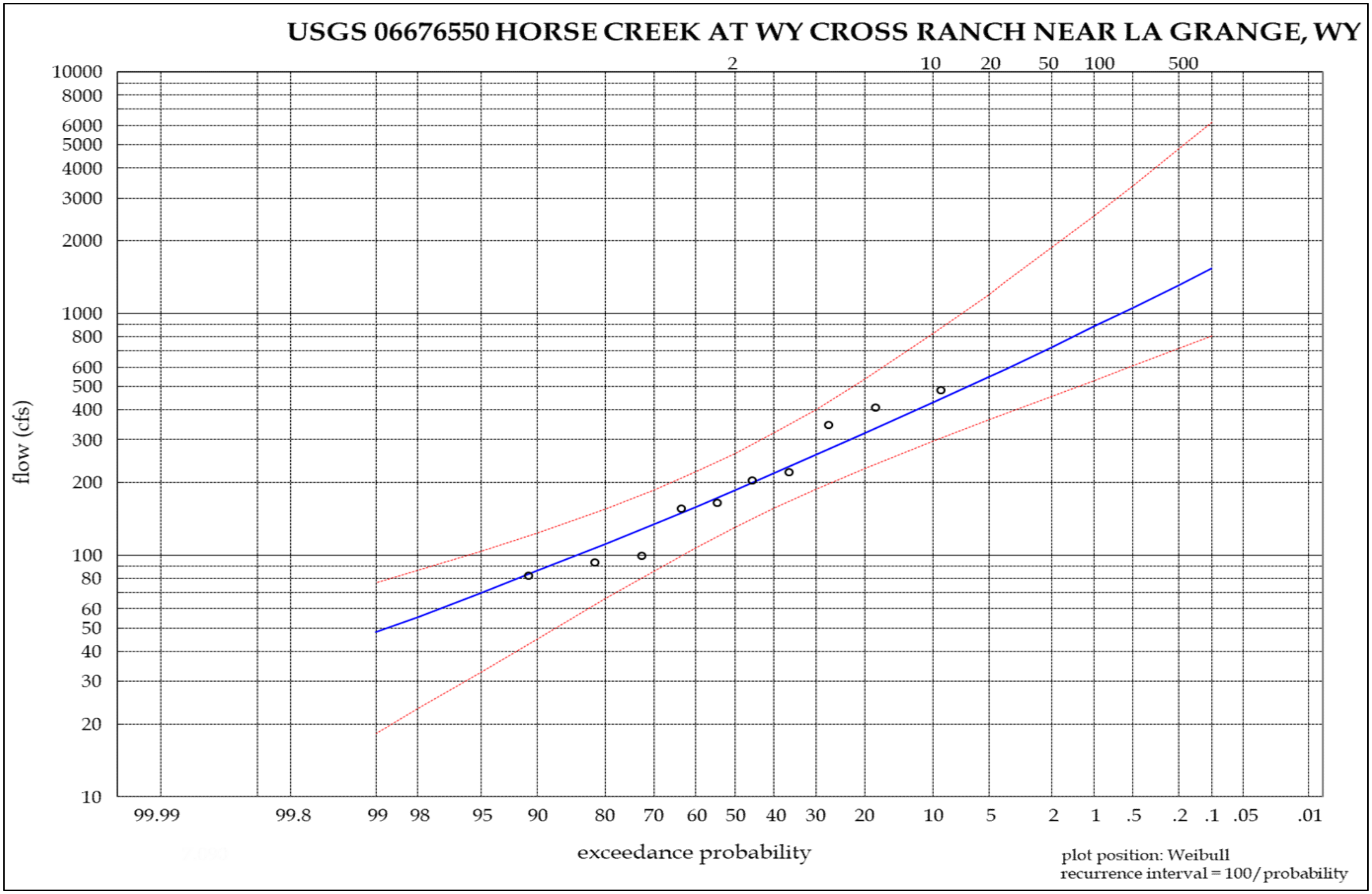
HUC12 Basin Name	Region	Area (sq mi)	Soil Index	Mean March Precip (in)	Latitude	Peak flows in cfs for various return periods										NOTES
						1.5 yr	2 yr	2.33 yr	5 yr	10 yr	25 yr	50 yr	100 yr	200 yr	500 yr	
38 - Upper Bull Canyon	3	1.08	2.33	1.19		14.63	27.15	35.09	93.40	176.97	341.77	516.61	739.56	1024.92	1525.54	Partial area, HUC 12 clipped to watershed boundary
39 - Upper Fox Creek	3	42.29	2.48	1.01		77.06	142.51	184.18	490.00	929.36	1815.37	2796.12	4108.90	5845.12	9045.72	
40 - Upper Little Bear Creek	4	33.81	2.21	1.12	41.50	26.15	38.17	44.66	81.51	124.36	196.18	265.67	351.30	453.98	619.80	
41 - Upper Little Horse Creek	3	39.33	2.48	1.11		74.75	138.24	178.66	475.22	901.20	1759.72	2709.14	3978.67	5656.42	8745.95	
42 - Upper Lone Tree Creek-Lower Lone Tree Creek	3	33.12	1.94	0.98		33.47	63.56	83.35	234.91	462.98	941.36	1486.91	2239.64	3265.65	5213.21	
43 - Upper Pumpkin Creek	3	0.48	2.80	1.11		18.51	33.62	42.94	108.96	199.93	372.33	548.32	763.54	1029.28	1477.18	Partial area, HUC 12 clipped to watershed boundary
44 - YBO Creek	3	49.98	2.11	0.96		50.92	95.85	125.10	346.06	673.70	1353.60	2124.35	3181.91	4613.67	7317.45	

APPENDIX 5C

PEAK FLOW AT GAGED SITES – LOG PEARSON III METHOD

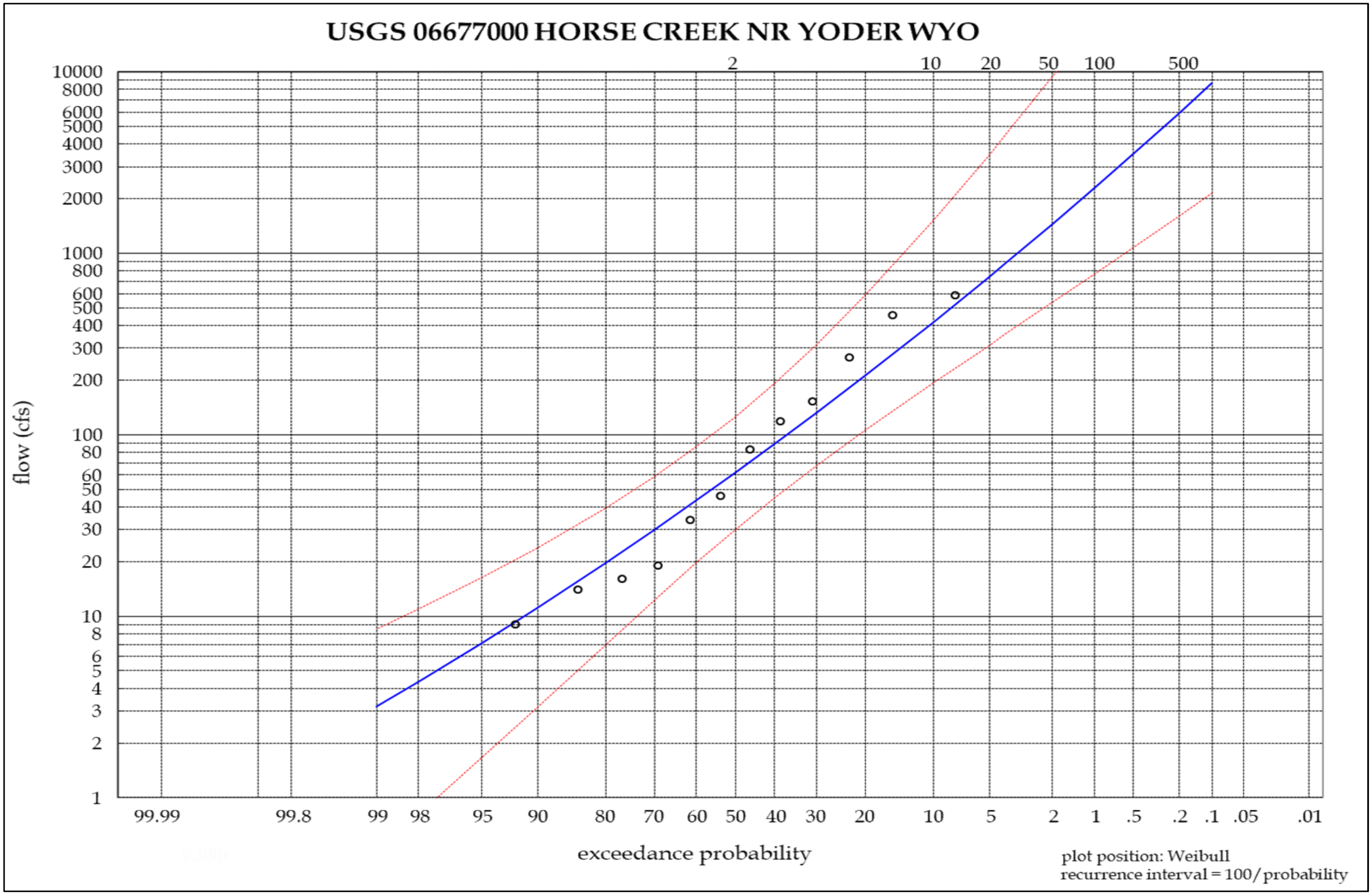
USGS 06676550 HORSE CREEK AT WY CROSS RANCH NEAR LA GRANGE, WY

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	1,540	6,187	805
500	1,317	4,811	716
200	1,056	3,382	605
100	882	2,543	528
50	727	1,874	454
25	589	1,346	384
20	547	1,202	363
10	427	824	296
5	319	535	228
3.333	259	402	187
2.5	218	320	156
2	186	264	130
1.667	159	221	107
1.429	135	186	86
1.250	111	155	66
1.111	86	124	45
1.053	70	104	33
1.020	56	87	23
1.010	48	77	18


USGS 06676550 HORSE CREEK AT WY CROSS RANCH NEAR LA GRANGE, WY
2
10
20
50
100
500
flow (cfs)
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 06677000 HORSE CREEK NR YODER WYO

recurrence (years)	Q (cfs)	Q_5 (cfs)	Q_{95} (cfs)
1000	8,691	138,153	2,151
500	5,959	78,032	1,611
200	3,514	35,184	1,071
100	2,293	18,534	768
50	1,451	9,364	535
25	882	4,486	359
20	743	3,491	312
10	417	1,516	193
5	212	589	106
3.333	132	315	67
2.5	89	192	45
2	62	126	30
1.667	43	86	20
1.429	30	59	12
1.250	20	39	7
1.111	11	24	3
1.053	7	16	2
1.020	4	11	1
1.010	3	8	1


USGS 06677000 HORSE CREEK NR YODER WYO
flow (cfs)
10000
8000
6000
5000
4000
3000
2000
1000
800
600
500
400
300
200
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
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

APPENDIX 6A

PROJECT DESCRIPTIONS AND COST ESTIMATES

IRR-001: Alps Ditch Conversion Project (Alps-001)

This project would entail the conversion of an existing open ditch 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 approximately 2,650 linear feet of buried 8-inch diameter HDPE pipeline.
- The pipeline would terminate at a settling pond associated with a center pivot sprinkler
- An additional overflow pipeline would extend from the settling pond to an existing stock reservoir. This pipeline would consist of approximately 1,100 linear feet of buried 8-inch diameter HDPE pipe.

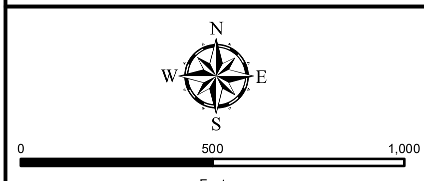
Project Location:

- Section 35, Township 23 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source: n/a



IRR-001 Alps 001 Alps Ditch Conversion Project Conceptual Design

Watershed Plan Component: **IRR-001**
Project Name: **Alps Ditch Conversion Project**
Project Sponsor/Number: **Alps-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 5,242
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	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12	3660	$ 43,920
13d	Irrigation Misc. Structure Small	Ea	$ 4,500	1	$ 4,500
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 57,662
	Contingencies (15% of subtotal)				$ 8,649
	Engineering and technical assistance (10% of subtotal)				$ 5,766
	Estimated project cost				$ 72,078

Horse Creek Watershed Study
Appendix 6A

IRR-002: Christofferson Ditch Diversion Reconstruction (Christofferson-001)

This project would involve replacement of an existing irrigation diversion structure on the North Fork Horse Creek. The ditch provides irrigation water for approximately 70 acres. Replacement of the structure would be extremely costly and according to the land owner, would likely exceed ability to finance the project. Consequently, repair of the facility is recommended in order to provide some utility.

The existing facility consists of a 48-inch gate on North Fork Horse Creek which is used to control water surface elevation for diversion. Adjacent to the gate is a 24-inch gate controlling water diverted to the irrigation ditch. Flows exceeding the capacity of the gate on North Fork Horse Creek would overflow an earthen berm which would likely require reconstruction if it did overflow.

A rehabilitation technique which would likely help the land owner for the immediate future would be to eliminate seepage around the gate structure on North Fork Horse Creek and thereby extend its lifespan.

Project components would include:

- Excavation of soil around the structure
- Replace excavated material with compacted fill material

- Placement of poured concrete adjacent to the concrete structure on the upstream face in an effort to eliminate seepage.

Project Location:

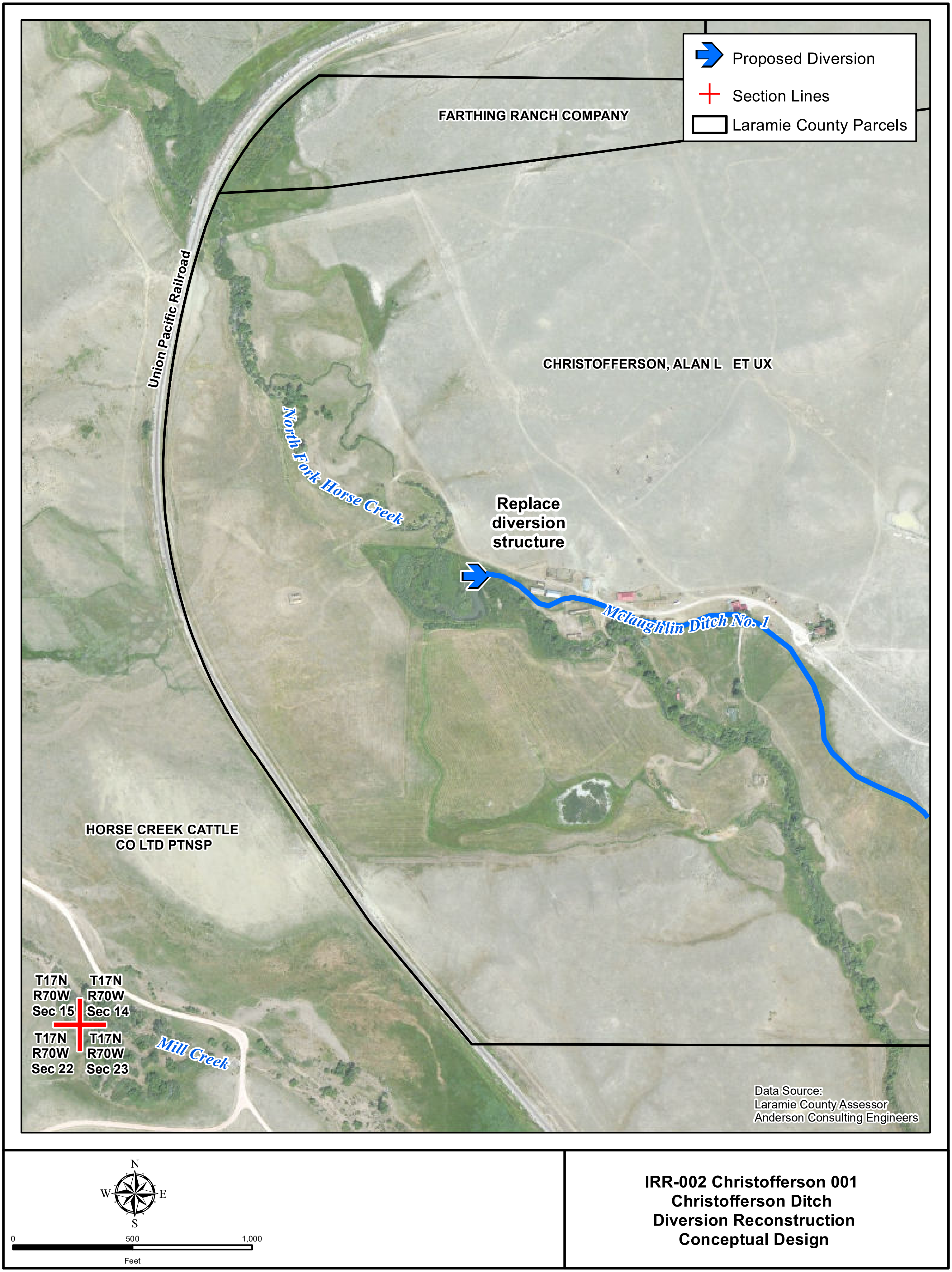
- Section 14, Township 17 North, Range 70 West

Land Ownership (Surface):

- Private

Water Source:

North Fork Horse Creek



IRR-002 Christofferson 001
Christofferson Ditch
Diversion Reconstruction
Conceptual Design

Watershed Plan Component: **IRR-002**
Project Name: **Christofferson Ditch Diversion Reconstruction**
Project Sponsor/Number: **Christofferson-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,433
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	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000	1	$ 18,000
13g	Irrigation Ditch Small (< 5cfs)	LF	$ 3		$ -
14a	Culvert - corrugated 18-inch diam	LF	$ 34		$ -
14b	Culvert - corrugated 24-inch diam	LF	$ 36	20	$ 722
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	$ 240
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125	10	$ 1,250
21	Filter fabric under riprap	SY	$ 4	10	$ 40
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				$ 26,765
	Contingencies (15% of subtotal)				$ 4,015
	Engineering and technical assistance (10% of subtotal)				$ 2,677
	Estimated project cost				$ 33,457

IRR-003: Davis Pipeline Project (Davis-002)

This project would entail the conversion of an existing open ditch 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.

The existing ditch begins at Hawk Springs Reservoir and extends approximately

Project components would include:

- Intalling a pipeline inlet facility
- Installing approximately 6,300 linear feet of 24-inch diameter buried HDPE pipeline.

Project Location:

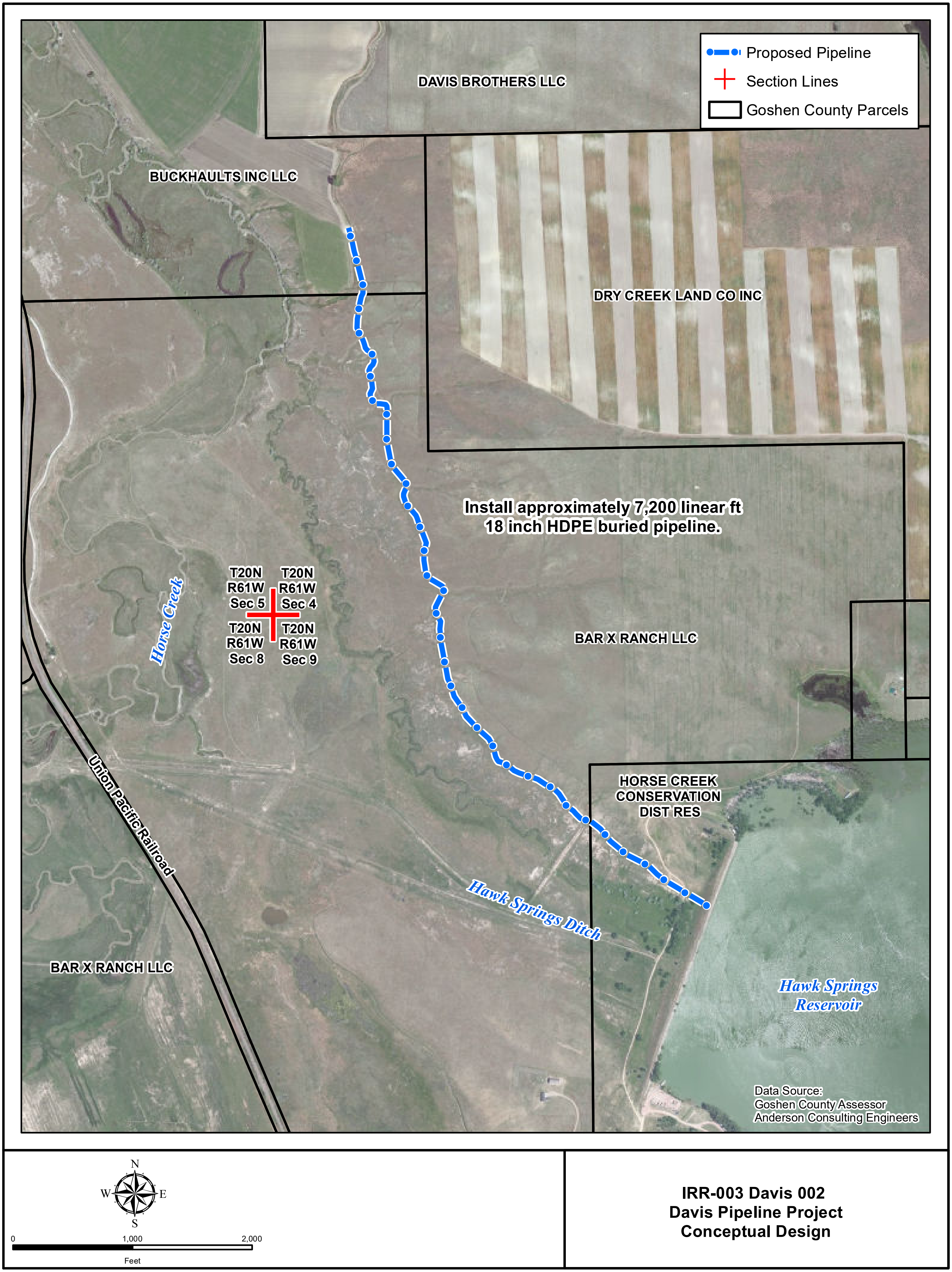
- Section 9, Township 20 North, Range 61 West

Land Ownership (Surface):

- Private

Water Source:

- Hawk Springs Reservoir



IRR-003 Davis 002
Davis Pipeline Project
Conceptual Design

Watershed Plan Component: **IRR-003**
Project Name: **Davis Pipeline Project**
Project Sponsor/Number: **Davis-002**

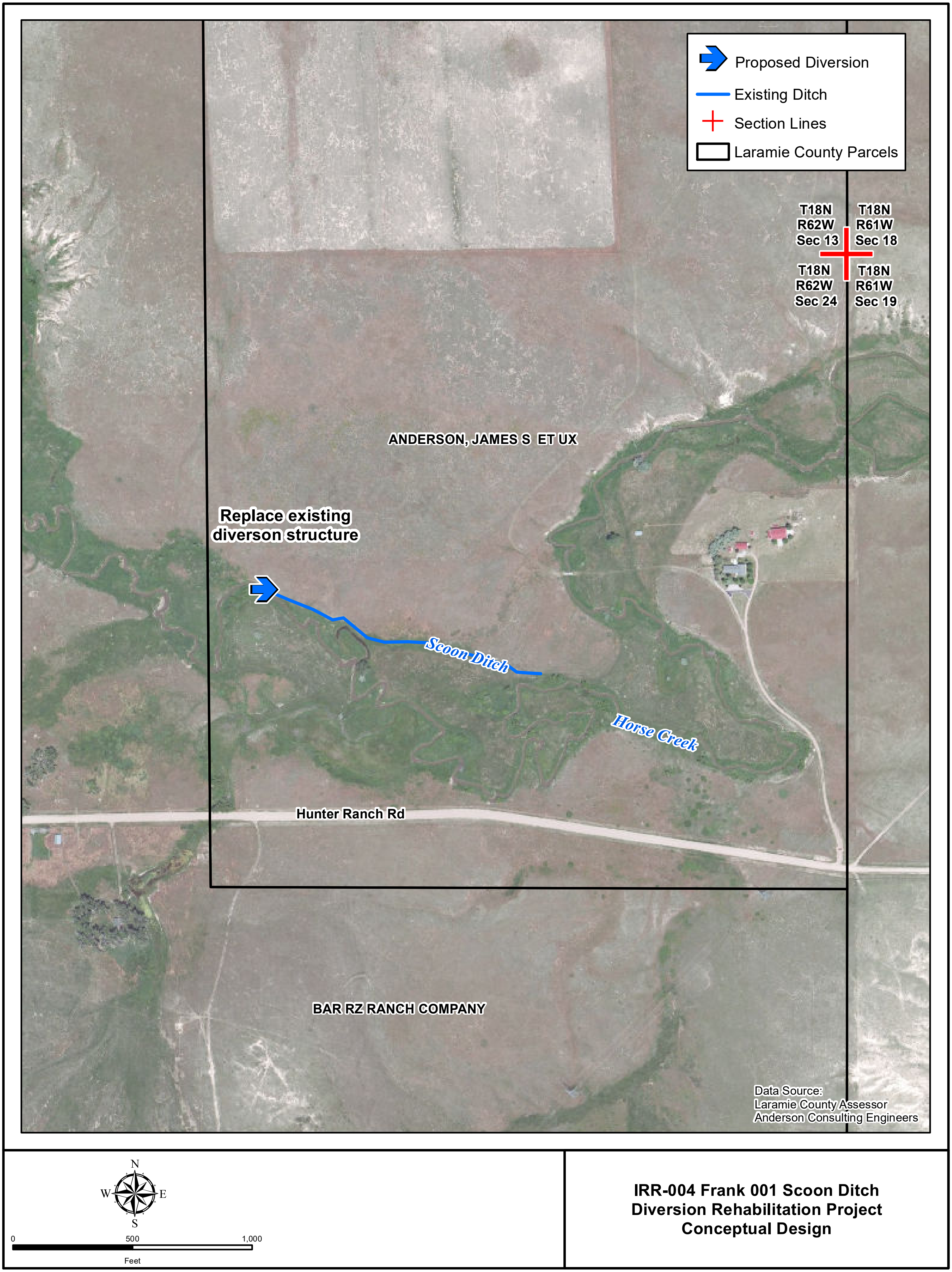
Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 26,100
1A	Lump sum based on other information	LS			
2a	Well -Drill, Case, and develop stock well. Assume 10" borehole and 5" SDR-17 PVC Casing*	LF	$ 50		$ -
2b	Spring Development	LS	$ 5,000		$ -
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		$ -
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 24-inch diameter	LF	$ 40	6300	$ 252,000
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000	1	$ 9,000
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 287,100
	Contingencies (15% of subtotal)				$ 43,065
	Engineering and technical assistance (10% of subtotal)				$ 28,710
	Estimated project cost				$ 358,875

IRR-004: Scoon Ditch Diversion Rehabilitation Project (Frank-001)

Project designed and managed by Laramie County Conservation District

Jeff Geyer is working with Frank on this project

307.772.2600



IRR-004 Frank 001 Scoon Ditch Diversion Rehabilitation Project Conceptual Design

Watershed Plan Component: **IRR-004**
Project Name: **Scoon Ditch Diversion Rehabilitation Project**
Project Sponsor/Number: **Frank-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
	Assistance for this project is currently being provided by Larimer County Conservation District				
1	Mobilization - assume 10% of other costs	LS			$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ -
	Contingencies (15% of subtotal)				$ -
	Engineering and technical assistance (10% of subtotal)				$ -
	Estimated project cost				$ -

IRR-005: Schwab Ditch Conversion Project (Hanlon-001)

This project would entail the conversion of an existing open ditch 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 approximately 2,400 linear feet of buried 8-inch diameter HDPE pipeline

Project Location:

- Section 23, Township 21 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

IRR-005 Hanlon 001
Schwab Ditch
Conversion Project
Conceptual Design

Watershed Plan Component: **IRR-005**
Project Name: **Schwab Ditch Conversion Project**
Project Sponsor/Number: **Hanlon-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,780
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12	2400	$ 28,800
13d	Irrigation Misc. Structure Small	Ea	$ 4,500	2	$ 9,000
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 41,580
	Contingencies (15% of subtotal)				$ 6,237
	Engineering and technical assistance (10% of subtotal)				$ 4,158
	Estimated project cost				$ 51,975

IRR-006: Sipola Ditch Conversion Project (Sipola-001)

This project would entail the conversion of an existing open concrete to a buried pipeline. The existing concrete ditch has failed. It experiences significant losses due to cracked and missing concrete sections. 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:

- Removal of existing concrete ditch (approximately 2,000 linear feet)
- Installing approximately 2,600 linear feet of 8-inch diameter buried HDPE pipeline

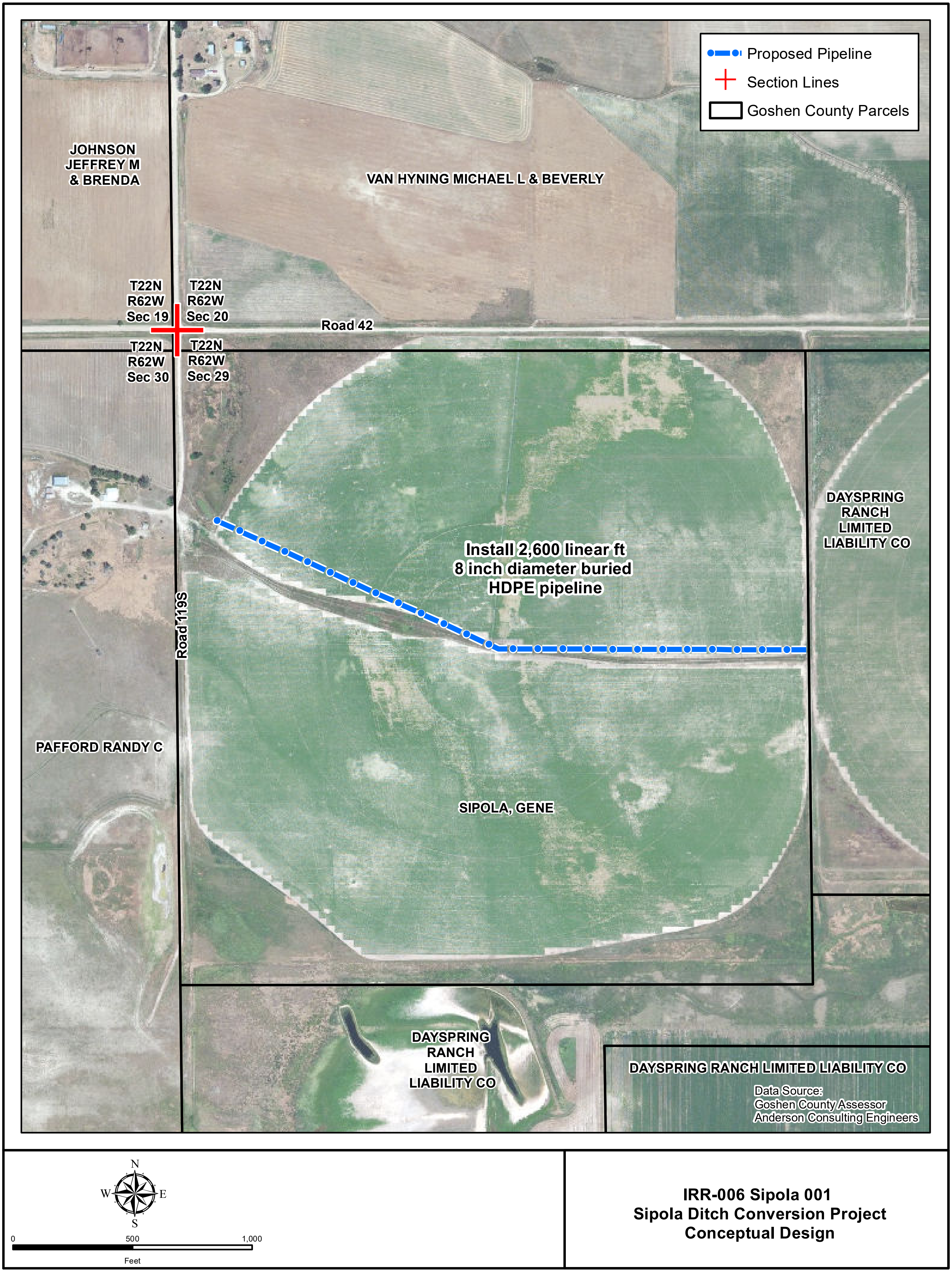
Project Location:

- Section 30, Township 22 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source: n/a



IRR-006 Sipola 001
Sipola Ditch Conversion Project
Conceptual Design

Watershed Plan Component: **IRR-006**
Project Name: **Sipola Ditch Conversion Project**
Project Sponsor/Number: **Sipola-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 4,020
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12	2600	$ 31,200
13d	Irrigation Misc. Structure Small	Ea	$ 4,500	2	$ 9,000
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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: remove existing concrete	LS	$ 12,000	1	$ 12,000
					$ 56,220
	Project Subtotal				$ 56,220
	Contingencies (15% of subtotal)				$ 8,433
	Engineering and technical assistance (10% of subtotal)				$ 5,622
	Estimated project cost				$ 70,275

IRR-007: Tomayer Pipeline Project (Tomayer-001)

This project would entail the conversion of an existing open ditch 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 approximately 175 linear feet of buried 18-inch diameter HDPE pipeline

Project Location:

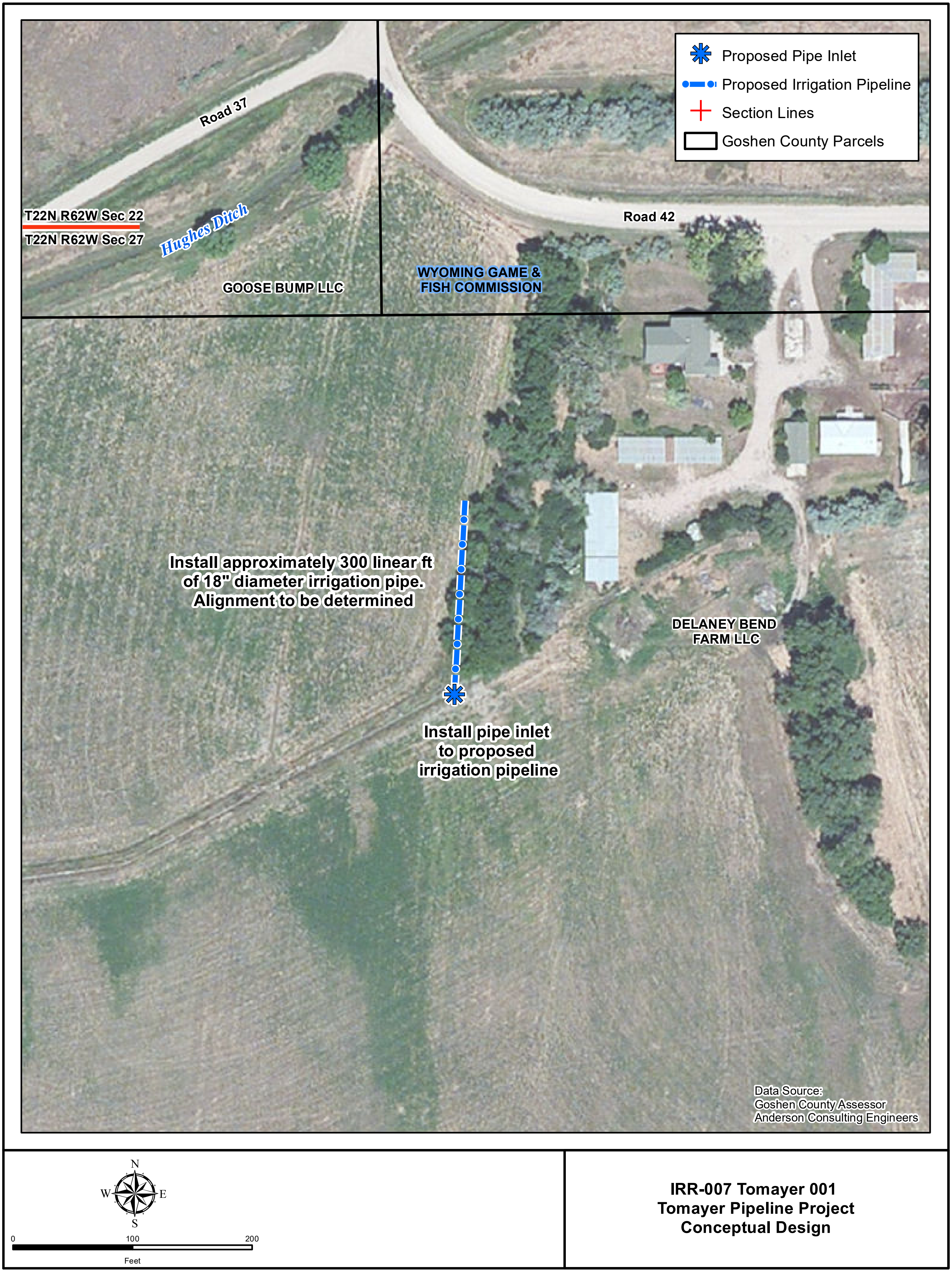
- Section 27, Township 22 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Existing irrigation ditch



IRR-007 Tomayer 001
Tomayer Pipeline Project
Conceptual Design

Watershed Plan Component: **IRR-007**
Project Name: **Tomayer Pipeline Project**
Project Sponsor/Number: **Tomayer-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,200
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20	175	$ 3,500
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500	1	$ 4,500
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 13,200
	Contingencies (15% of subtotal)				$ 1,980
	Engineering and technical assistance (10% of subtotal)				$ 1,320
	Estimated project cost				$ 16,500

Horse Creek Watershed Study
Appendix 6A

IRR-008: Bear Creek Ditch Measurement Device (Thaler-002)

This project would entail replacement of an existing measurement device. The existing device is antiquated and users are unable to determine ditch discharge because the structure is incomplete; parts are missing. The existing structure is antiquated and requires accessories which users do not possess and are no longer available for purchase.

Completion of this project would include:

Surveying the Bear Creek Ditch to determine channel slope and profile.

Selection of the appropriate type of measurement device; slope is limited.

Installation of the measurement device.

Project Location:

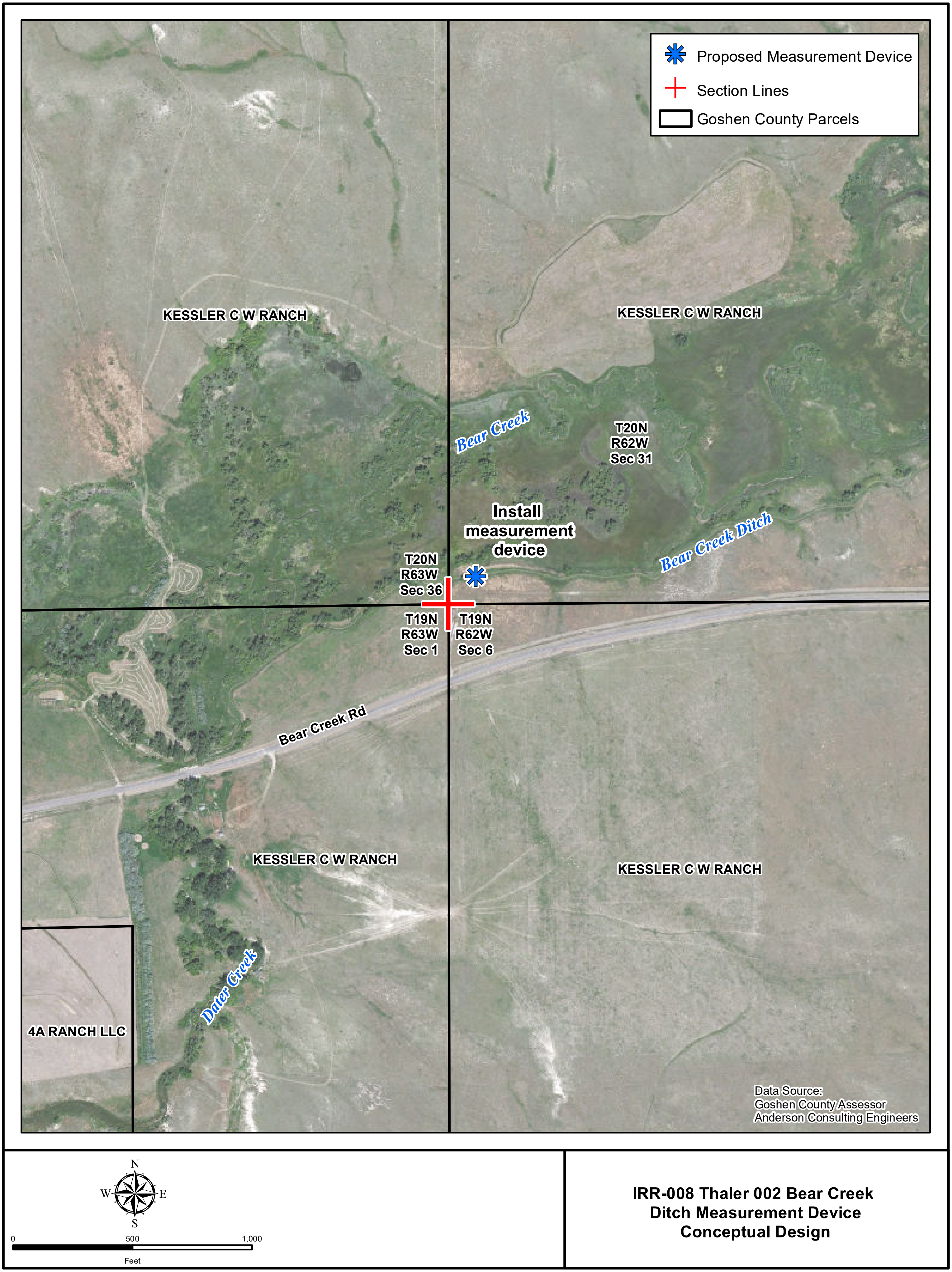
- Section 31, Township 20 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Bear Creek Ditch



IRR-008 Thaler 002 Bear Creek Ditch Measurement Device Conceptual Design

Watershed Plan Component: **IRR-008**
Project Name: **Bear Creek Ditch Measurement Device**
Project Sponsor/Number: **Thaler-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,500
1A	Lump sum based on other information	LS			$ 25,000
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 27,500
	Contingencies (15% of subtotal)				$ 4,125
	Engineering and technical assistance (10% of subtotal)				$ 2,750
	Estimated project cost				$ 34,375

Horse Creek Watershed Study
Appendix 6A

IRR-009 Fox Creek Diversion Structure (Thaler-001)

This project involves replacement of an irrigation diversion structure on Fox Creek. Currently, the existing structure's operation is complicated by sediment within Fox Creek. Bank erosion is evident upstream of the structure and would need to be mitigated to provide optimal solution to the current problem. Combining a stream channel stabilization effort with structure redesign and replacement would likely result in a viable solution to the current situation.

Components of the project would involve:

- Detailed survey and assessment of the erosive reach upstream of the diversion. Channel stabilization techniques would include installation of a series of check structures which would stabilize the bed of Fox Creek. Recontouring vertical banks would enable vegetation to become reestablished. This combination of techniques would reduce the amount of sediment transported downstream to the structure.
- As indicated in the figure below, water is diverted from Fox Creek and conveyed approximately 350 feet downstream to a settling pond. From the pond, water is pumped to a center pivot. To minimize the sediment transported to the pond and ultimately to the pivot system, a pair of check structures could be installed as indicated:
- One structure would control water conveyed to the pond and the other control water conveyed back to Fox Creek. The structure conveying water to the pond could consist of an over-shot configuration of check boards where water must flow over the boards to the pond.
- The structure conveying water back to Fox Creek would be configured such that water could flow under check boards and convey sediment back to Fox Creek.

Project Location:

- Section 29, Township 20 North, Range 62 West

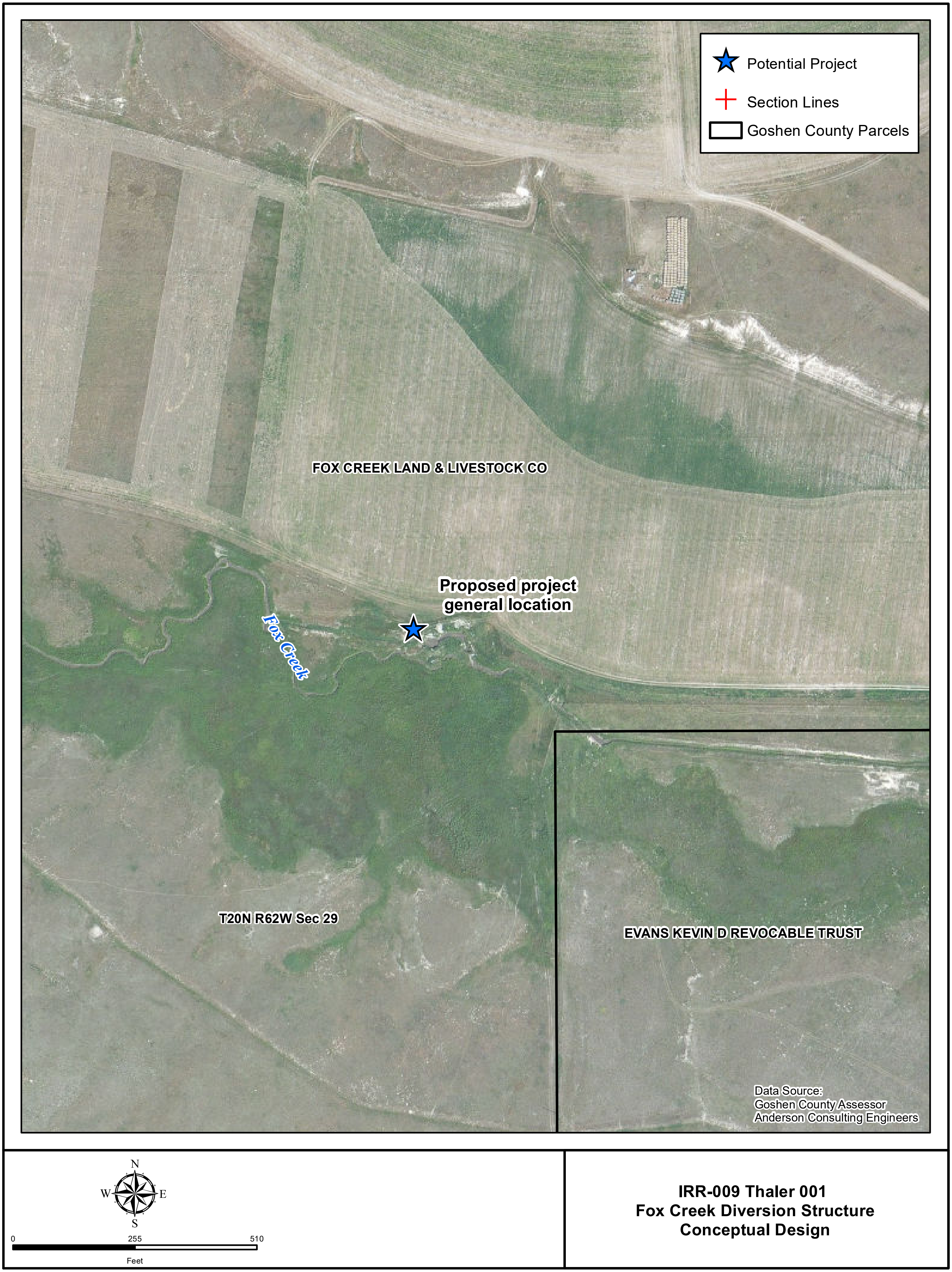
Land Ownership (Surface):

- Private

Water Source:

- Fox Creek

Horse Creek Watershed Study
Appendix 6A



IRR-009 Thaler 001
Fox Creek Diversion Structure
Conceptual Design

Watershed Plan Component: **IRR-009**
Project Name: **Fox Creek Diversion Structure**
Project Sponsor/Number: **Thaler-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,600
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000	2	$ 36,000
13g	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				$ 39,600
	Contingencies (15% of subtotal)				$ 5,940
	Engineering and technical assistance (10% of subtotal)				$ 3,960
	Estimated project cost				$ 49,500

L/W-001: Berry Well Construction Project No. 1 (Berry-001)

This project would involve drilling a new well to replace an existing well in poor condition, 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 one 1,200-gallon rubber tire stock tanks
- Installing approximately 3,200 linear feet of 1.5-in HDPE buried pipeline
- Installing a new well approximately 250 feet deep.
- Abandonment of existing well.

Project Location:

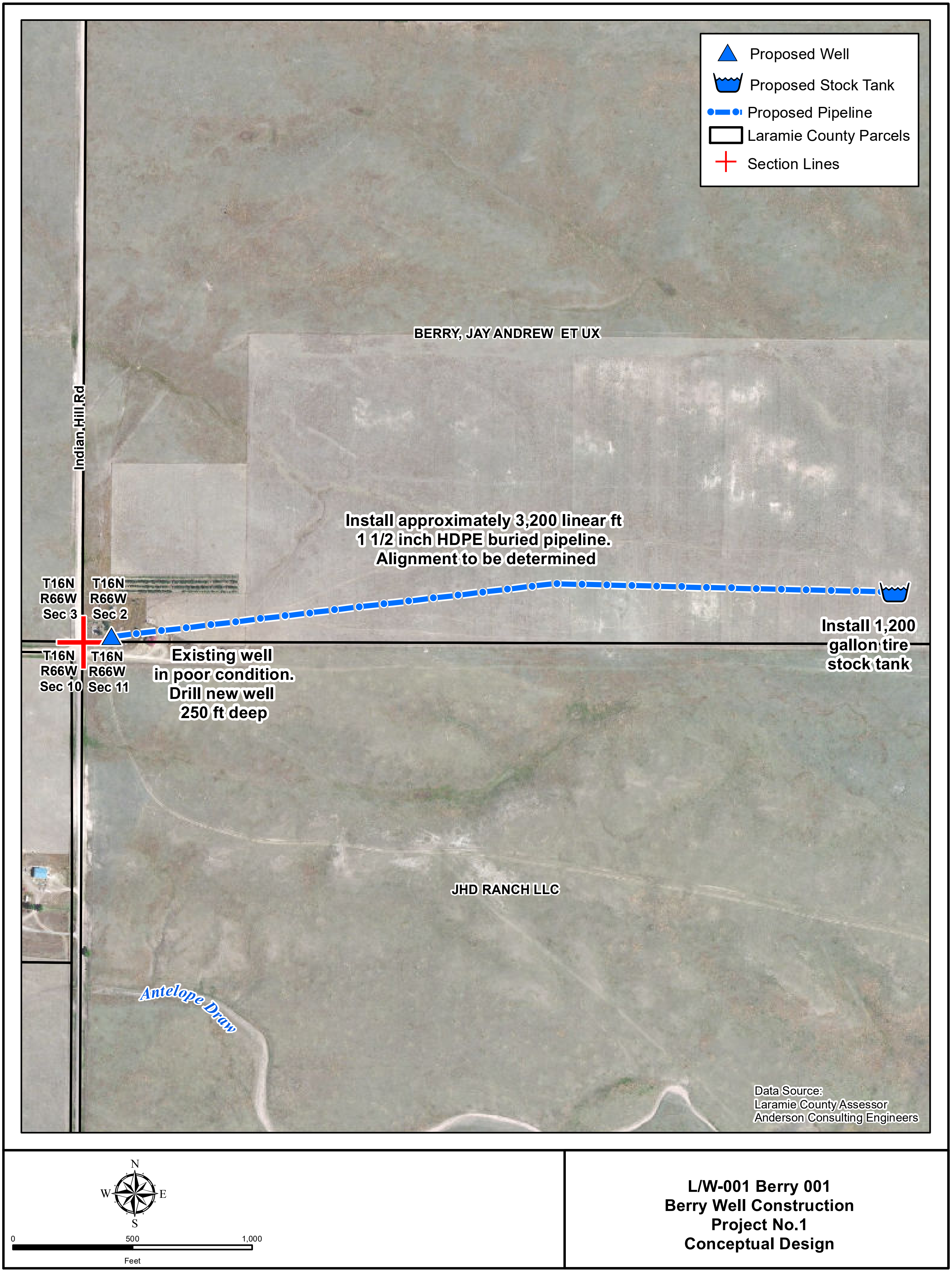
- Section 2, Township 16 North, Range 66 West

Land Ownership (Surface):

- Private

Water Source:

- Well replacement



L/W-001 Berry 001
Berry Well Construction
Project No.1
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Hydrogeologic Report: Berry-001

The Berry-001 prospect is located in T16N, R66W, Sec. 2, about 14 miles north of Cheyenne, at approximate elevation 6155 feet[1]. This site is 2 miles outside (south) of the topographic basin of Horse Creek.

The surface formation at the site is the Ogallala, underlain in this area by the Arikaree Formation, and beneath that, the White River Formation.

There are 6 existing groundwater permits in the surrounding area. The attached figure provides locations[2].

Permit[3]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
14855	Bruce Smith	7	200	240
3613	Ralph Zimmerman	5 - 10	80 (est.)	210
89093	Conrad Dodson, Jr.	20	280	440
75444	Conrad Dodson, Jr.	25	215	507
8779	JHD Ranch, LLC	5	130	140
187759	Carter Brothers Construction	12	165	480

[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 Engineer's 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.

[3]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

Based on the information filed with the Wyoming State Engineer's Office, permit #14855 is very close to the Berry-001 prospect. Unfortunately, there is no information on that well beyond that listed in the above table (except the 1910 estimated construction date). The 200 feet reported depth-to-water indicates a groundwater elevation of approximately 5,950 feet, which is consistent with the elevation and reported depth-to-water from #3613, a short distance to the southwest. At the Berry-001 prospect, that groundwater elevation indicates a static (i.e. before pumping) depth-to-water of approximately 200 feet.

Although a famous aquifer across the Great Plains, the Ogallala Formation in Laramie County is of quite variable productivity. Successful wells commonly accumulate production from more than one discrete water-bearing zone and greater penetration generally yields greater production. Neither of the two closest permits provides information on production zones, providing only the production estimates of "5 - 10 gpm" and "7 gpm". Presumably, a 200 - 250 feet well in this vicinity could secure similar production.

The log supplied with well #89093 indicates 240 feet of Ogallala, beneath which the White River Formation was encountered. The well was completed with perforations from 380 to 440 feet, in what was described as "dark red claystone sandstone and lenticular conglomerate". This log demonstrates the difficulty in picking out the individual formations present in this area, and the need to go to greater depth to find adequate water in some circumstances.

In the "North Cheyenne Study Area", south of this prospect, but in the same aquifer, the Wyoming State Engineer's Office requires new wells be drilled to a minimum depth of 160 ft. below the static water level and to have at least 60 ft. of screened interval. At the Berry-001 prospect, this recommendation would be total well depth of 360 ft. Part of that recommendation was to anticipate the cumulative drawdown of the many rural residential wells north of Cheyenne, of course, which is unlikely at the Berry-001 prospect.

Chemical analyses are available for neither of these wells, but the owners opined that the groundwater quality is "good" on their permit documents, and that is consistent with what one would expect from this aquifer.

Conclusions:

1. There is a high likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Ogallala Formation in this area.

2. A well depth on the order of 250 feet should be sufficient, as production is a function of accumulating water from multiple zones rather than simply drilling to a known production zone at a known depth.

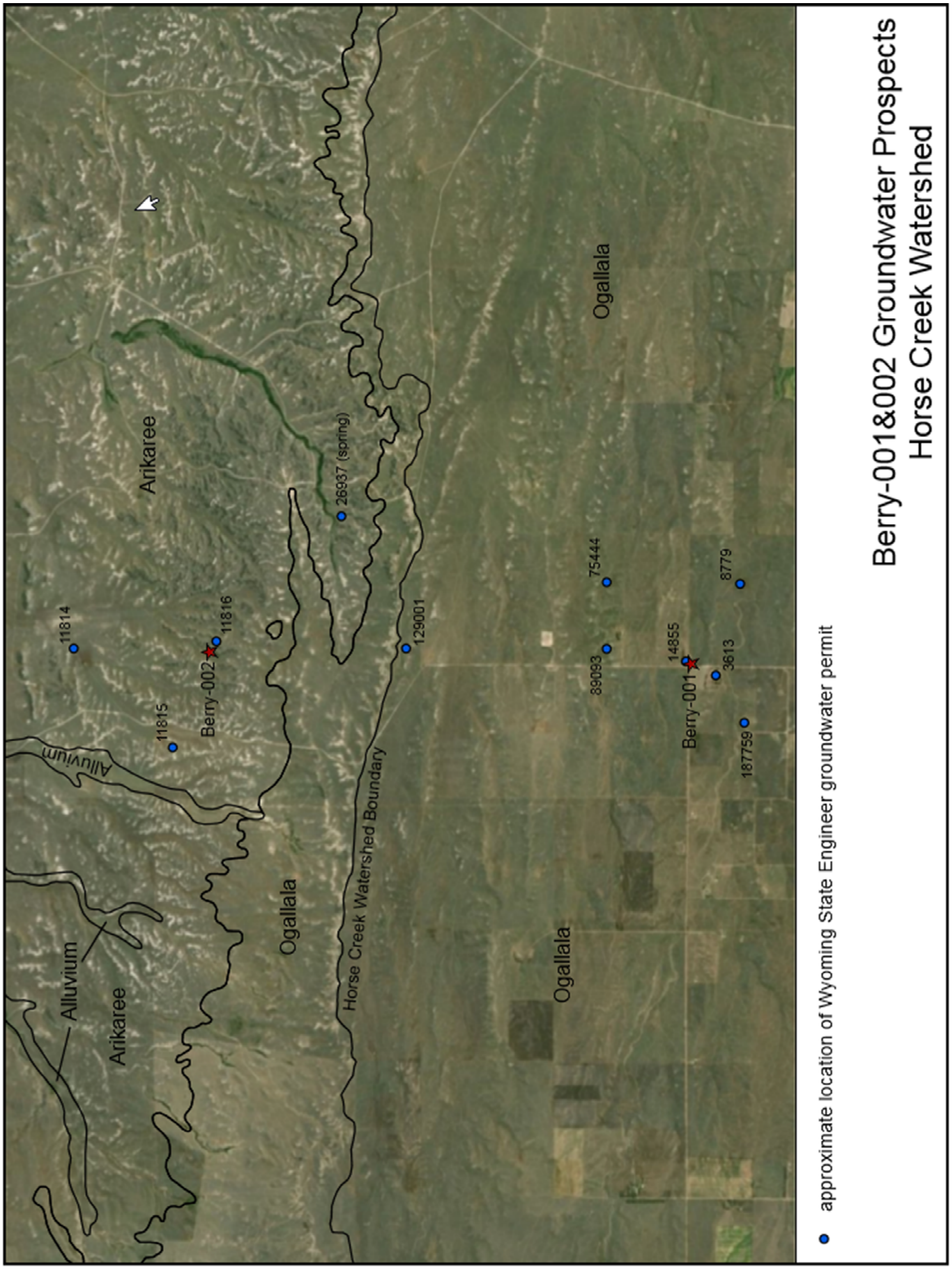
3. A static depth-to-water around 200 feet is expected. A pump setting at least 40 feet below the static water level is recommended to accommodate in-well drawdown, interference drawdown from nearby wells, and long-term water level fluctuations.

4. Although hydrogeologic conditions may vary over short distances, those variations are not predictable in this area. Thus, exact site selection may be guided by surface convenience within this general area.

5. Groundwater quality at this location is likely adequate for stock and domestic use.

6. 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.

Horse Creek Watershed Study
Appendix 6A



Watershed Plan Component: **L/W-001**
Project Name: **Berry Well Construction Project No. 1**
Project Sponsor/Number: **Berry 001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,910
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		$ -
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	3200	$ 9,600
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 32,010
	Contingencies (15% of subtotal)				$ 4,802
	Engineering and technical assistance (10% of subtotal)				$ 3,201
	Estimated project cost				$ 40,013

L/W-002: Berry Well Construction Project No. 2 (Berry-002)

This project would involve drilling a new well to replace an existing well in poor condition, 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 one 1,200-gallon rubber tire stock tanks
- Installing a new well approximately 250 feet deep.
- Installing new solar platform, pump and requisite fittings in the new well.
- Abandonment of existing well.

Project Location:

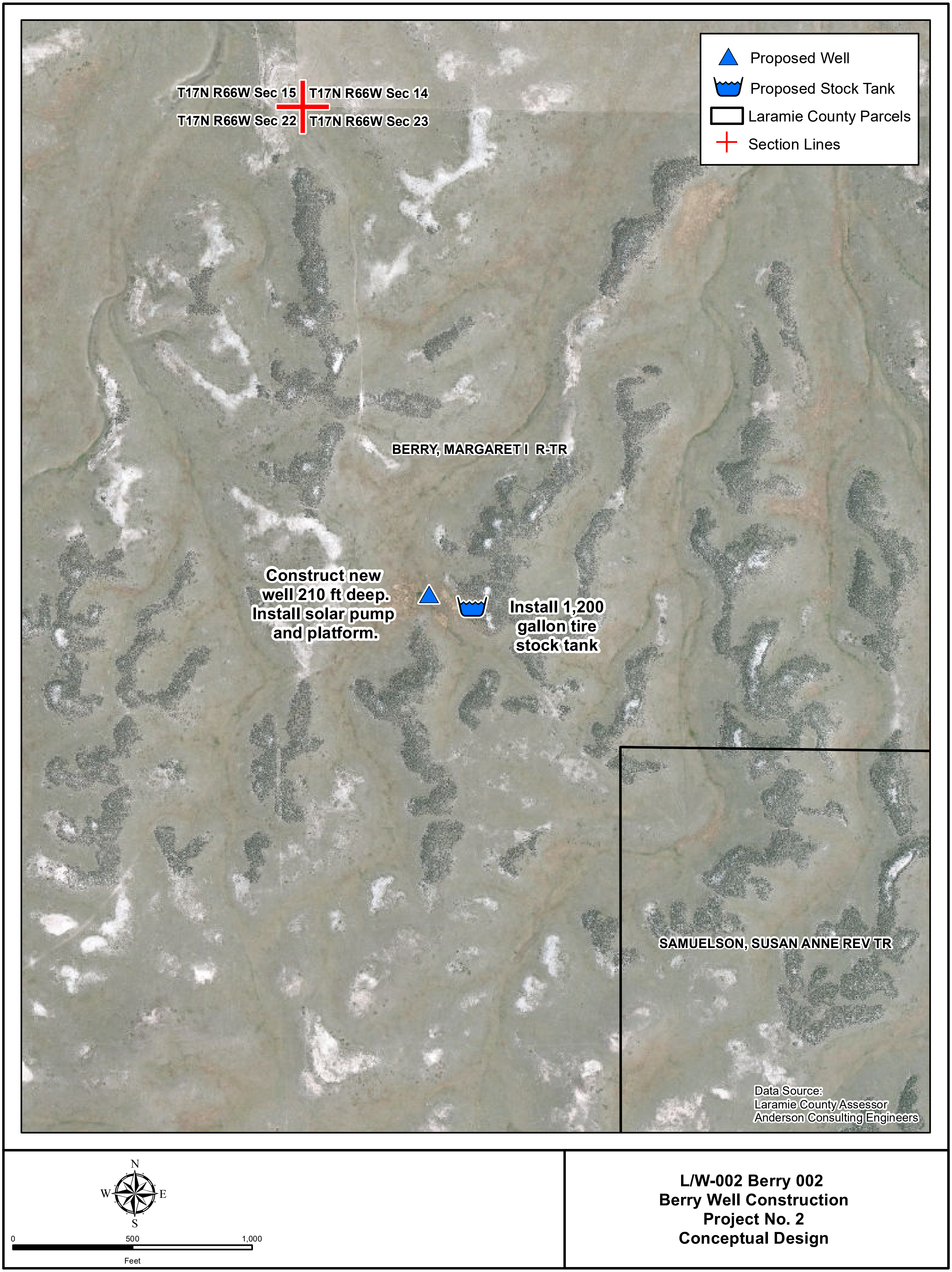
Section 23, Township 17 North, Range 66 West

Land Ownership (Surface):

Private

Water Source:

Well replacement



L/W-002 Berry 002
Berry Well Construction
Project No. 2
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Hydrogeologic Report: Berry-002

The Berry-002 prospect is located in T16N, R66W, Sec. 11, about 14 miles north of Cheyenne, at approximate elevation 6155 feet[1]. This site is 2 miles outside (south) of the topographic basin of Horse Creek.

The surface formation at the site is the Ogallala, underlain in this area by the Arikaree Formation, and beneath that, the White River Formation.

There are 6 existing groundwater permits in the surrounding area. The attached figure provides locations[2].

Permit[3]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
14855	Bruce Smith	7	200	240
3613	Ralph Zimmerman	5 - 10	80 (est.)	210
89093	Conrad Dodson, Jr.	20	280	440
75444	Conrad Dodson, Jr.	25	215	507
8779	JHD Ranch, LLC	5	130	140
187759	Carter Brothers Construction	12	165	480

[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 Engineer's 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.

[3]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

Based on the information filed with the Wyoming State Engineer's Office, permit #14855 is very close to the Berry-001 prospect. Unfortunately, there is no information on that well beyond that listed in the above table (except the 1910 estimated construction date). The 200 feet reported depth-to-water indicates a groundwater elevation of approximately 5,950 feet, which is consistent with the elevation and reported depth-to-water from #3613, a short distance to the southwest. At the Berry-001 prospect, that groundwater elevation indicates a static (i.e. before pumping) depth-to-water of approximately 200 feet.

Although a famous aquifer across the Great Plains, the Ogallala Formation in Laramie County is of quite variable productivity. Successful wells commonly accumulate production from more than one discrete water-bearing zone and greater penetration generally yields greater production. Neither of the two closest permits provides information on production zones, providing only the production estimates of "5 - 10 gpm" and "7 gpm". Presumably, a 200 - 250 feet well in this vicinity could secure similar production.

The log supplied with well #89093 indicates 240 feet of Ogallala, beneath which the White River Formation was encountered. The well was completed with perforations from 380 to 440 feet, in what was described as "dark red claystone sandstone and lenticular conglomerate". This log demonstrates the difficulty in picking out the individual formations present in this area, and the need to go to greater depth to find adequate water in some circumstances.

In the "North Cheyenne Study Area", south of this prospect, but in the same aquifer, the Wyoming State Engineer's Office requires new wells be drilled to a minimum depth of 160 ft. below the static water level and to have at least 60 ft. of screened interval. At the Berry-001 prospect, this recommendation would be total well depth of 360 ft. Part of that recommendation was to anticipate the cumulative drawdown of the many rural residential wells north of Cheyenne, of course, which is unlikely at the Berry-001 prospect.

Chemical analyses are available for neither of these wells, but the owners opined that the groundwater quality is "good" on their permit documents, and that is consistent with what one would expect from this aquifer.

Conclusions:

1. There is a high likelihood of developing groundwater supplies on the order of 5 - 10 gpm from the Ogallala Formation in this area.

2. A well depth on the order of 250 feet should be sufficient, 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 static depth-to-water around 200 feet is expected. A pump setting at least 40 feet below the static water level is recommended to accommodate in-well drawdown, interference drawdown from nearby wells, and long-term water level fluctuations.

4. Although hydrogeologic conditions may vary over short distances, those variations are not predictable in this area. Thus, exact site selection may be guided by surface convenience within this general area.

5. Groundwater quality at this location is likely adequate for stock and domestic use.

6. 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.

Watershed Plan Component: **L/W-002**
Project Name: **Berry Well Construction Project No. 2**
Project Sponsor/Number: **Berry 002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,150
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		$ -
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 34,650
	Contingencies (15% of subtotal)				$ 5,198
	Engineering and technical assistance (10% of subtotal)				$ 3,465
	Estimated project cost				$ 43,313

L/W-003: Berry Well Construction Project (Berry-003)

The proposed project would entail installation of a solar platform/pump in an existing well.

Project components would include:

- Installing one 1,200-gallon rubber tire stock tanks
- Installing a new well approximately 250 feet deep.
- Installing new solar platform, pump and requisite fittings in the new well.

Project Location:

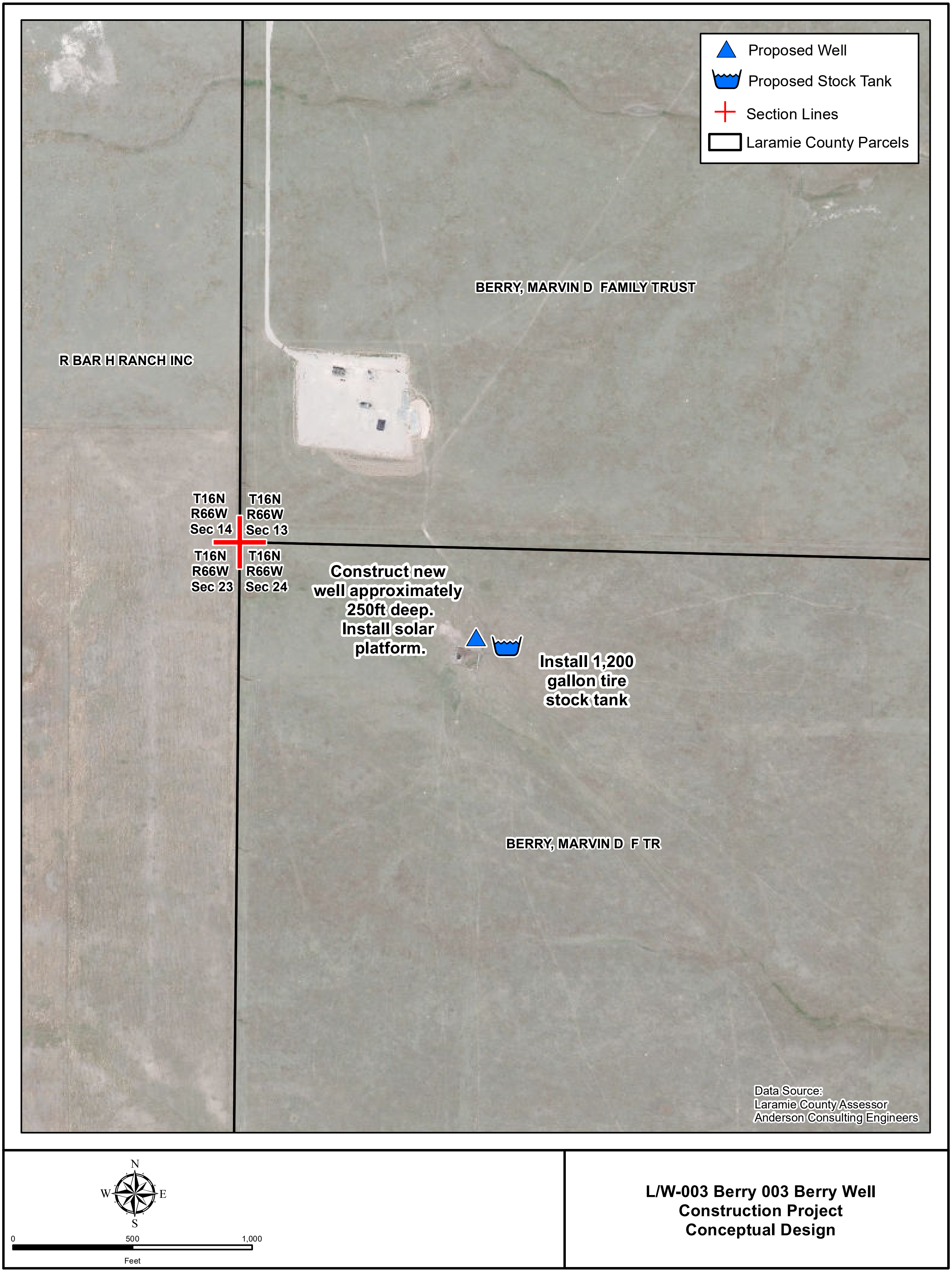
- Section 24, Township 16 North, Range 66 West

Land Ownership (Surface):

- Private

Water Source:

- New well



L/W-003 Berry 003 Berry Well
Construction Project
Conceptual Design

Watershed Plan Component: **L/W-003**
Project Name: **Berry Well Rehabilitation Project**
Project Sponsor/Number: **Berry 003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,180
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 34,980
	Contingencies (15% of subtotal)				$ 5,247
	Engineering and technical assistance (10% of subtotal)				$ 3,498
	Estimated project cost				$ 43,725

L/W-004: Borchardt Solar Platform Installation (Borchardt-001)

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:

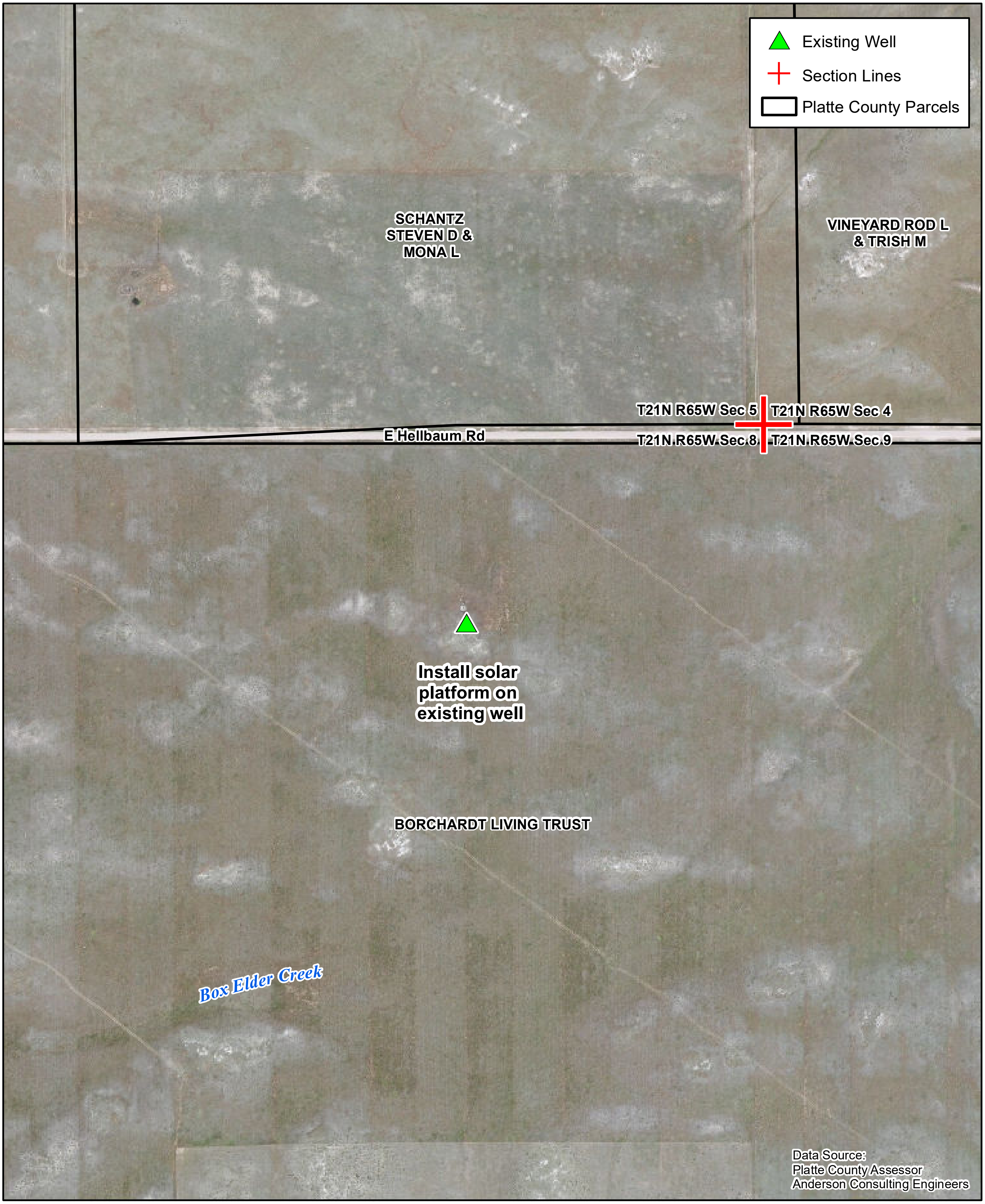
- Section 8, Township 21 North, Range 65 West

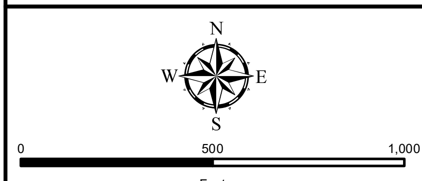
Land Ownership (Surface):

- Private

Water Source:

- Existing well





L/W-004 Borchardt 001
Borchardt Solar
Platform Installation
Conceptual Design

Watershed Plan Component: **L/W-004**
Project Name: **Borchardt Solar Platform Installation**
Project Sponsor/Number: **Borchardt-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,200
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 13,200
	Contingencies (15% of subtotal)				$ 1,980
	Engineering and technical assistance (10% of subtotal)				$ 1,320
	Estimated project cost				$ 16,500

L/W-005: Borchardt Pipeline Extension Project (Borchardt-002)

This project involves extending a buried pipeline system to provide additional reliable water sources for wildlife and livestock. Currently, an existing well provides water to several stock tanks in the area. By adding several short buried pipeline extensions, the landowner can provide water in several additional pastures and optimize the grazing management plan.

Project components would include:

- Installing three additional 1 ½ buried HDPE pipelines:
  - 1,500 linear feet
  - 2,600 linear feet
  - 1,900 linear feet
- Installing three 1,200 gallon rubber tire stock tanks

Project Location:

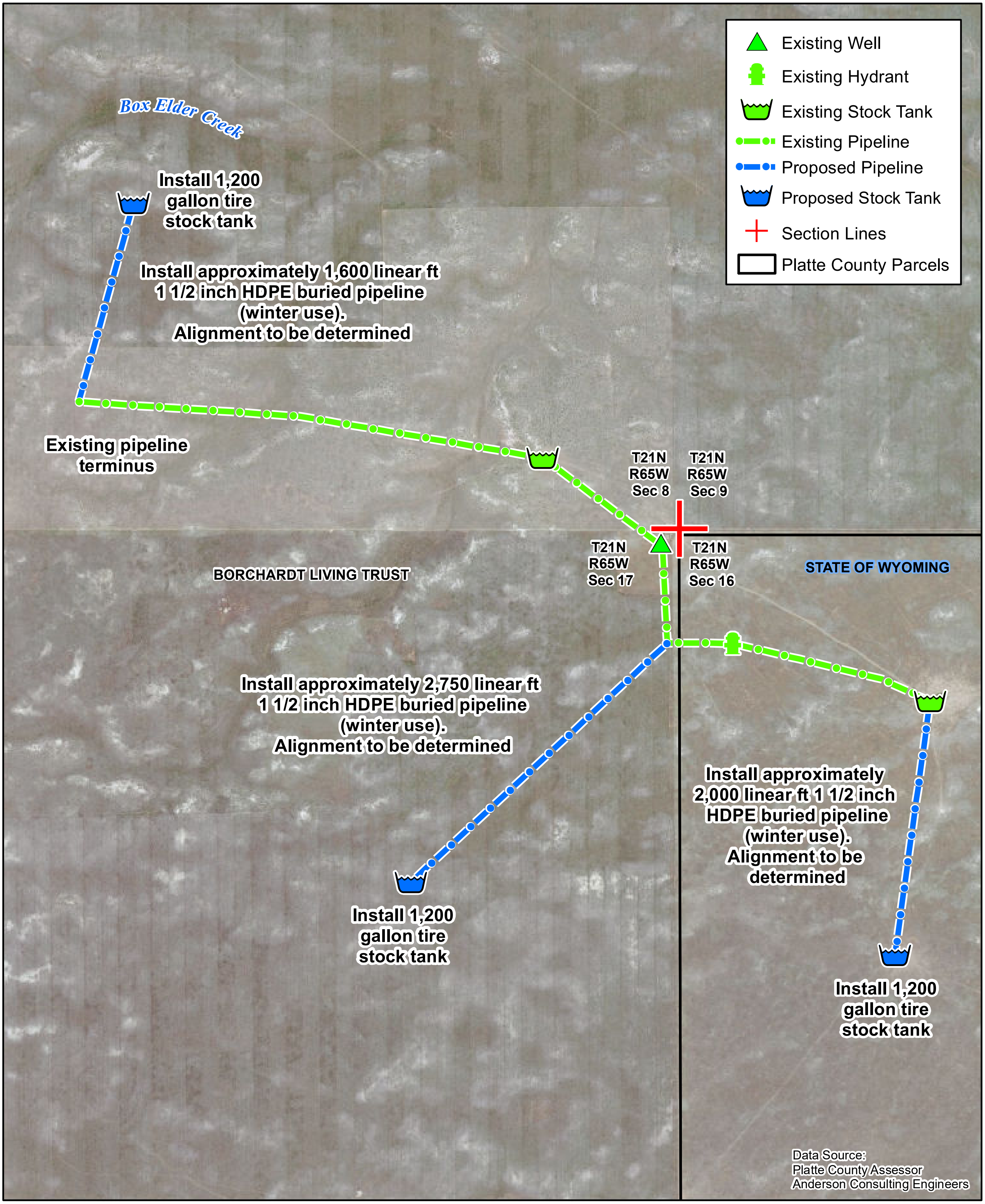
- Sections 8, 16 and 17, Township 21 North, Range 65 West

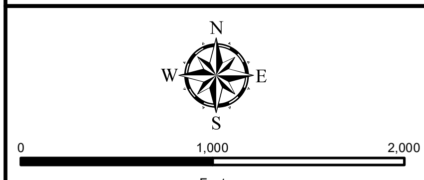
Land Ownership (Surface):

- Private

Water Source:

- Existing well





L/W-005 Borchardt 002
Borchardt Pipeline
Extension Project
Conceptual Design

Watershed Plan Component: **L/W-005**
Project Name: **Borchardt Pipeline Extension Project**
Project Sponsor/Number: **Borchardt-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,850
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	3	$ 10,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	6000	$ 18,000
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 31,350
	Contingencies (15% of subtotal)				$ 4,703
	Engineering and technical assistance (10% of subtotal)				$ 3,135
	Estimated project cost				$ 39,188

L/W-006: Borchardt Stock Tank Project (Borchardt-003)

This project involves extending a buried pipeline from an existing well to provide a reliable source of livestock and wildlife water in an area without alternate sources.

Project components would include:

- Installing approximately 650 linear feet of 1 ½ buried HDPE pipeline
- Installing one 1,200 gallon rubber tire stock tank
-

Project Location:

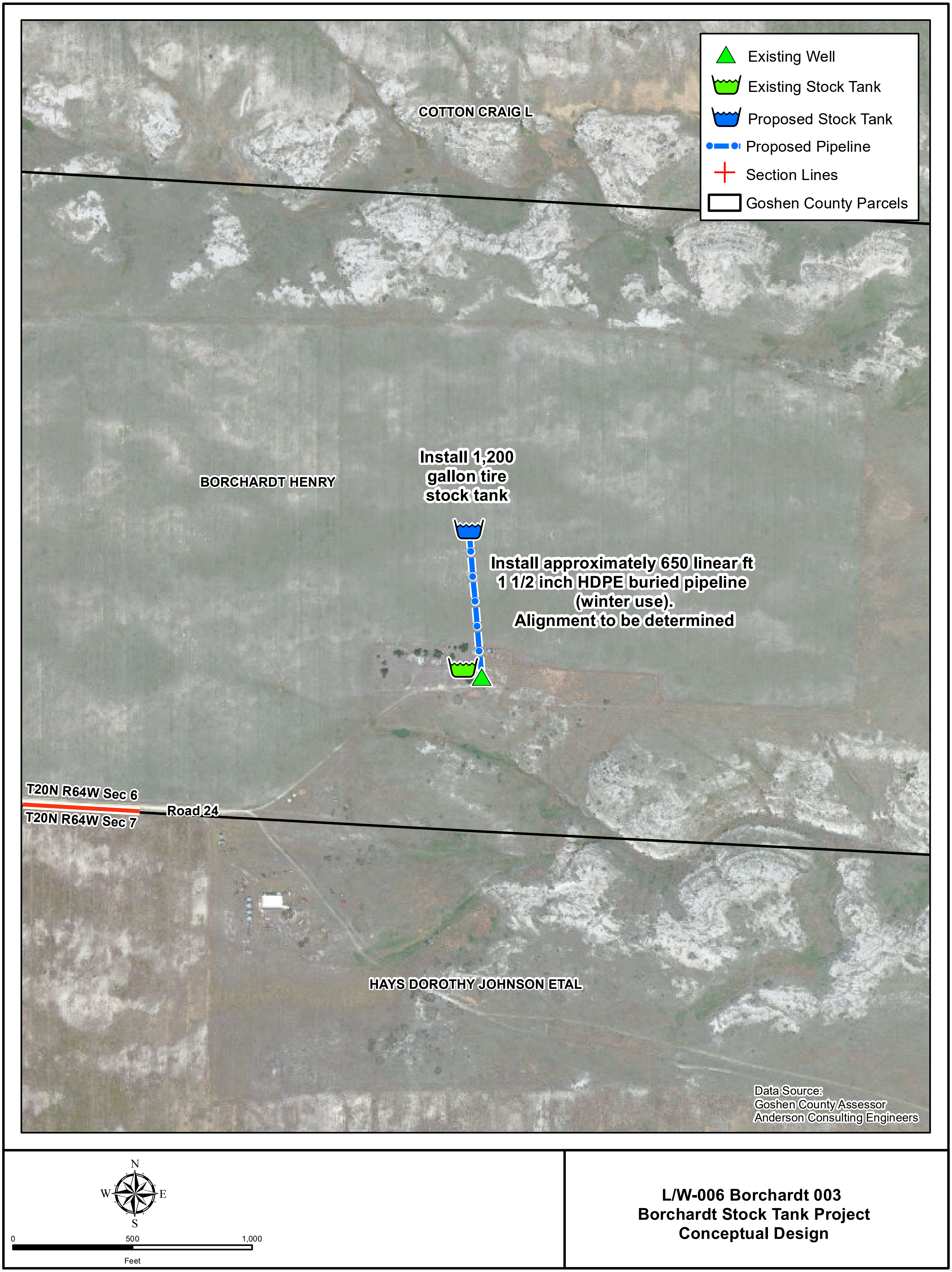
- Section 6, Township 20 North, Range 64 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-006 Borchardt 003
Borchardt Stock Tank Project
Conceptual Design

Watershed Plan Component: **L/W-006**
Project Name: **Borchardt Stock Tank Project**
Project Sponsor/Number: **Borchardt-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 545
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	650	$ 1,950
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 5,995
	Contingencies (15% of subtotal)				$ 899
	Engineering and technical assistance (10% of subtotal)				$ 600
	Estimated project cost				$ 7,494

L/W-007: Borchardt Spring Development Project (Borchardt-004)

The proposed project would involve development of an existing spring.

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 spring development system.
- Installing 1,200-gallon rubber tire stock tank
- Installing approximately 250 LF of 1.5" diameter buried HDPE pipeline
-

Project Location:

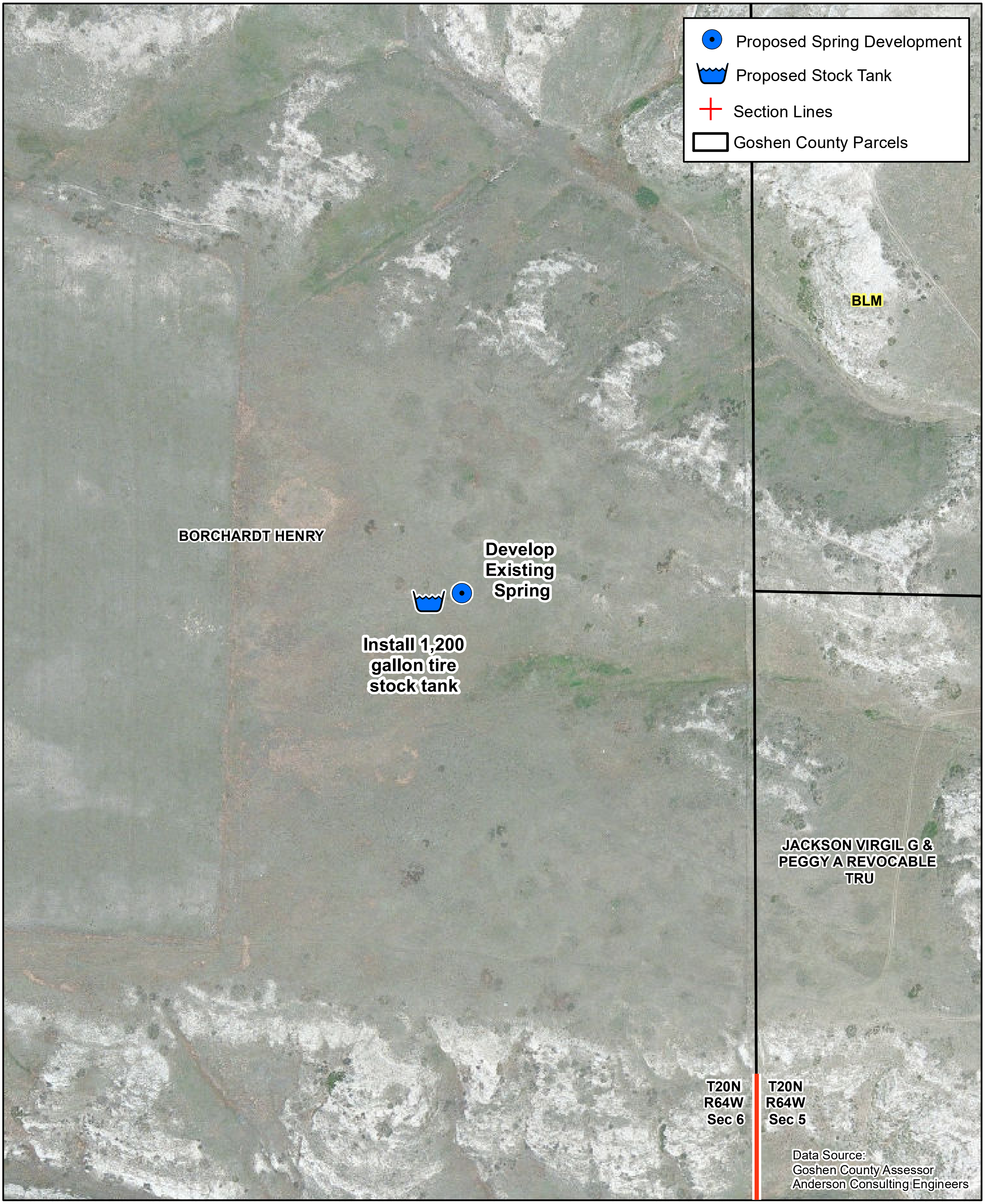
- Section 6, Township 20 North, Range 64 West

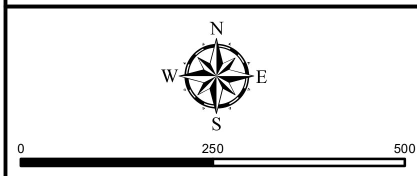
Land Ownership (Surface):

- Private

Water Source:

- Existing spring





L/W-007 Borchardt 004
Borchardt Spring
Development Project
Conceptual Design

Watershed Plan Component: **L/W-007**
Project Name: **Borchardt Spring Development Project**
Project Sponsor/Number: **Borchardt-004**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 925
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 10,175
	Contingencies (15% of subtotal)				$ 1,526
	Engineering and technical assistance (10% of subtotal)				$ 1,018
	Estimated project cost				$ 12,719

L/W-008: Buchaults Pipeline Project (Buchaults-001)

This project involves extending a buried pipeline from an existing well to provide a reliable source of livestock and wildlife water in an area as an alternative to the Horse Creek riparian zone.

Project components would include:

- Installing approximately 3,500 linear feet of 1 ½ buried HDPE pipeline
- Installing one 1,200 gallon rubber tire stock tank

Project Location:

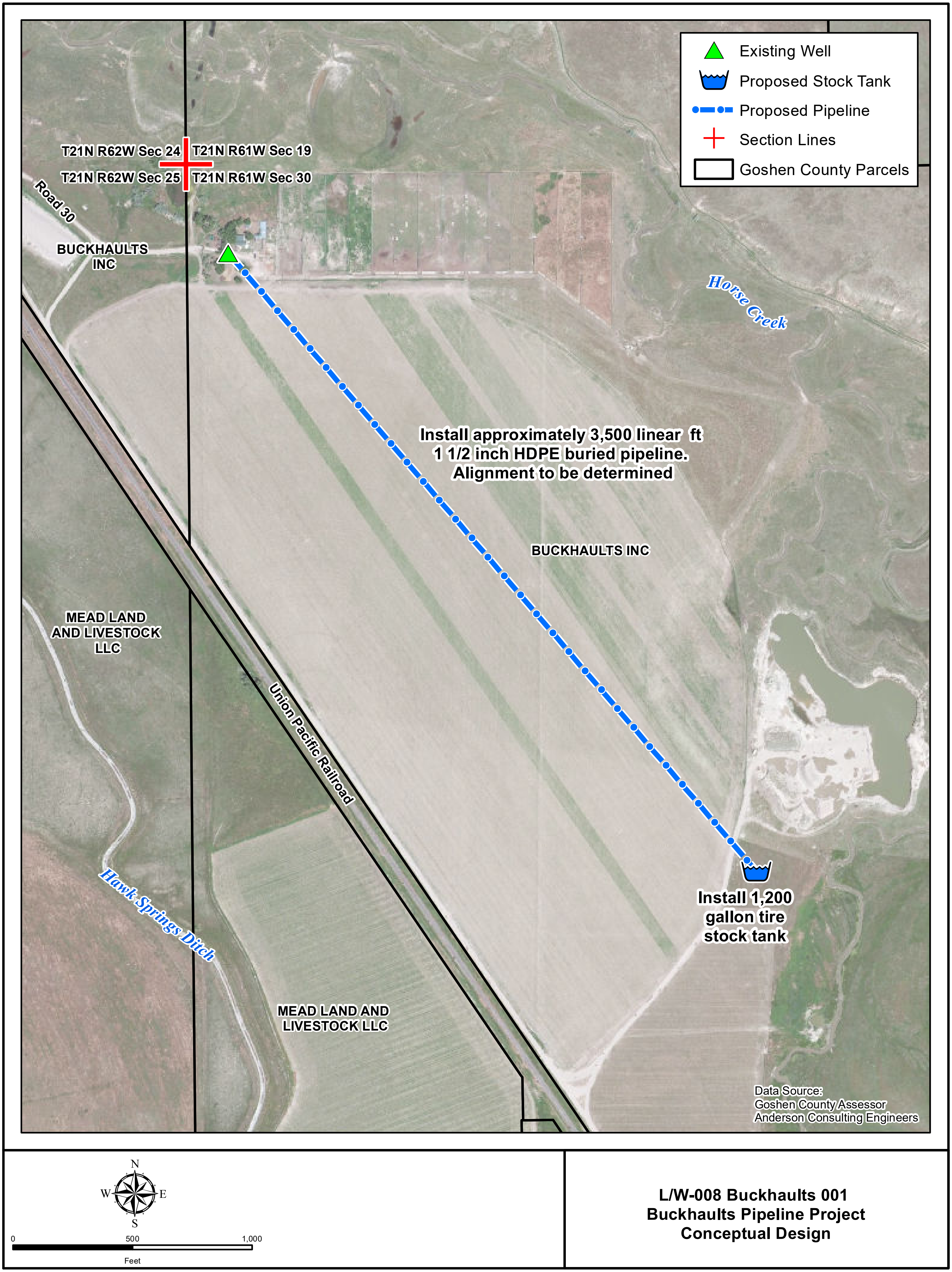
Section 30, Township 21 North, Range 61 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-008 Buckhaults 001
Buckhaults Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-008**
Project Name: **Buchaults Pipeline Project**
Project Sponsor/Number: **Buchaults-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,400
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	1	$ 3,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	3500	$ 10,500
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 15,400
	Contingencies (15% of subtotal)				$ 2,310
	Engineering and technical assistance (10% of subtotal)				$ 1,540
	Estimated project cost				$ 19,250

L/W-009: Cecil Well Construction Project (Cecil-001)

This project would involve construction of a new well, buried pipeline, and stock tank. Construction of the project would provide a reliable source of water for wildlife and livestock as well as facilitating greater grazing management opportunity.

Project components would include:

- Constructing a new well approximately 200 feet deep.
- Installing approximately 2,800 linear feet of buried 1 ½ inch HDPE pipeline
- Installing one 1,200 rubber tire stock tank

Project Location:

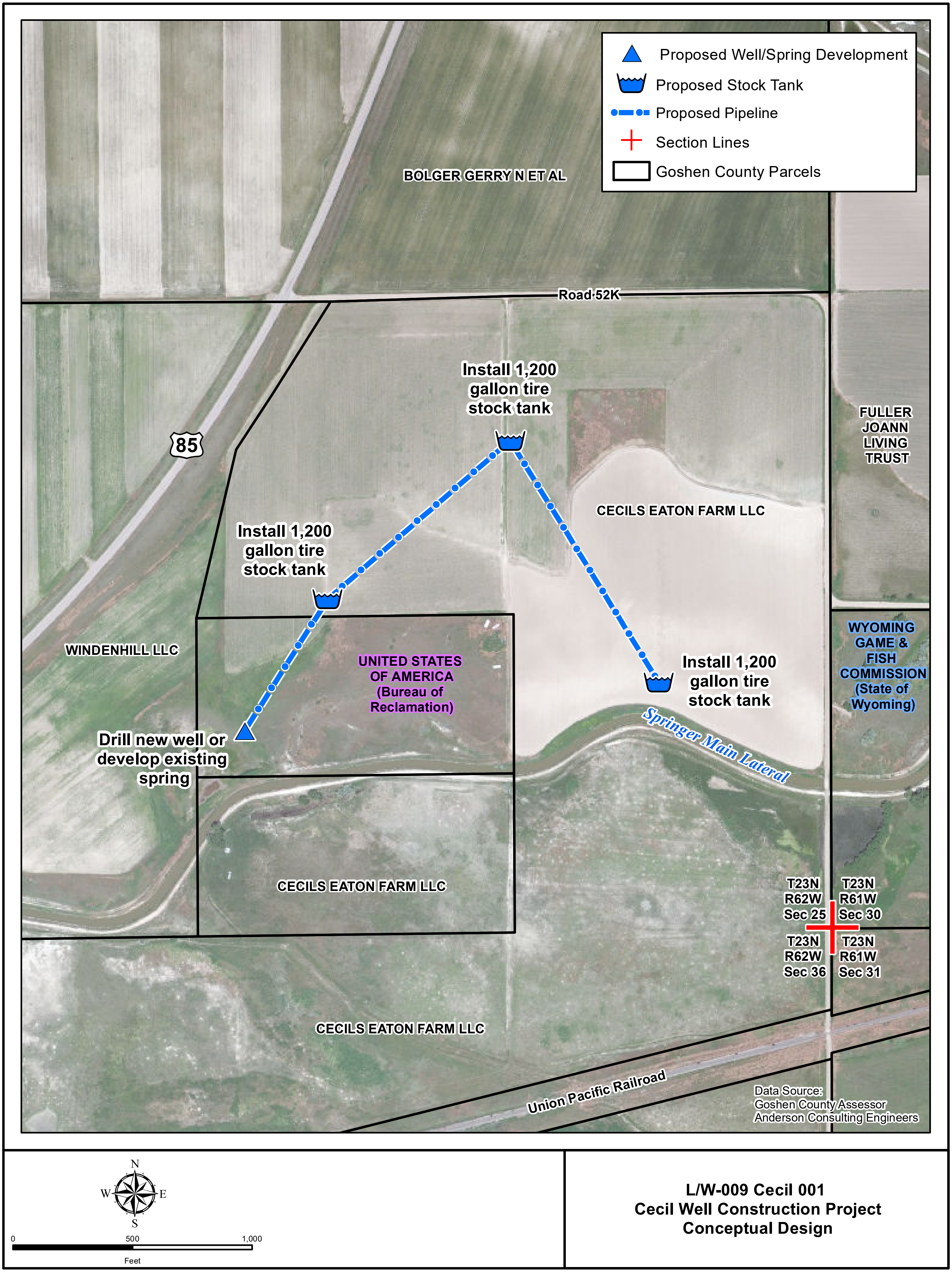
- Section 25, Township 23 North, Range 62 West

Land Ownership (Surface):

- Bureau of Reclamation
- Private

Water Source:

- New well



L/W-009 Cecil 001
Cecil Well Construction Project
Conceptual Design

Hydrogeologic Report: Cecil-001 & 002

The Cecil-001 site is located in T23N, R62W, Sec. 25; the Cecil-002 site is nearby, in T23N, R61W, Sec. 31. The sites are about 2 miles northeast of Yoder, at approximate elevations 4247 and 4232 feet, respectively.

The prospective wells are in an area of active surface-water irrigation, along the Springer Main Lateral of the Gering-Ft. Laramie Canal. Bedrock at the site is the Chadron Member of the White River Formation, which is typically a poor groundwater producer with marginal groundwater quality.

There are 12 existing groundwater permits in this area. See the attached figure for locations[1].

Permit[2]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
30256	John Gronewold	25	10	35
108068	Bob Cottier	25	30	105
23281	A. F. Vorphal	15	20	100
23282	A. F. Vorphal	5 - 10	4	18
19494	Kenneth Kennedy	15	Unknown	100
83064	Dayton Raben	15	99	184
10937	Roy Raben	10	36	180

[1]The location of the prospective well is accurate; the locations of the State Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[2]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

33955	Keith Newman	20		24		38	
84025	Charlotte Johnson		14		14.5	120	
23277	Peter Vorphal		17		20		120
29562	Donald Clapp		25		18		100
29538	Donald Clapp		5		25		50

The location, depth, and depth-to-water suggest permits #30256 and #23282 have simply captured a local, shallow accumulation of irrigation water. (No details on the material are available.)

Permit #29538 also fits the pattern of a shallow aquifer recharged by local sources, underlain by bedrock clay layers in the Chadron. Although this well was 50 feet deep, the log documents that the lower 23 feet are clay and that the groundwater production is from sand and gravel deposits from 20 to 27 feet. Permit #33955 also found a productive gravel between 20 and 38 feet in depth.

Permit #108068 was reportedly completed in a layer of “coarse sand” between 78 and 105 feet, beneath 53 feet of clay. This well is more indicative of conditions in the Chadron aquifer, and indicates a static water level elevation in that stratum at approximately 4200 feet.

Permits #83064 and #10937 were drilled near one another, to similar depth. Stratigraphic data are provided only for #83064, i.e. completed in a “gray sandstone” from 164 to 182 ft., beneath 100 feet of clay and shale. (The test for this well indicated a production (specific capacity) of 0.2 gpm per foot of drawdown.) Comparison with #108068 suggests either two distinct water-bearing zones at depth, or a single zone that dips slightly (0.5 degrees) toward the northeast.

The limited information available for #23281 and #23277 - depth and water level - suggest a similar situation there, i.e. a modestly productive stratum at depth.

All of those well owners who opined on groundwater quality felt the quality was “good”, i.e. for the intended use of watering stock. Evaluation of Chadron groundwater as a drinking water supply for the Town of Yoder, found it to exceed standards for Total Dissolved Solids, sodium, and uranium, and the sodium adsorption ratio (SAR) was found to be high for irrigation use.

Conclusions:

1. There appear to be two potential aquifers in the Cecil well prospects area: 1) a shallow (less than 40 feet) gravel stratum; and 2) a deeper (100 - 200 feet) stratum of sand and gravel within the clay layers of the Chadron Formation. The former is likely to be the more productive, but is also likely to be less widespread. The latter is likely less productive (but still sufficient for livestock use), but, being deeper, provides opportunity for additional drawdown.

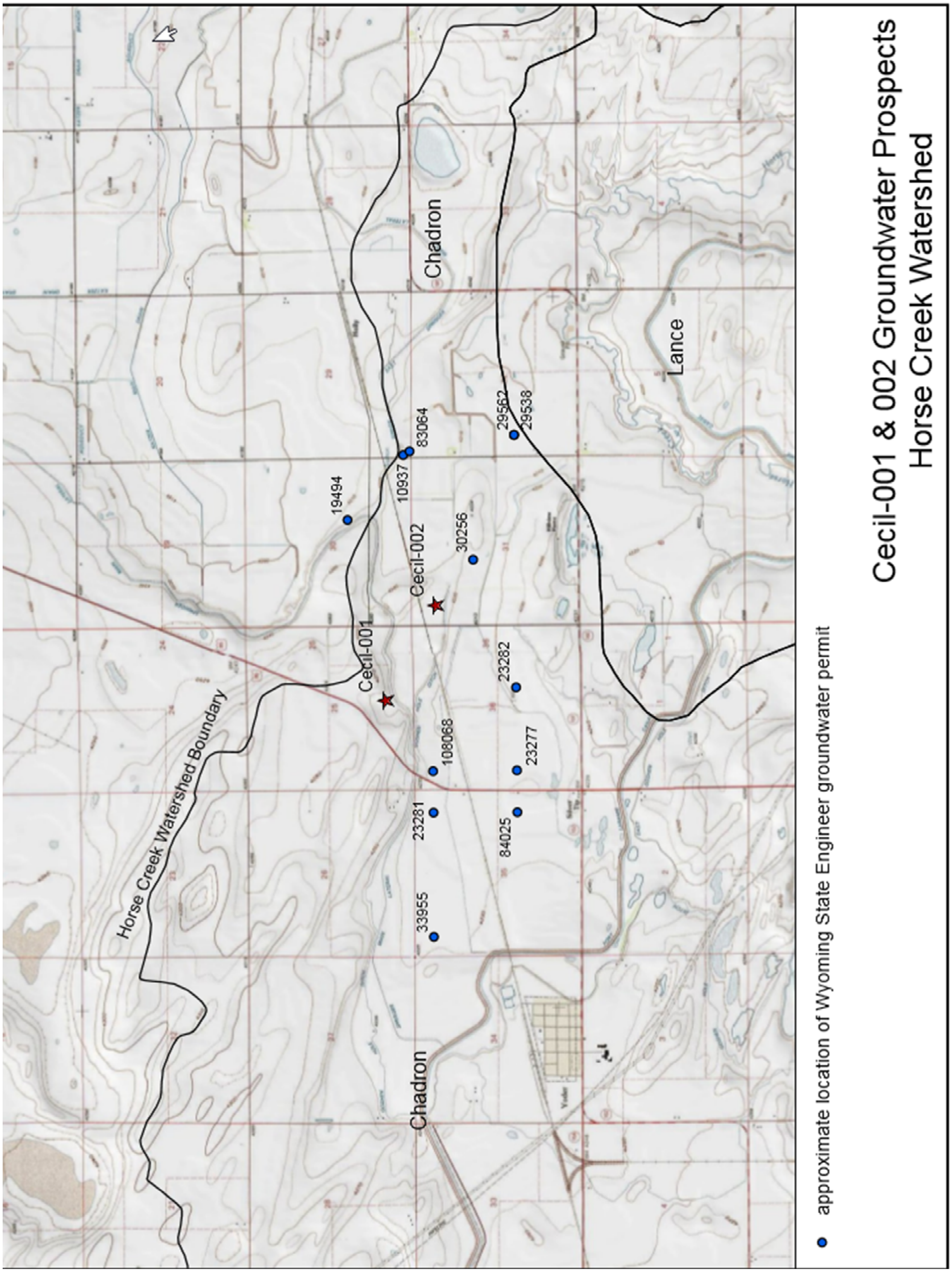
2. An effective development strategy may be to make careful observations during drilling to assess the presence of a shallow aquifer, and in the absence of such evidence, continue drilling to potentially encounter the deeper aquifer.

3. Groundwater quality at this location is unlikely to be high, but appears to have been found adequate for stock use.

4. Although hydrogeologic conditions may vary substantially over short distances in these strata, those variations are insufficiently understood to provide detailed siting criteria. Precise well locations should be governed by access and engineering convenience.

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.

Horse Creek Watershed Study
Appendix 6A



Watershed Plan Component: **L/W-009**
Project Name: **Cecil Well Construction Project**
Project Sponsor/Number: **Cecil-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,960
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	200	$ 10,000
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	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	2800	$ 8,400
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5	120	$ 600
8b	12' wire gate	LS	$ 600	1	$ 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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 32,560
	Contingencies (15% of subtotal)				$ 4,884
	Engineering and technical assistance (10% of subtotal)				$ 3,256
	Estimated project cost				$ 40,700

L/W-010: Cecil Pipeline Project No. 1 (Cecil-002)

This project would involve construction of a new well, buried pipeline, and stock tank. Construction of the project would provide a reliable source of water for wildlife and livestock as well as facilitating greater grazing management opportunity.

Project components would include:

- Constructing a new well approximately 200 feet deep.
- Installing approximately 5,100 linear feet of buried 1 ½ inch HDPE pipeline
- Installing two 1,200 rubber tire stock tanks
- Consent from Wyoming Game and Fish may be required depending upon the final alignment design of the pipeline

Project Location:

- Section 36, Township 23 North, Range 62 West
- Sections 30 and 31, Township 23 North, Range 61 West

Land Ownership (Surface):

- Private
- Wyoming Game and Fish

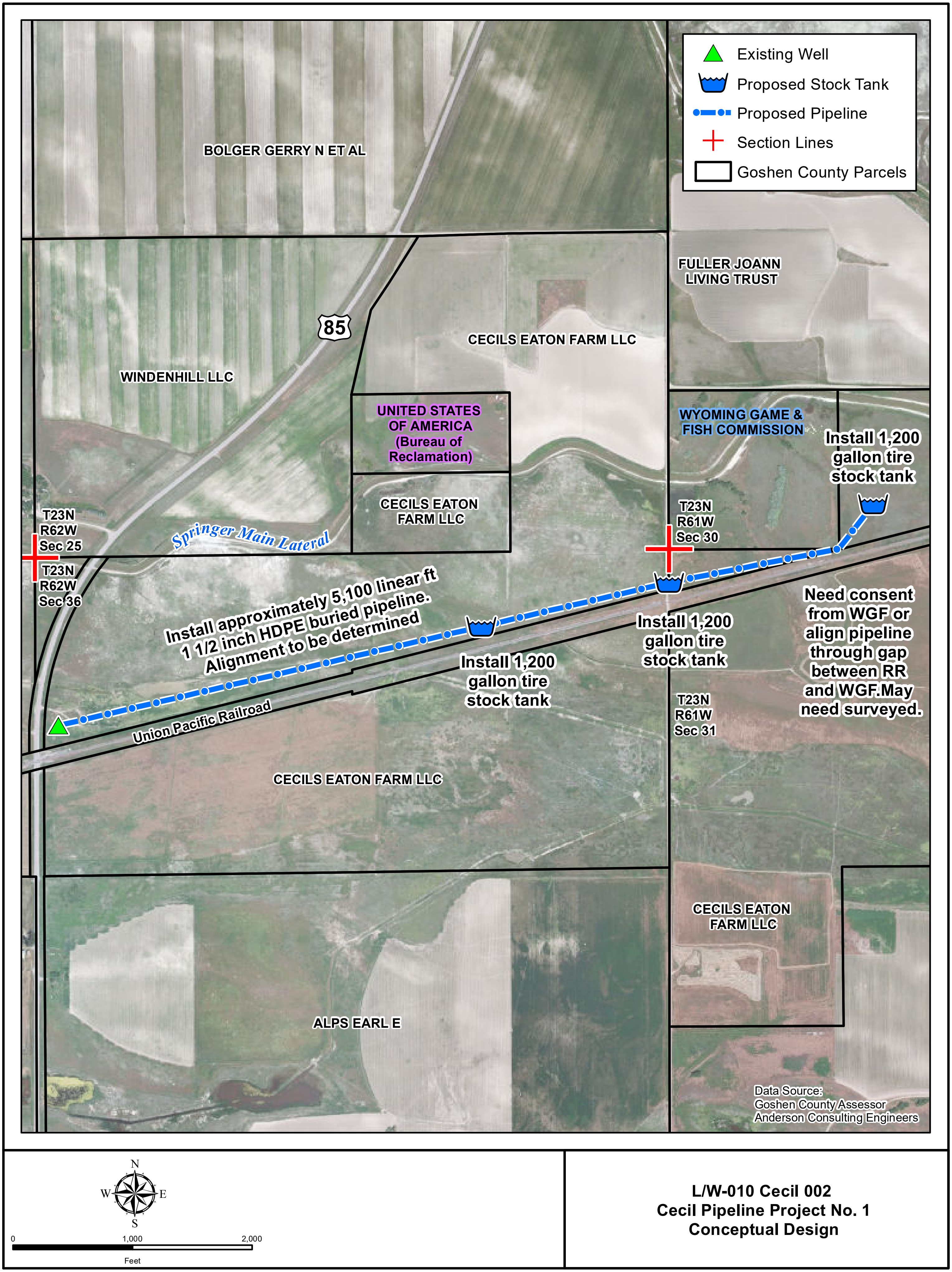
Water Source:

- New Well

Hydrogeologic Report: Cecil-001 & 002

The Cecil-001 site is located in T23N, R62W, Sec. 25; the Cecil-002 site is nearby, in T23N, R61W, Sec. 31. The sites are about 2 miles northeast of Yoder, at approximate elevations 4247 and 4232 feet, respectively.

The prospective wells are in an area of active surface-water irrigation, along the Springer Main Lateral of the Gering-Ft. Laramie Canal. Bedrock at the site is the Chadron Member of the White River Formation, which is typically a poor groundwater producer with marginal groundwater quality.



L/W-010 Cecil 002
Cecil Pipeline Project No. 1
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

There are 12 existing groundwater permits in this area. See the attached figure for locations[1].

Permit[2]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
30256	John Gronewold	25	10	35
108068	Bob Cottier	25	30	105
23281	A. F. Vorphal	15	20	100
23282	A. F. Vorphal	5 - 10	4	18
19494	Kenneth Kennedy	15	Unknown	100
83064	Dayton Raben	15	99	184
10937	Roy Raben	10	36	180
33955	Keith Newman	20	24	38
84025	Charlotte Johnson	14	14.5	120
23277	Peter Vorphal	17	20	120
29562	Donald Clapp	25	18	100
29538	Donald Clapp	5	25	50

The location, depth, and depth-to-water suggest permits #30256 and #23282 have simply captured a local, shallow accumulation of irrigation water. (No details on the material are available.)

Permit #29538 also fits the pattern of a shallow aquifer recharged by local sources, underlain by bedrock clay layers in the Chadron. Although this well was 50 feet deep, the log documents that

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[1]The location of the prospective well is accurate; the locations of the State Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[2]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

the lower 23 feet are clay and that the groundwater production is from sand and gravel deposits from 20 to 27 feet. Permit #33955 also found a productive gravel between 20 and 38 feet in depth.

Permit #108068 was reportedly completed in a layer of "coarse sand" between 78 and 105 feet, beneath 53 feet of clay. This well is more indicative of conditions in the Chadron aquifer, and indicates a static water level elevation in that stratum at approximately 4200 feet.

Permits #83064 and #10937 were drilled near one another, to similar depth. Stratigraphic data are provided only for #83064, i.e. completed in a "gray sandstone" from 164 to 182 ft., beneath 100 feet of clay and shale. (The test for this well indicated a production (specific capacity) of 0.2 gpm per foot of drawdown.) Comparison with #108068 suggests either two distinct water-bearing zones at depth, or a single zone that dips slightly (0.5 degrees) toward the northeast.

The limited information available for #23281 and #23277 - depth and water level - suggest a similar situation there, i.e. a modestly productive stratum at depth.

All of those well owners who opined on groundwater quality felt the quality was "good", i.e. for the intended use of watering stock. Evaluation of Chadron groundwater as a drinking water supply for the Town of Yoder, found it to exceed standards for Total Dissolved Solids, sodium, and uranium, and the sodium adsorption ratio (SAR) was found to be high for irrigation use.

Conclusions:

1. There appear to be two potential aquifers in the Cecil well prospects area: 1) a shallow (less than 40 feet) gravel stratum; and 2) a deeper (100 - 200 feet) stratum of sand and gravel within the clay layers of the Chadron Formation. The former is likely to be the more productive, but is also likely to be less widespread. The latter is likely less productive (but still sufficient for livestock use), but, being deeper, provides opportunity for additional drawdown.

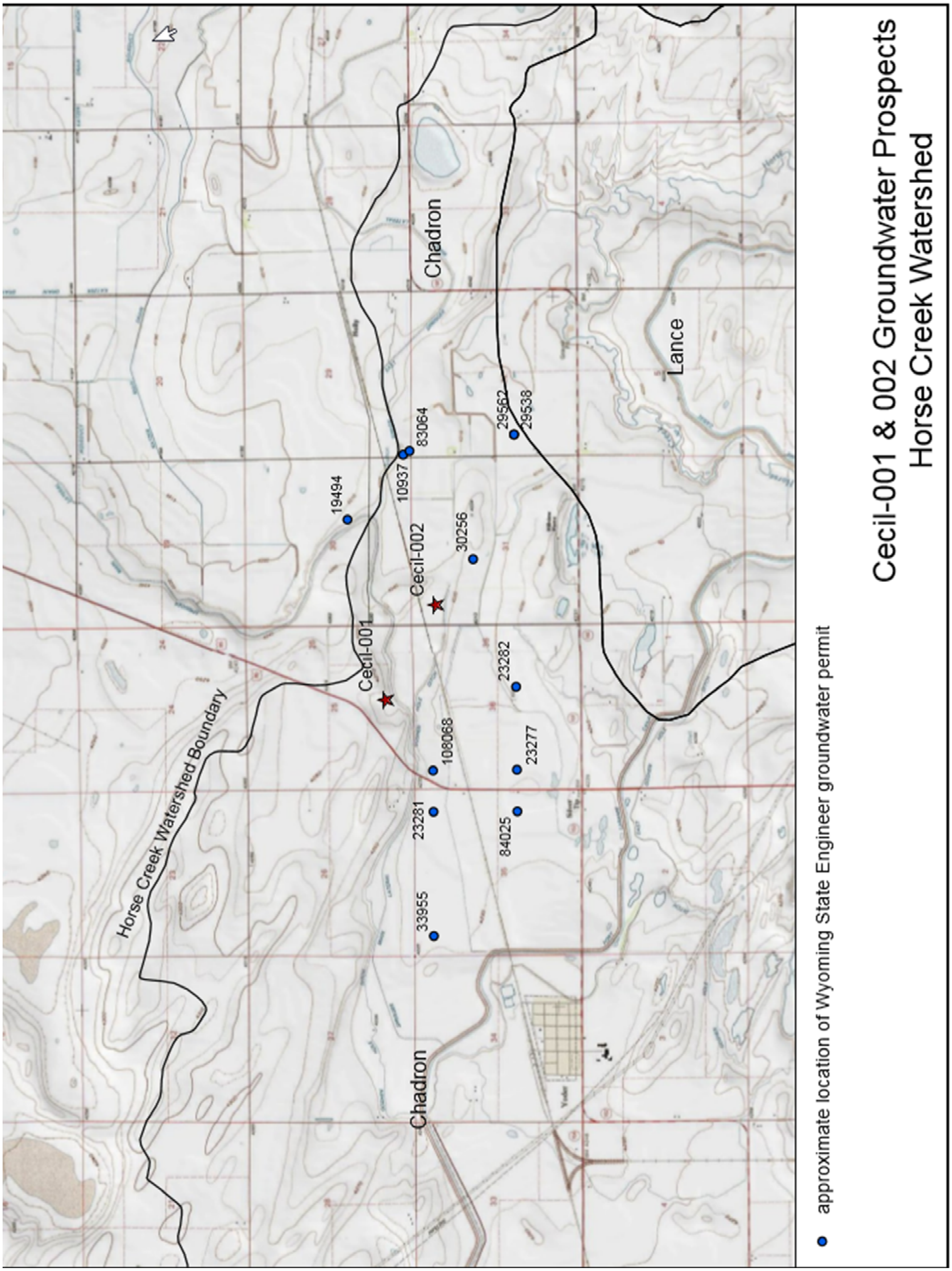
2. An effective development strategy may be to make careful observations during drilling to assess the presence of a shallow aquifer, and in the absence of such evidence, continue drilling to potentially encounter the deeper aquifer.

3. Groundwater quality at this location is unlikely to be high, but appears to have been found adequate for stock use.

4. Although hydrogeologic conditions may vary substantially over short distances in these strata, those variations are insufficiently understood to provide detailed siting criteria. Precise well locations should be governed by access and engineering convenience.

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.

Horse Creek Watershed Study
Appendix 6A



Watershed Plan Component: **L/W-010**
Project Name: **Cecil Pipeline Project No. 1**
Project Sponsor/Number: **Cecil-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,005
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	1	$ 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	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	2	$ 7,000
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	5100	$ 15,300
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5	120	$ 600
8b	12' wire gate	LS	$ 600	1	$ 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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 33,055
	Contingencies (15% of subtotal)				$ 4,958
	Engineering and technical assistance (10% of subtotal)				$ 3,306
	Estimated project cost				$ 41,319

L/W-011: Cecil Pipeline Project No. 2 (Cecil-003)

This project would involve construction of a new well, buried pipeline, and stock tank. Construction of the project would provide a reliable source of water for wildlife and livestock as well as facilitating greater grazing management opportunity.

Project components would include:

- Constructing a new well approximately 200 feet deep.
- Installing approximately 3,450 linear feet of buried 1 ½ inch HDPE pipeline
- Installing one 1,200 rubber tire stock tank

Project Location:

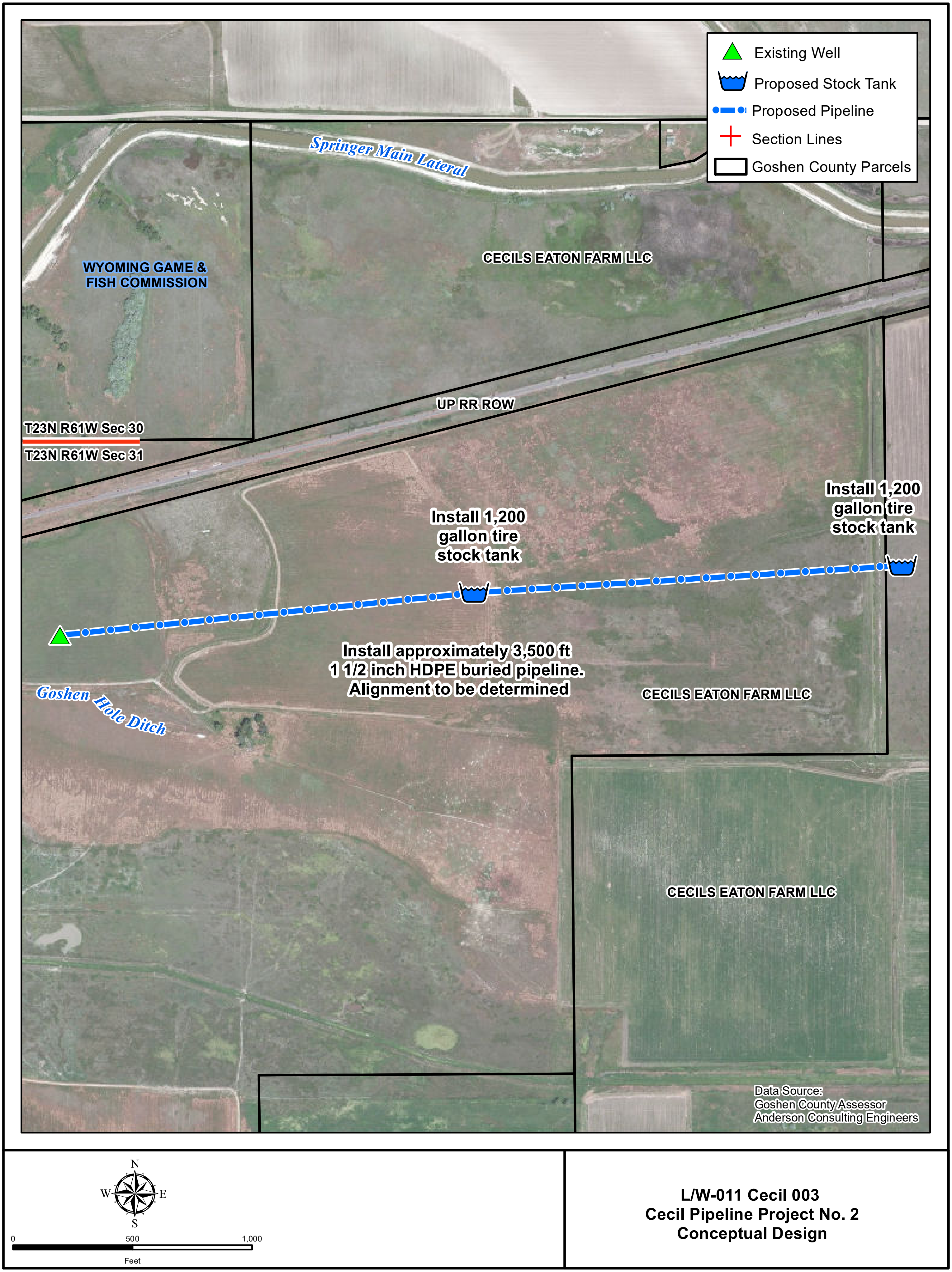
- Section 31, Township 23 North, Range 61 West

Land Ownership (Surface):

- Private

Water Source:

- New well



L/W-011 Cecil 003
Cecil Pipeline Project No. 2
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Hydrogeologic Report:

The Cecil-001 site is located in T23N, R62W, Sec. 25; the Cecil-002 site is nearby, in T23N, R61W, Sec. 31. The sites are about 2 miles northeast of Yoder, at approximate elevations 4247 and 4232 feet, respectively.

The prospective wells are in an area of active surface-water irrigation, along the Springer Main Lateral of the Gering-Ft. Laramie Canal. Bedrock at the site is the Chadron Member of the White River Formation, which is typically a poor groundwater producer with marginal groundwater quality.

There are 12 existing groundwater permits in this area. See the attached figure for locations[1].

Permit[2]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
30256	John Gronewold	25	10	35
108068	Bob Cottier	25	30	105
23281	A. F. Vorphal	15	20	100
23282	A. F. Vorphal	5 - 10	4	18
19494	Kenneth Kennedy	15	Unknown	100
83064	Dayton Raben	15	99	184
10937	Roy Raben	10	36	180
33955	Keith Newman	20	24	38

[1]The location of the prospective well is accurate; the locations of the State Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[2]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

84025	Charlotte Johnson	14	14.5	120
23277	Peter Vorphal	17	20	120
29562	Donald Clapp	25	18	100
29538	Donald Clapp	5	25	50

The location, depth, and depth-to-water suggest permits #30256 and #23282 have simply captured a local, shallow accumulation of irrigation water. (No details on the material are available.)

Permit #29538 also fits the pattern of a shallow aquifer recharged by local sources, underlain by bedrock clay layers in the Chadron. Although this well was 50 feet deep, the log documents that the lower 23 feet are clay and that the groundwater production is from sand and gravel deposits from 20 to 27 feet. Permit #33955 also found a productive gravel between 20 and 38 feet in depth.

Permit #108068 was reportedly completed in a layer of "coarse sand" between 78 and 105 feet, beneath 53 feet of clay. This well is more indicative of conditions in the Chadron aquifer, and indicates a static water level elevation in that stratum at approximately 4200 feet.

Permits #83064 and #10937 were drilled near one another, to similar depth. Stratigraphic data are provided only for #83064, i.e. completed in a "gray sandstone" from 164 to 182 ft., beneath 100 feet of clay and shale. (The test for this well indicated a production (specific capacity) of 0.2 gpm per foot of drawdown.) Comparison with #108068 suggests either two distinct water-bearing zones at depth, or a single zone that dips slightly (0.5 degrees) toward the northeast.

The limited information available for #23281 and #23277 - depth and water level - suggest a similar situation there, i.e. a modestly productive stratum at depth.

All of those well owners who opined on groundwater quality felt the quality was "good", i.e. for the intended use of watering stock. Evaluation of Chadron groundwater as a drinking water supply for the Town of Yoder, found it to exceed standards for Total Dissolved Solids, sodium, and uranium, and the sodium adsorption ratio (SAR) was found to be high for irrigation use.

Conclusions:

1. There appear to be two potential aquifers in the Cecil well prospects area: 1) a shallow (less than 40 feet) gravel stratum; and 2) a deeper (100 - 200 feet) stratum of sand and gravel within the clay layers of the Chadron Formation. The former is likely to be the more productive, but is also likely to be less widespread. The latter is likely less productive (but still sufficient for livestock use), but, being deeper, provides opportunity for additional drawdown.

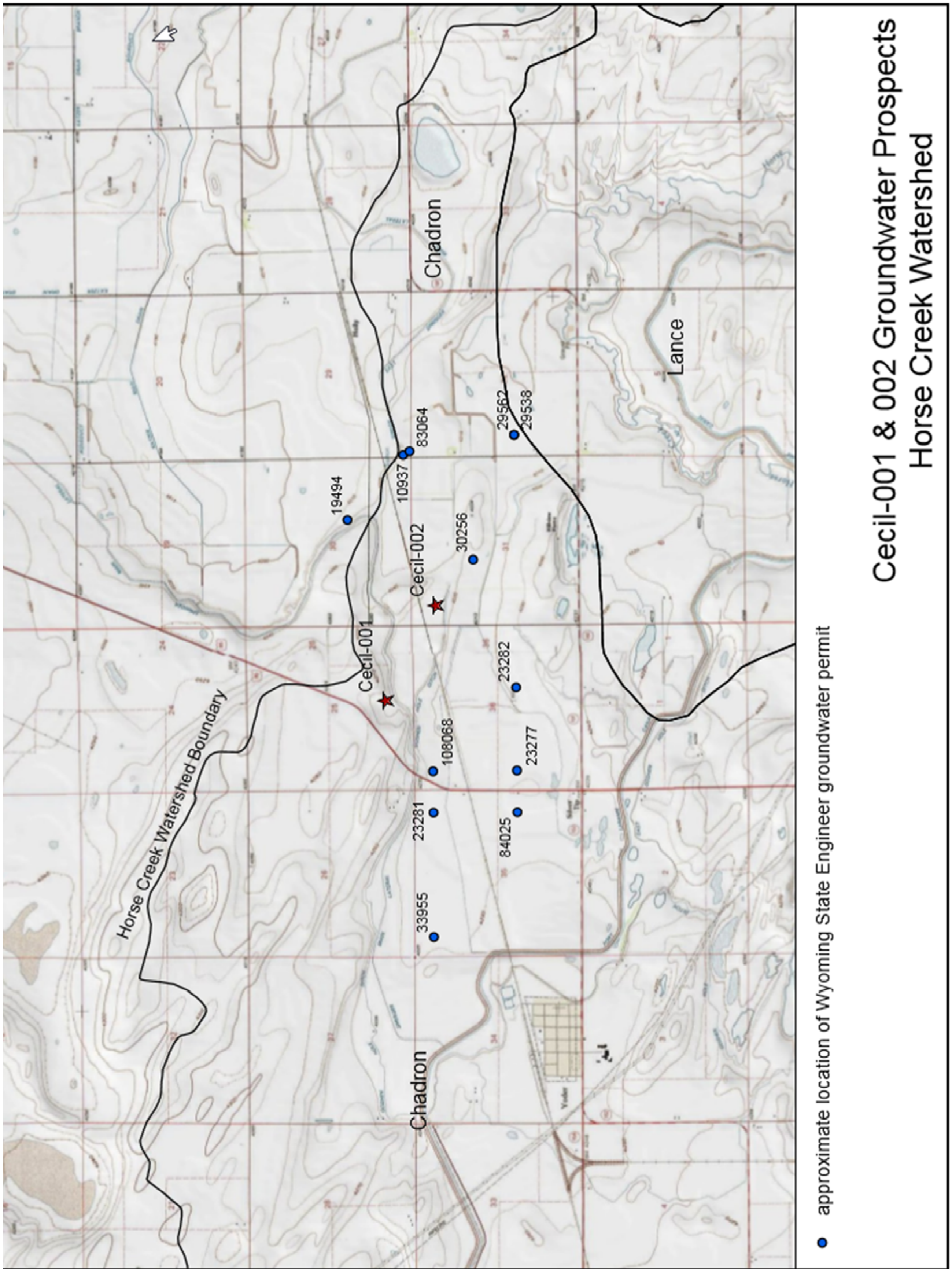
2. An effective development strategy may be to make careful observations during drilling to assess the presence of a shallow aquifer, and in the absence of such evidence, continue drilling to potentially encounter the deeper aquifer.

3. Groundwater quality at this location is unlikely to be high, but appears to have been found adequate for stock use.

4. Although hydrogeologic conditions may vary substantially over short distances in these strata, those variations are insufficiently understood to provide detailed siting criteria. Precise well locations should be governed by access and engineering convenience.

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.

Horse Creek Watershed Study
Appendix 6A



Watershed Plan Component: **L/W-011**
Project Name: **Cecil Pipeline Project No. 2**
Project Sponsor/Number: **Cecil-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,155
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	200	$ 10,000
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	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	3450	$ 10,350
7	Misc valves and piping at tank(s)	Ea	$ 500	1	$ 500
8a	3 Wire fence with wood posts	LF	$ 5	120	$ 600
8b	12' wire gate	LS	$ 600	1	$ 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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 34,705
	Contingencies (15% of subtotal)				$ 5,206
	Engineering and technical assistance (10% of subtotal)				$ 3,471
	Estimated project cost				$ 43,381

L/W-012: Chamberlain Pipeline Project (Chamberlain-001)

This project involves rehabilitation of an existing well, extending buried pipelines to several locations within the landowners pasture management system, and installation of several stock tanks. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Evaluation and possible rehabilitation of an existing well
- Installation of approximately 5,760 linear feet of buried HDPE pipeline
- Installation of three 1,200 rubber tire stock tanks

Project Location:

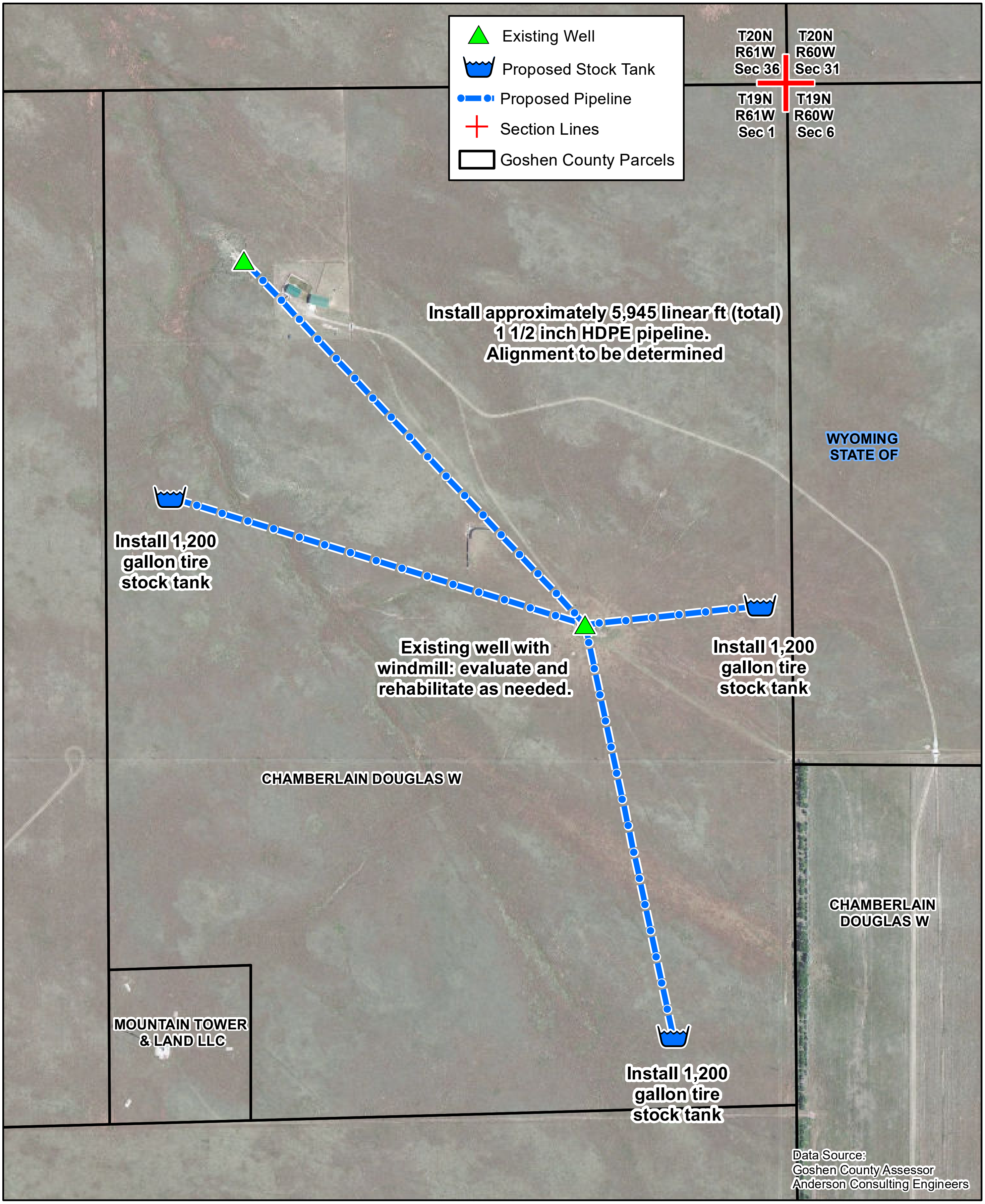
- Section 1, Township 19 North, Range 61 West

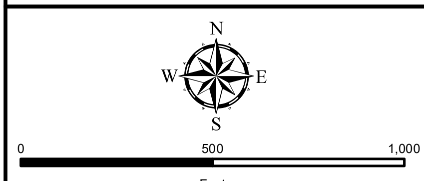
Land Ownership (Surface):

- Private

Water Source:

- Existing well





L/W-012 Chamberlain 001
Chamberlain Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-012**
Project Name: **Chamberlain Pipeline Project**
Project Sponsor/Number: **Chamberlain-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,778
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	3	$ 10,500
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	5760	$ 17,280
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 30,558
	Contingencies (15% of subtotal)				$ 4,584
	Engineering and technical assistance (10% of subtotal)				$ 3,056
	Estimated project cost				$ 38,198

L/W-013: Clark Well Construction (Clark-001)

This stock watering project will consist of drilling a new well run on a solar platform with the ability to incorporate a storage tank and allow for generator backup.

Project components would include:

- Installing a new well, approximately 360 feet deep
- Installing a solar platform/pump
- Installing approximately 50 linear feet of buried 1 ½ inch HDPE pipeline

Project Location:

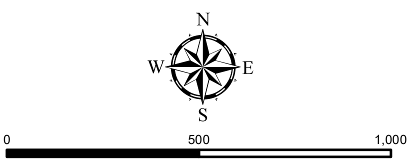
- Section 28, Township 17 North, Range 67 West

Land Ownership (Surface):

- Private

Water Source:

- New Well Construction



L/W-013 Clark 001
Clark Well Construction
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Hydrogeologic Report:

Clark-001

The Clark-001 site is located in T17N, R67W, Sec. 28, about 16 miles north of Cheyenne, at approximate elevation 6308 feet[1]. The surface formation at the site is the Ogallala, through which Horse Creek has cut through to expose the underlying Arikaree Formation downstream. The lithology of the two formations is such that the contact between the two is rarely clear in well logs, but in either formation groundwater production is a function of discontinuous coarse-grained strata rather than hitting a specific, known layer.

There are 9 existing groundwater permits in this area. See the attached figure for locations[2].

Permit[3]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
51403	Alfred Hume	25	flowing	6
51404	Alfred Hume	15	flowing	10
15378	Lewis Ranch Co.	5	100	220
15377	Lewis Ranch Co.	5		200
4805	Mary Moyers	7.5	3	20
4806	True Ranches, LLC	5	75	140
40634	Marilyn Cole	10	50	125
40633	Marilyn Cole	10	150	190

[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 Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[3]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

62175	WSEO	0	85	200

[62175 is a monitor well but water-bearing 85-180 ft and 180-340 ft (well log).]

Permits #51403 and #51404 are simply developed springs, at elevations of approximately 6155 and 6170 feet, respectively. These are likely the expression of groundwater moving downward through the Ogallala Formation encountering a less-permeable layer and then flowing laterally to discharge to the surface along the south slopes of the Horse Creek valley. The groundwater elevation at #15378 is 6180 feet based on the location, surface elevation, and depth-to-water, suggesting this as a consistent local water table.

On the far (SW) side of the Clark prospect, the apparent surface elevations and depths-to-water for permits #40634 and #40633 indicate a groundwater elevation of approximately 6280 feet. Thus, interpolation to the Clark site suggests an equivalent depth-to-water of approximately 60 feet.

The water-bearing unit developed at #15378 is described as “sand & gravel”, from 180 to 200 feet in depth. This stratum was also encountered in #15377, logged between 190 and 200 feet. The equivalent depth to this stratum at the Clark prospect would be 230 feet. However, the unit may not be that extensive, as the log from #62175 (a State Engineer’s Office monitor well) logged “silt” from 85 to 180 feet, and “clay” from 180 to 340 feet (although both were noted as “water bearing”).

Chemical analyses are not available for the neighboring wells, but the owners opined that the groundwater quality is “good” on their permit documents, and that is consistent with what one would expect from this aquifer.

Conclusions:

1. Groundwater production in these strata is a function of the accumulation from multiple, commonly discontinuous water-bearing zones. Thus, the deeper the well, the greater the chances of encountering sufficient water to meet objectives.

2. A depth-to-water of approximately 60 feet is indicated by the reported water levels of neighboring wells, adjusted for surface elevation.

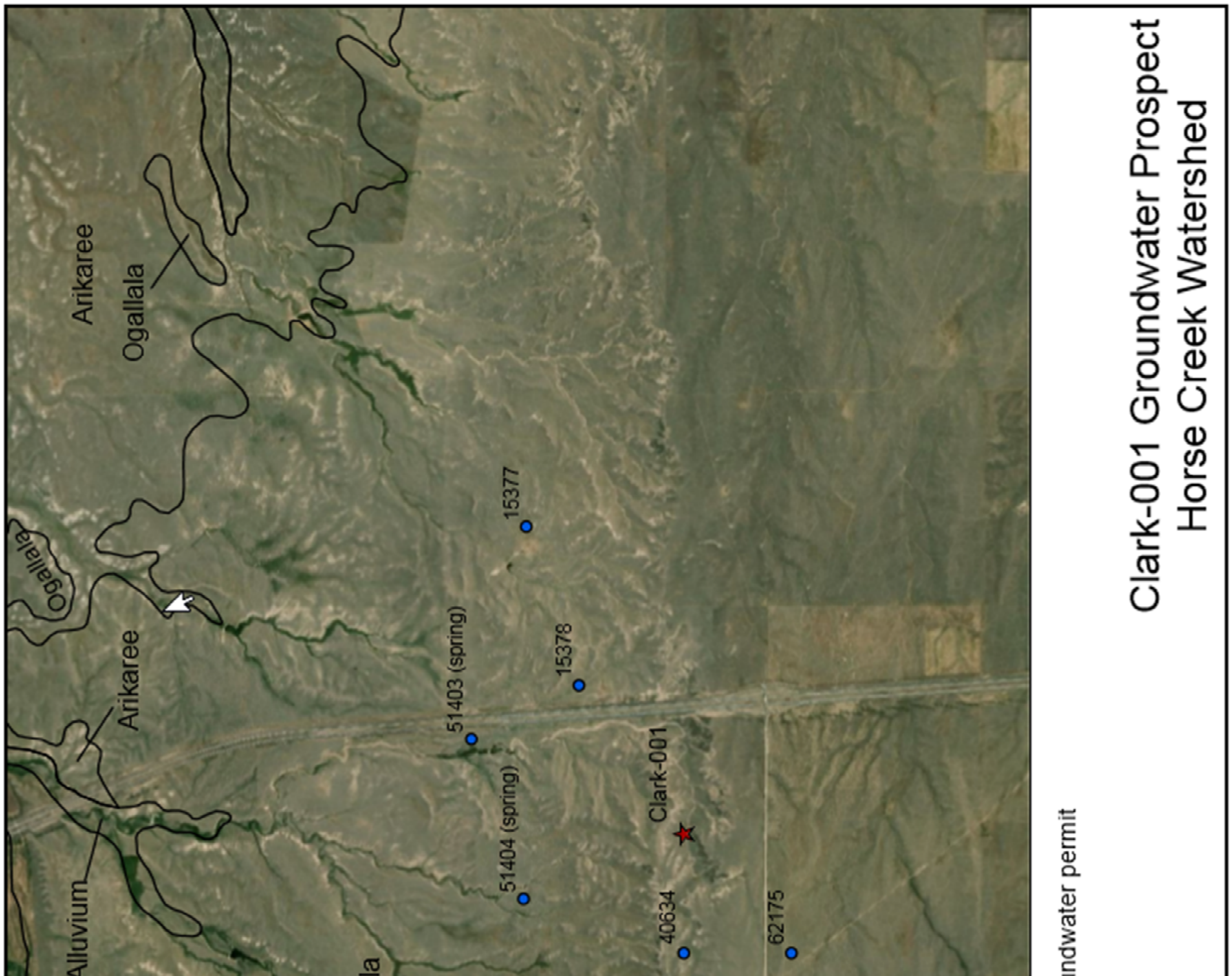
3. Drilling of least 120 feet beyond the expected groundwater level is recommended based on local experience. In the "North Cheyenne Study Area", the Wyoming State Engineer's Office requires new wells be drilled to a minimum depth of 160 ft. below the static water level to accommodate in-well drawdown, interference drawdown from nearby wells, and long-term water level fluctuations.

4. Thus, wells in this area should anticipate the need to drill on the order of 200 feet to provide secure production of 5 - 10 gpm.

5. Groundwater quality at this location is likely adequate for stock and domestic use.

6. Although hydrogeologic conditions may vary substantially over short distances in these strata, those variations are insufficiently understood to provide detailed siting criteria. Precise well locations should be governed by access and engineering convenience.

7. 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.


Clark-001 Groundwater Prospect
Horse Creek Watershed
approximate location of Wyoming State Engineer groundwater permit
Arikaree
Ogallala
Ogallala
Arikaree
Alluvium
Ogallala
Alluvium
Alluvium
15377
15378
51403 (spring)
51404 (spring)
Clark-001
40634
62175
40633
4805
4806

Watershed Plan Component: **L/W-013**
Project Name: **Clark Well Construction**
Project Sponsor/Number: **Clark-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,685
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	360	$ 18,000
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		$ -
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	50	$ 150
7	Misc valves and piping at tank(s)	Ea	$ 500	4	$ 2,000
8a	3 Wire fence with wood posts	LF	$ 5	120	$ 600
8b	12' wire gate	LS	$ 600	1	$ 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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 40,535
	Contingencies (15% of subtotal)				$ 6,080
	Engineering and technical assistance (10% of subtotal)				$ 4,054
	Estimated project cost				$ 50,669

L/W-014: Davis Stock Reservoir Rehabilitation (Davis-001)

This project would involve construction of a new stock reservoir to replace an existing reservoir filled with sediment. The location of the new reservoir would be immediately downstream of the existing reservoir. Upon completion, the new stock reservoir would provide a reliable source of livestock and wildlife water as an alternative to riparian sources.

Project components would include:

- Installing a new stock reservoir
- Incorporation of a reservoir outlet system such as the commercially available AgriDrain.

Project Location:

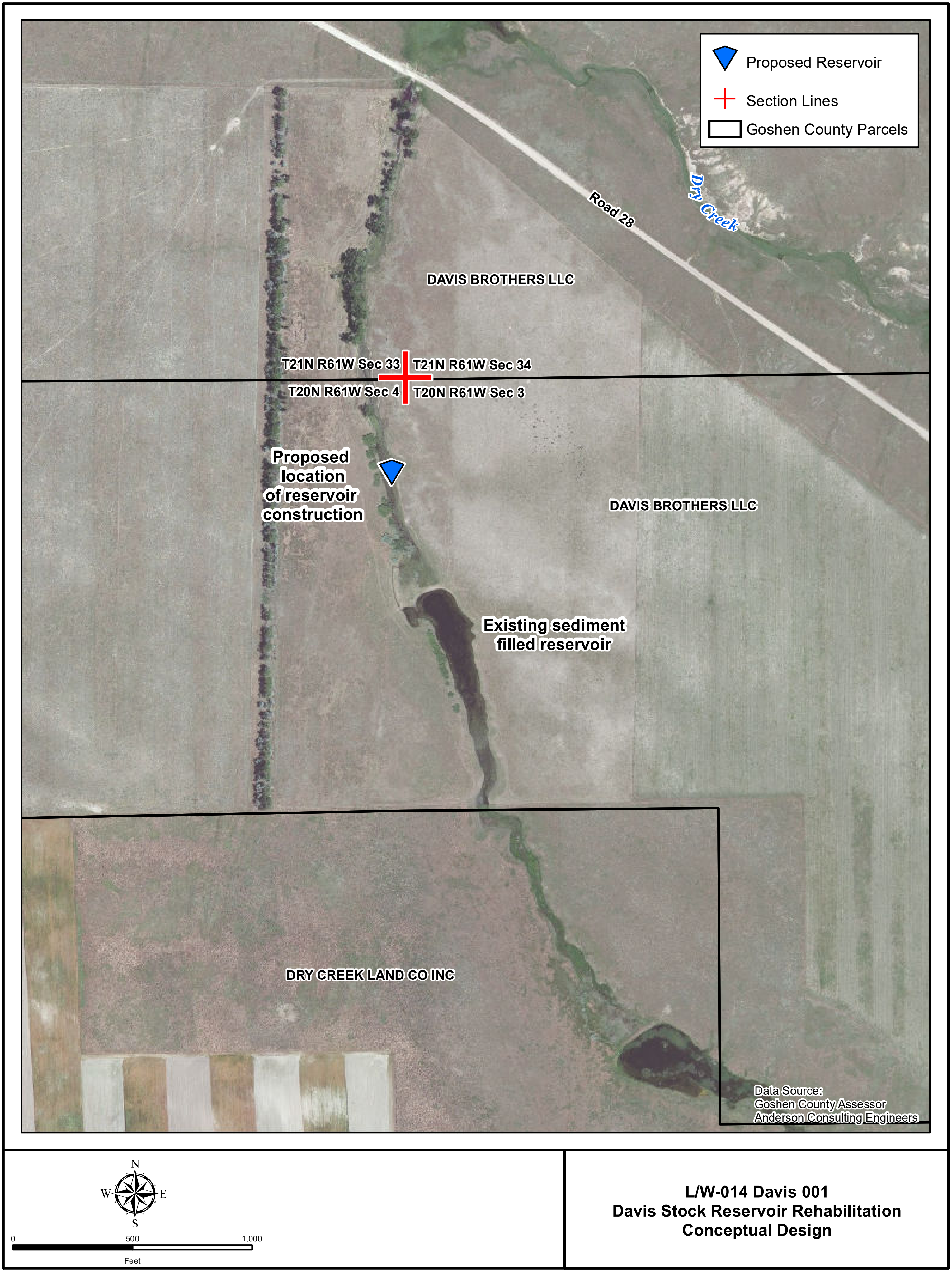
- Section 3 and 4, Township 20 North, Range 61 West

Land Ownership (Surface):

- Private

Water Source:

- Unnamed tributary to Dry Creek which is tributary to Horse Creek



L/W-014 Davis 001
Davis Stock Reservoir Rehabilitation
Conceptual Design

Watershed Plan Component: **L/W-014**
Project Name: **Davis Stock Reservoir Rehabilitation**
Project Sponsor/Number: **Davis-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,353
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7	2850	$ 18,525
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				$ 32,128
	Contingencies (15% of subtotal)				$ 4,819
	Engineering and technical assistance (10% of subtotal)				$ 3,213
	Estimated project cost				$ 40,159

L/W-015: Dereemer Pipeline Project (Dereemer-001)

This stock watering project will enlarge (or extend) an existing stock diversion for better utilization of three existing pastures, one currently without water. Three 8-foot tanks will be placed at the end of a 3800-ft 1 ½" pipeline and fenced in a way that allows access from both pastures.

This project will provide a much better distribution of cattle over the three pastures totaling over 2400 acres. This development will help reduce trailing within the highly erosive soils which leads to extensive gullying during large precipitation events. It will also allow a longer duration of grazing in the higher foothills section of the pasture, reducing the time cattle will spend down on Horse Creek. Finally, the ranch and especially these pastures maintain abundant populations of mule deer, antelope and other non-game wildlife.

Project components would include:

- Installing a solar platform/pump system
- Installing approximately 3,800 linear feet of buried 1 ½ inch HDPE pipeline
- Installing three 800 gallon rubber tire stock tanks

Project Location:

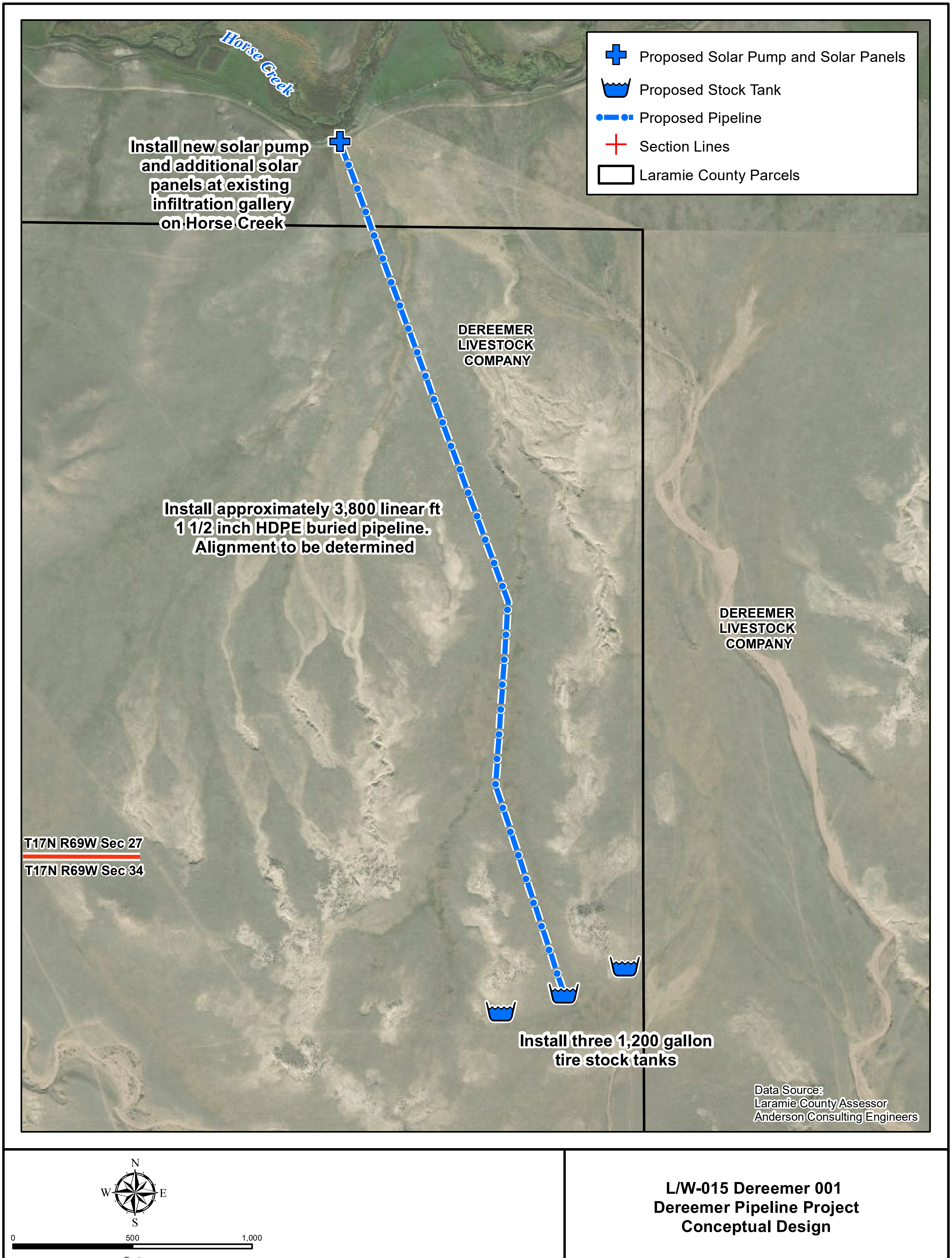
Section 27 and 34, Township 17 North, Range 69 West

Land Ownership (Surface):

Private

Water Source:

Horse Creek



L/W-015 Dereemer 001
Dereemer Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-015**
Project Name: **Dereemer Pipeline Project**
Project Sponsor/Number: **Dereemer-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,598
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	1	$ 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	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	3	$ 7,080
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	3800	$ 11,400
7	Misc valves and piping at tank(s)	Ea	$ 500	6	$ 3,000
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 39,578
	Contingencies (15% of subtotal)				$ 5,937
	Engineering and technical assistance (10% of subtotal)				$ 3,958
	Estimated project cost				$ 49,473

L/W-016: Drake Well Construction Project (Drake-001)

This stock watering project will develop a new source of water for better utilization of a currently dry CRP pasture (204 acres) while also providing water to a 322-acre pasture that had previously been serviced by a windmill well. This project incorporates a new 360-foot well with electric pump, 8850-feet of 1 ½” pipe, and three 8-foot tire tanks for more consistent watering.

This project will provide a much better distribution of cattle over the two pastures totaling 526-acres. These pastures provide newly established CRP forbs and grasses for the resident pronghorn populations that frequent the ranch, along with other species of wildlife. With this development, the well will provide wildlife water too.

Project Location:

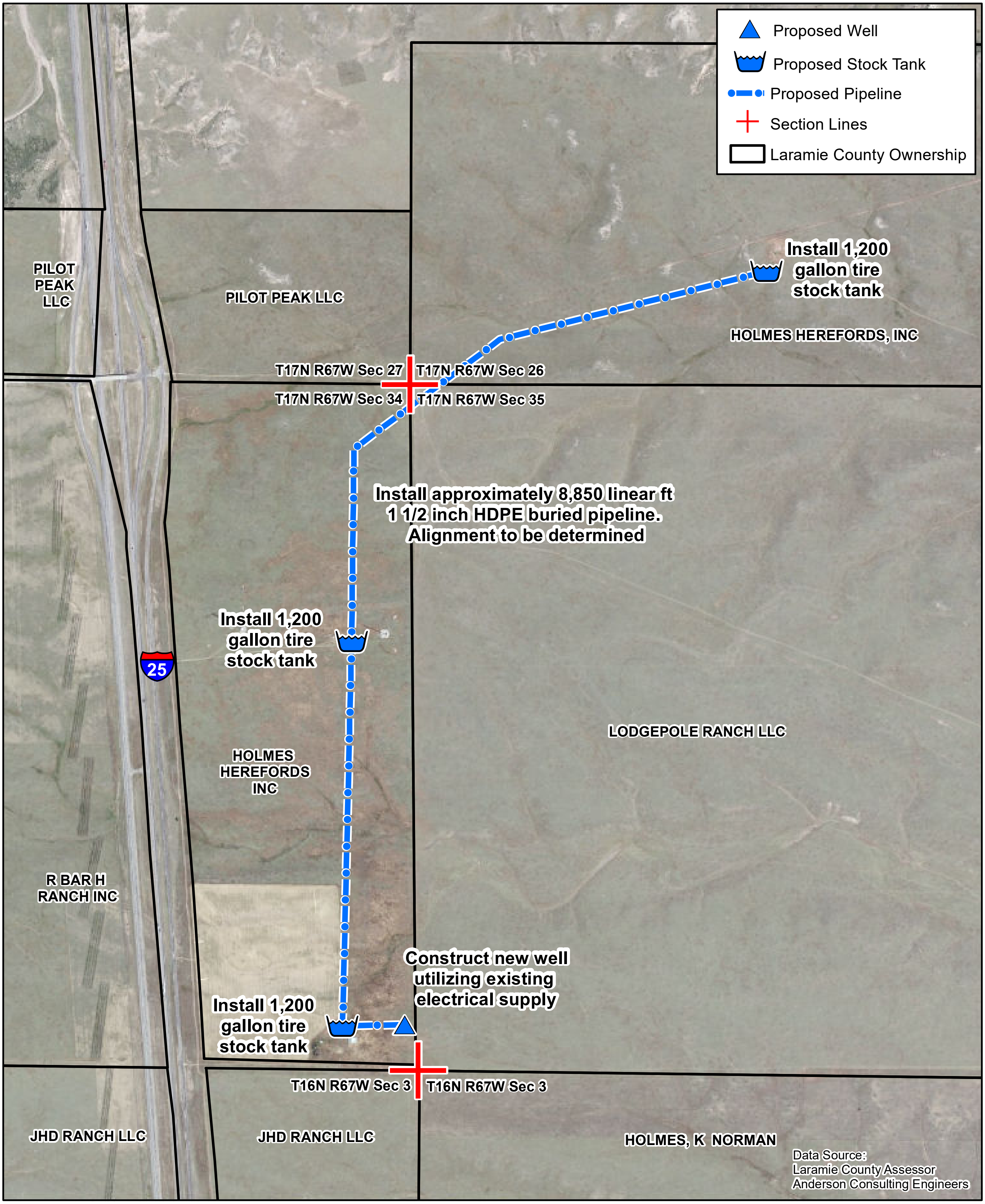
Sections 26, 34 and 35, Township 17 North, Range 67 West

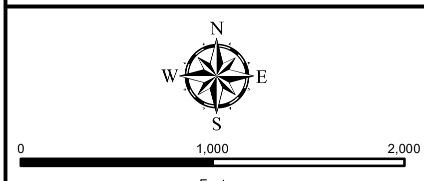
Land Ownership (Surface):

Private

Water Source:

New well





L/W-016 Drake 001
Drake Well Construction Project
Conceptual Design

Watershed Plan Component: **L/W-016**
Project Name: **Drake Well Construction Project**
Project Sponsor/Number: **Drake-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 6,425
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	360	$ 18,000
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	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	8850	$ 26,550
7	Misc valves and piping at tank(s)	Ea	$ 500	4	$ 2,000
8a	3 Wire fence with wood posts	LF	$ 5	120	$ 600
8b	12' wire gate	LS	$ 600	1	$ 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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 70,675
	Contingencies (15% of subtotal)				$ 10,601
	Engineering and technical assistance (10% of subtotal)				$ 7,068
	Estimated project cost				$ 88,344

L/W-017: Eklund Solar Platform / Pipeline Project (Eklund-001)

This project involves improvements to an existing well and extension of a buried pipeline to a proposed stock tank. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing a solar platform / pump and requisite fittings and connections in an existing well.
- Installation of approximately 3,200 linear feet of buried 1 ½ inch diameter HDPE pipeline
- Installation of one 1,200 gallon rubber tire stock tank.

Project Location:

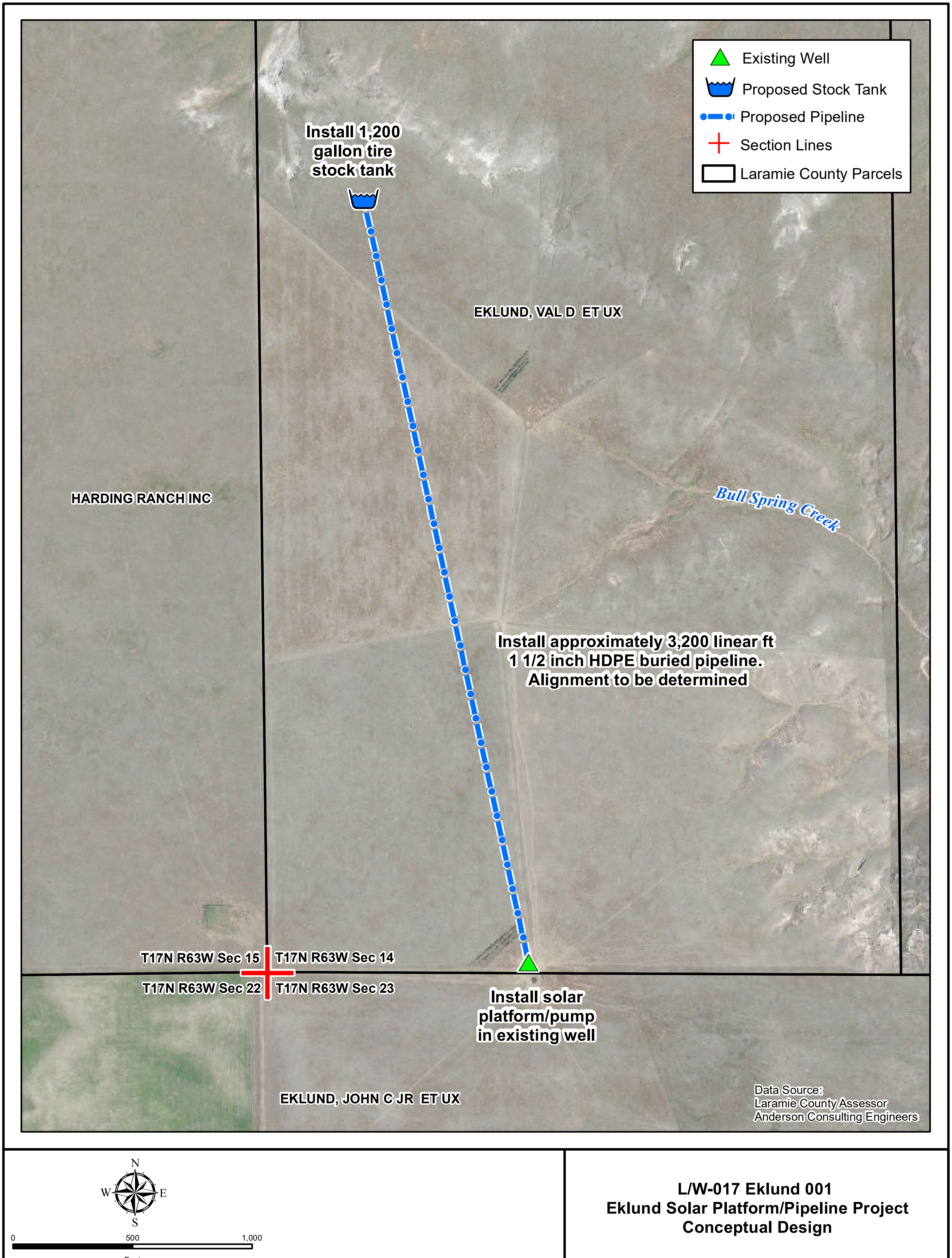
- Section 14, Township 17 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-017 Eklund 001
Eklund Solar Platform/Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-017**
Project Name: **Eklund Solar Platform / Pipeline Project**
Project Sponsor/Number: **Eklund-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,860
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		$ -
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	3200	$ 9,600
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 31,460
	Contingencies (15% of subtotal)				$ 4,719
	Engineering and technical assistance (10% of subtotal)				$ 3,146
	Estimated project cost				$ 39,325

L/W-018: Frank Pipeline Project (Frank-003)

This project consists of extending an existing pipeline supplied by an existing well.

Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing approximately 3,700 linear feet of 1 ½ inch diameter buried HDPE pipeline
- Installing one 1,200 gallon rubber tire stock tank

Project Location:

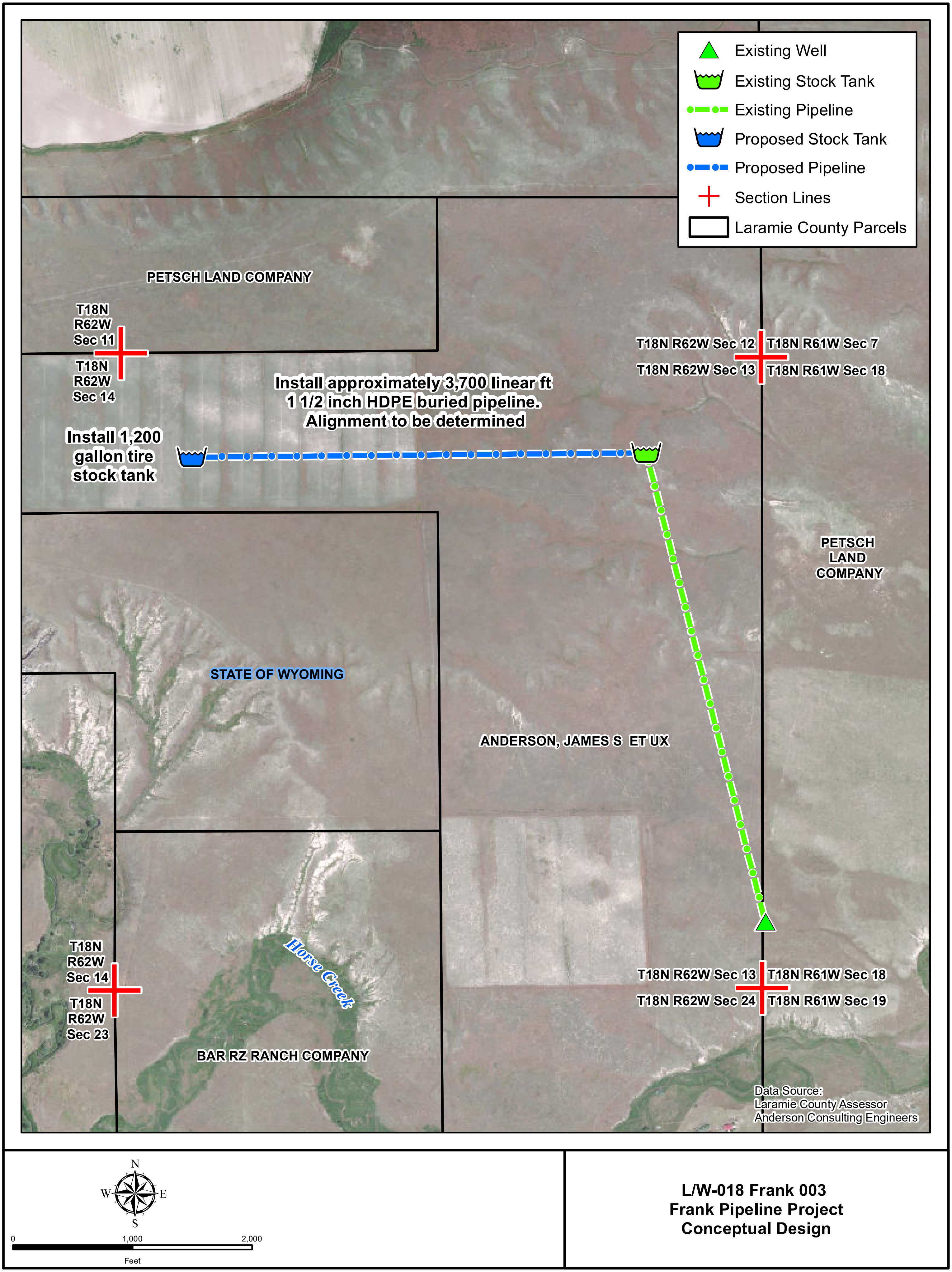
- Section 13, Township 18 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-018 Frank 003
Frank Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-018**
Project Name: **Frank Pipeline Project**
Project Sponsor/Number: **Frank-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,460
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 16,060
	Contingencies (15% of subtotal)				$ 2,409
	Engineering and technical assistance (10% of subtotal)				$ 1,606
	Estimated project cost				$ 20,075

L/W-019: Grandstaff Pipeline Project (Grandstaff-001)

This project involves extension of buried pipelines from an existing well to two new stock tanks. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing two pipelines from an existing well:
    - Approximately 2,675 linear feet of buried 1 ½ inch diameter HDPE pipeline aligned to the north.
    - Approximately 1,700 linear feet of buried 1 ½ inch diameter HDPE pipeline aligned to the south
- Installation of two 1,200 gallon rubber tire stock tanks (one at terminus of each pipeline).

Project Location:

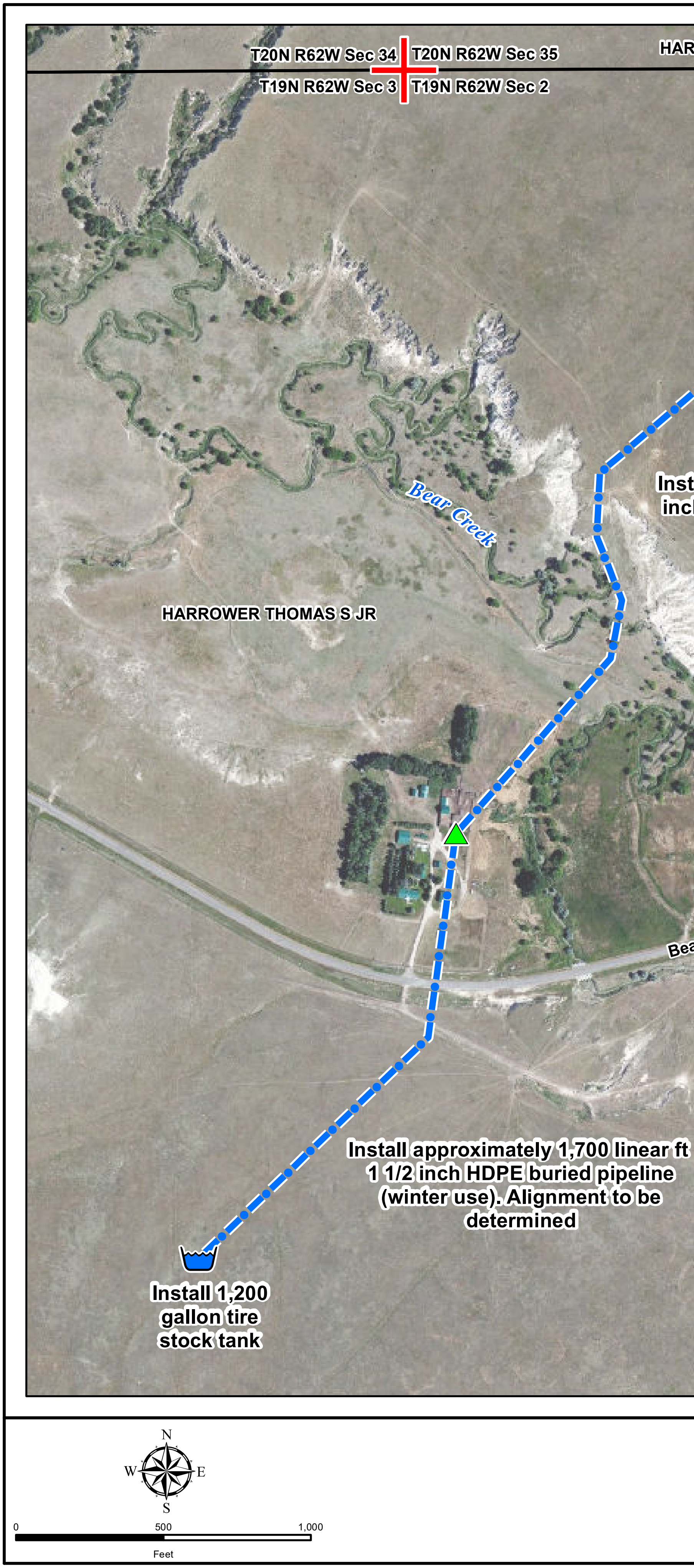
Sections 2 and 3, Township 19 North, Range 62 West

Land Ownership (Surface):

Private

Water Source:

Existing well



L/W-019 Grandstaff 001
Grandstaff Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-019**
Project Name: **Grandstaff Pipeline Project**
Project Sponsor/Number: **Grandstaff-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,013
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	2	$ 7,000
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	4375	$ 13,125
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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 ove	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				$ 22,138
	Contingencies (15% of subtotal)				$ 3,321
	Engineering and technical assistance (10% of subtotal)				$ 2,214
	Estimated project cost				$ 27,672

L/W-020: Jackson Pipeline Project (Jackson-001)

This project involves extension of a buried pipeline from an existing well to a new stock tank. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing approximately 3,200 linear feet of 1 ½ inch diameter buried HDPE pipeline.
- Installation of one 1,200 gallon rubber tire stock tank.

Project Location:

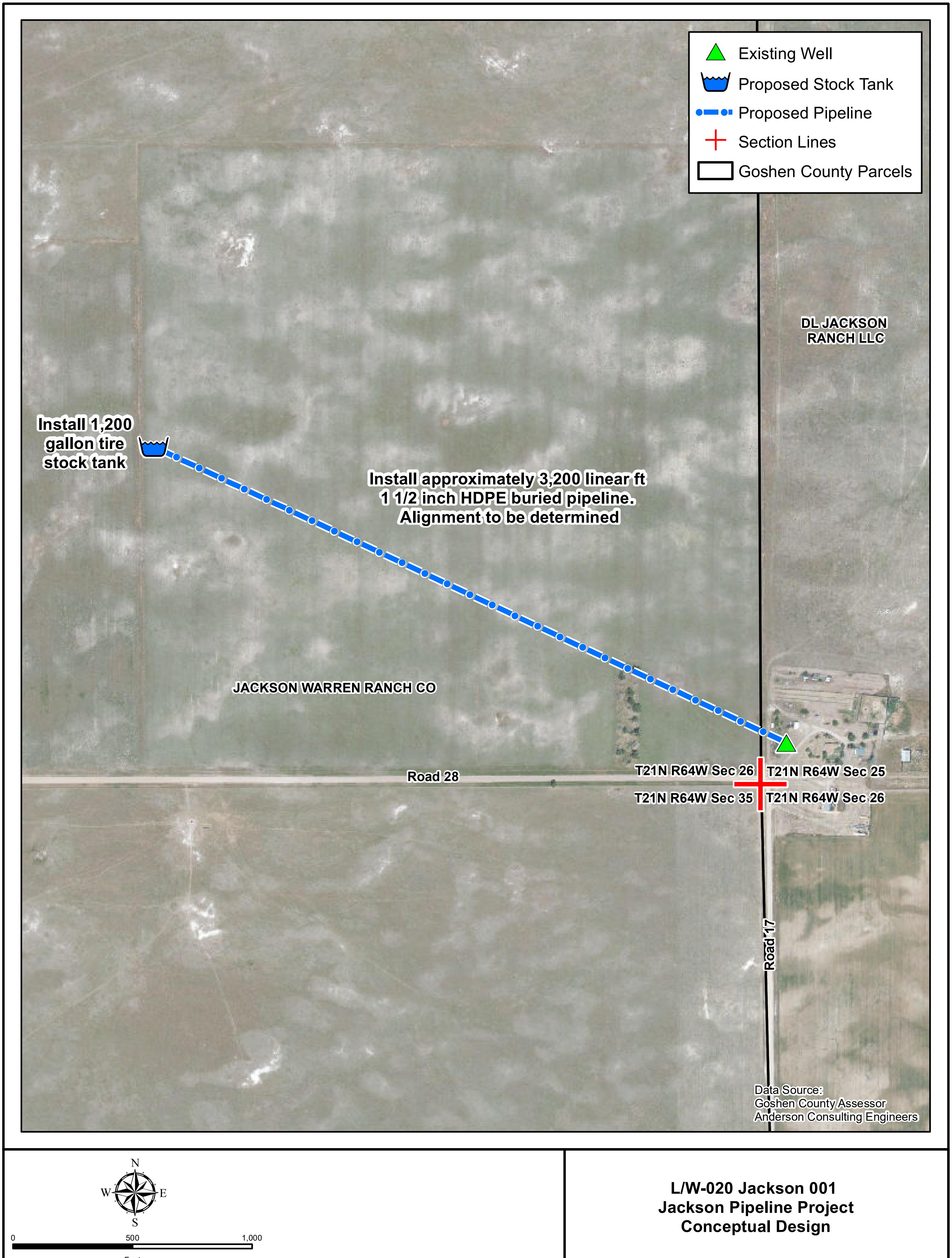
- Section 26, Township 21 North, Range 64 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-020 Jackson 001
Jackson Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-020**
Project Name: **Jackson Pipeline Project**
Project Sponsor/Number: **Jackson-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,310
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	3200	$ 9,600
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 14,410
	Contingencies (15% of subtotal)				$ 2,162
	Engineering and technical assistance (10% of subtotal)				$ 1,441
	Estimated project cost				$ 18,013

L/W-021: Ruiz Solar Platform Project (Ruiz-001)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well

Project Location:

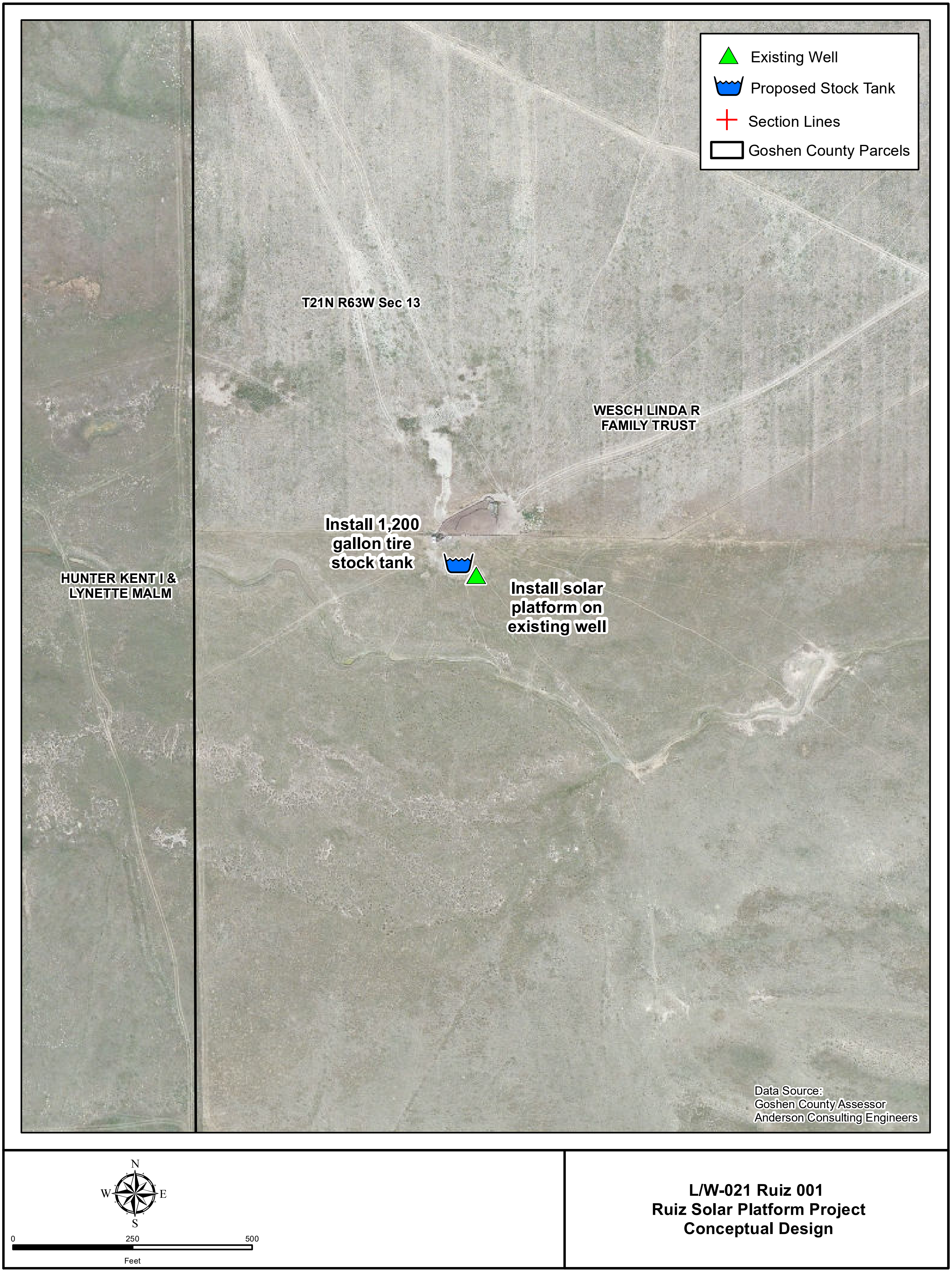
- Section 13, Township 21 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well



L/W-021 Ruiz 001
Ruiz Solar Platform Project
Conceptual Design

Watershed Plan Component: **L/W-021**
Project Name: **Ruiz Solar Platform Project**
Project Sponsor/Number: **Ruiz-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,550
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 17,050
	Contingencies (15% of subtotal)				$ 2,558
	Engineering and technical assistance (10% of subtotal)				$ 1,705
	Estimated project cost				$ 21,313

L/W-022: Ruiz Pipeline Project No. 1 (Ruiz-002)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well
- Installing approximately 1,500 linear feet of 1 ½ inch buried HDPE pipeline
- Installing two 1,200 gallon rubber tire stock tanks.

Project Location:

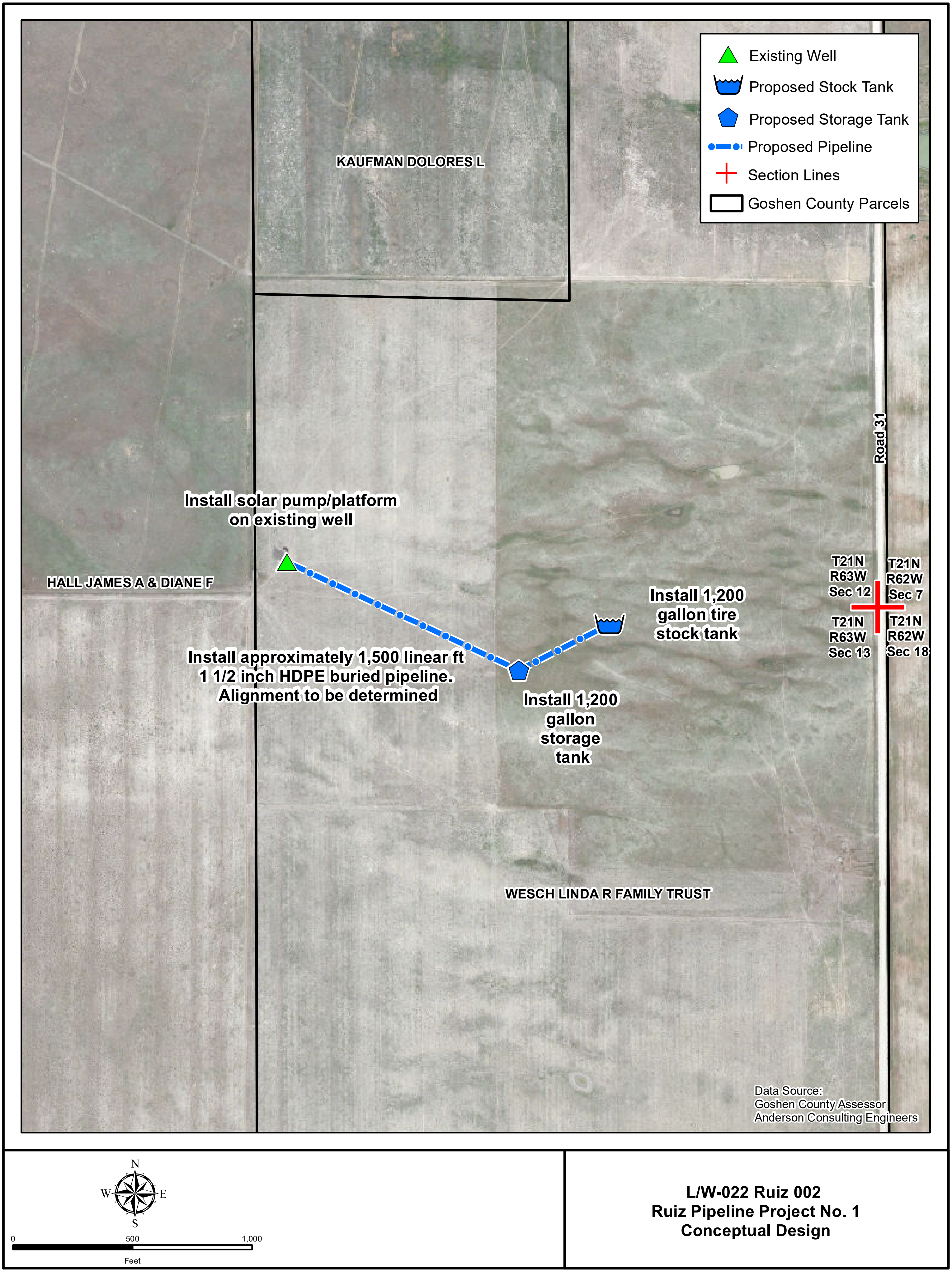
- Sections 12 and 13, Township 21 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well.



L/W-022 Ruiz 002
Ruiz Pipeline Project No. 1
Conceptual Design

Watershed Plan Component: **L/W-022**
Project Name: **Ruiz Pipeline Project No. 1**
Project Sponsor/Number: **Ruiz-002**

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	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	2	$ 7,000
5e	Storage Tank	gal	$ 1		$ -
6	1 1/2" Class 200 HDPE pipeline installed at 4'	LF	$ 3	1500	$ 4,500
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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

L/W-023: Ruiz Pipeline Project No. 2 (Ruiz-003)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well
- Installation of approximately 500 linear feet of buried 1 ½ inch HDPE pipeline
- Installation of one 1,200 gallon rubber tire stock tank

Project Location:

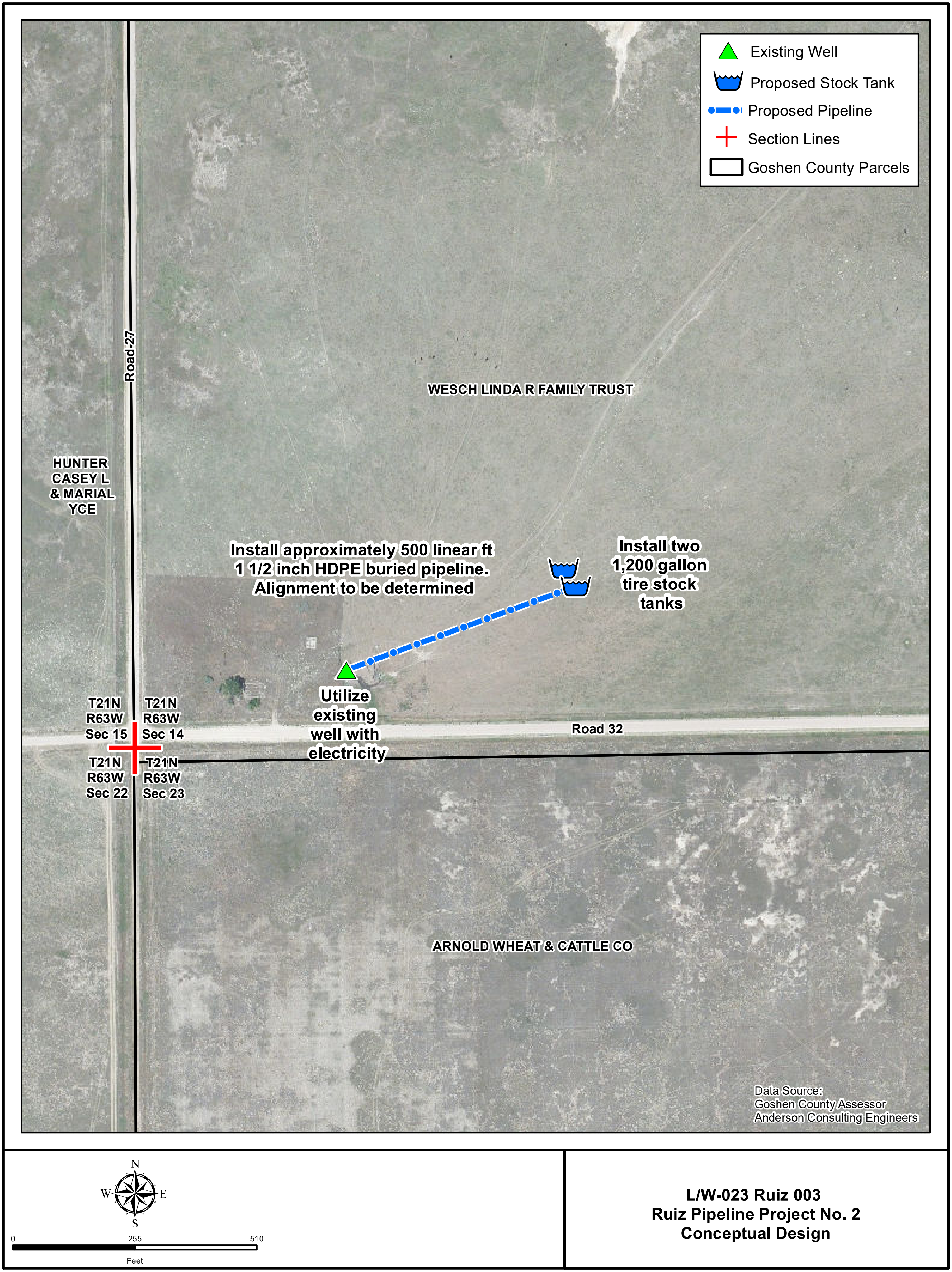
- Section 14, Township 21 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-023 Ruiz 003
Ruiz Pipeline Project No. 2
Conceptual Design

Watershed Plan Component: **L/W-023**
Project Name: **Ruiz Pipeline Project No. 2**
Project Sponsor/Number: **Ruiz-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,950
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	1	$ 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	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	500	$ 1,500
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 21,450
	Contingencies (15% of subtotal)				$ 3,218
	Engineering and technical assistance (10% of subtotal)				$ 2,145
	Estimated project cost				$ 26,813

L/W-024: Scheer D. Well Construction Project (ScheerD-001)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife as an alternative to riparian sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well
- Installation of approximately 650 linear feet of buried 1 ½ inch HDPE pipeline
- Installation of one 1,200 gallon rubber tire stock tank

Project Location:

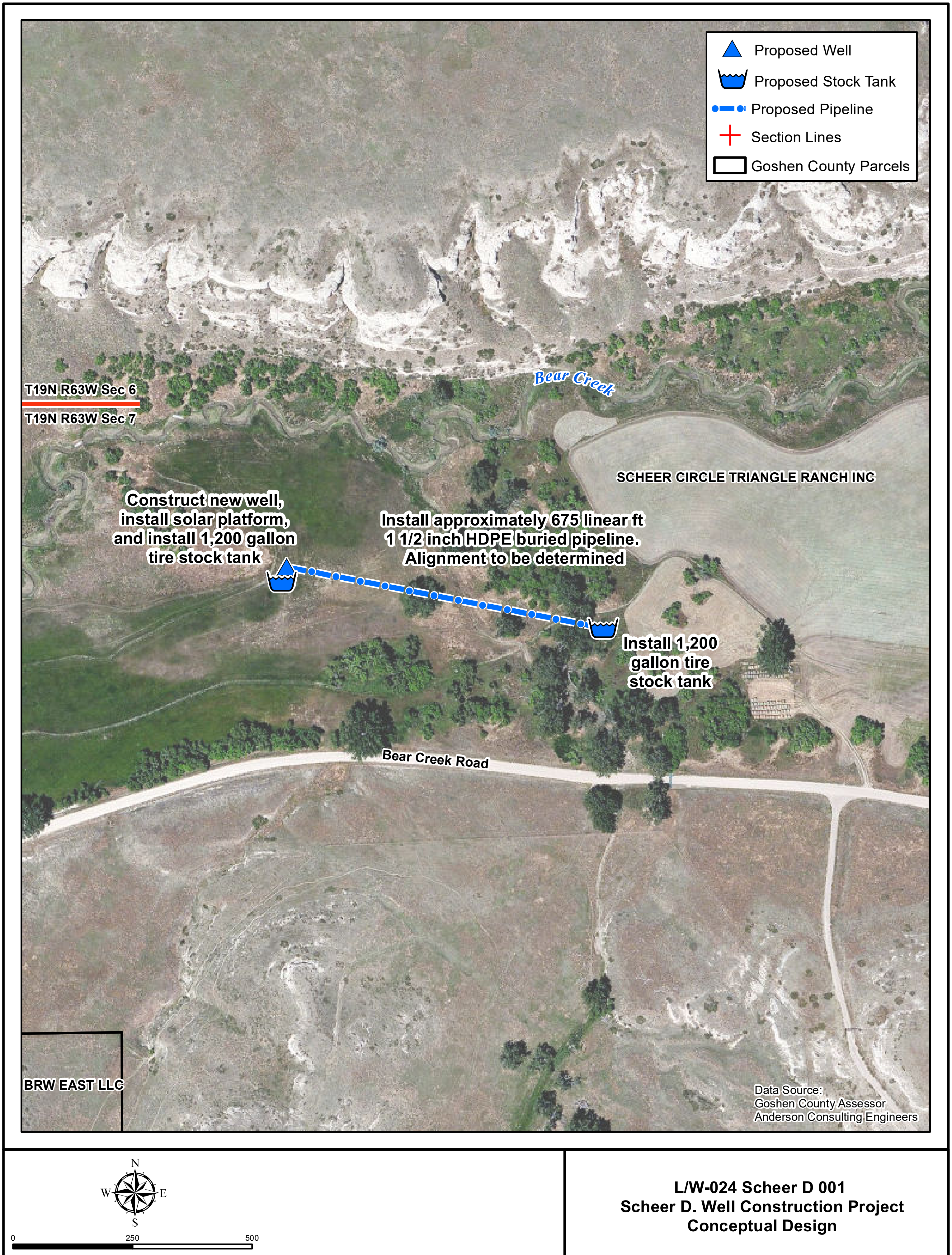
- Section 7, Township 19 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well



L/W-024 Scheer D 001
Scheer D. Well Construction Project
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Hydrogeologic Report

Scheer D-001

The Scheer-001 site is located in T19N, R63W, Sec. 7, about 16 miles west of LaGrange, at approximate elevation 4933 feet[1]. The site is in the alluvial deposits of Bear Creek deposited in a channel of Arikaree Formation bedrock, but with the underlying Brule Member of the White River Formation present at depth.

There are 7 existing groundwater permits in this area. See the attached figure for locations[2].

Permit[3]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
177429	Bartlett Ranch Wyoming, LLC	15	63	320
8553	Bartlett Ranch Wyoming, LLC 25	15	65	
10214	Scheer Circle Triangle Ranch	20	12	40
198056	H. B. Bartlett	5	225	400
19354	Vandehei Land Co.	8	140	
59036	Scheer Circle Triangle Ranch	15	100	170

[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 Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[3]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

10367	Scheer Circle Triangle Ranch	180[4]	95	168

Existing permits in the valley bottom (#8553, #177429, and #10214) show mixed results. #8553 encountered "gravel" between 10 and 65 feet and was completed with perforations from 0 to 50 feet. Nearby #177429 reported "coarse sand" and "gravel" only to a depth of 16 feet, and was completed with perforations from 220 to 320 feet in a mixed clay, sandstone, and sandy clay layers. No details are available for the downstream well, #10214, but the reported total depth and depth-to-water suggest conditions like #8553. Thus, a productive shallow gravel aquifer appears to be present along Bear Creek at select locations.

The depth and production of the four upland wells are akin to #177429, which was unable to find sufficient shallow water, so continued into the deeper bedrock. Although Permit #198056 listed the Brule Formation at 35 feet, review of the log and comparison with the others in the area suggest a correct Brule top at approximately 260 feet. Thus, the other wells appear to have been completed in the sandstones of the Arikaree Formation. In any case, in these formations, groundwater production is a function of accumulating many separate water-bearing zones. This condition is reflected in the varying depths of the wells and varying lengths of screen or perforations (20 to 80 feet).

All of those well owners who opined on groundwater quality felt the quality was "good", i.e. for the intended use of watering stock, which is consistent with what one would expect from the strata penetrated.

Conclusions:

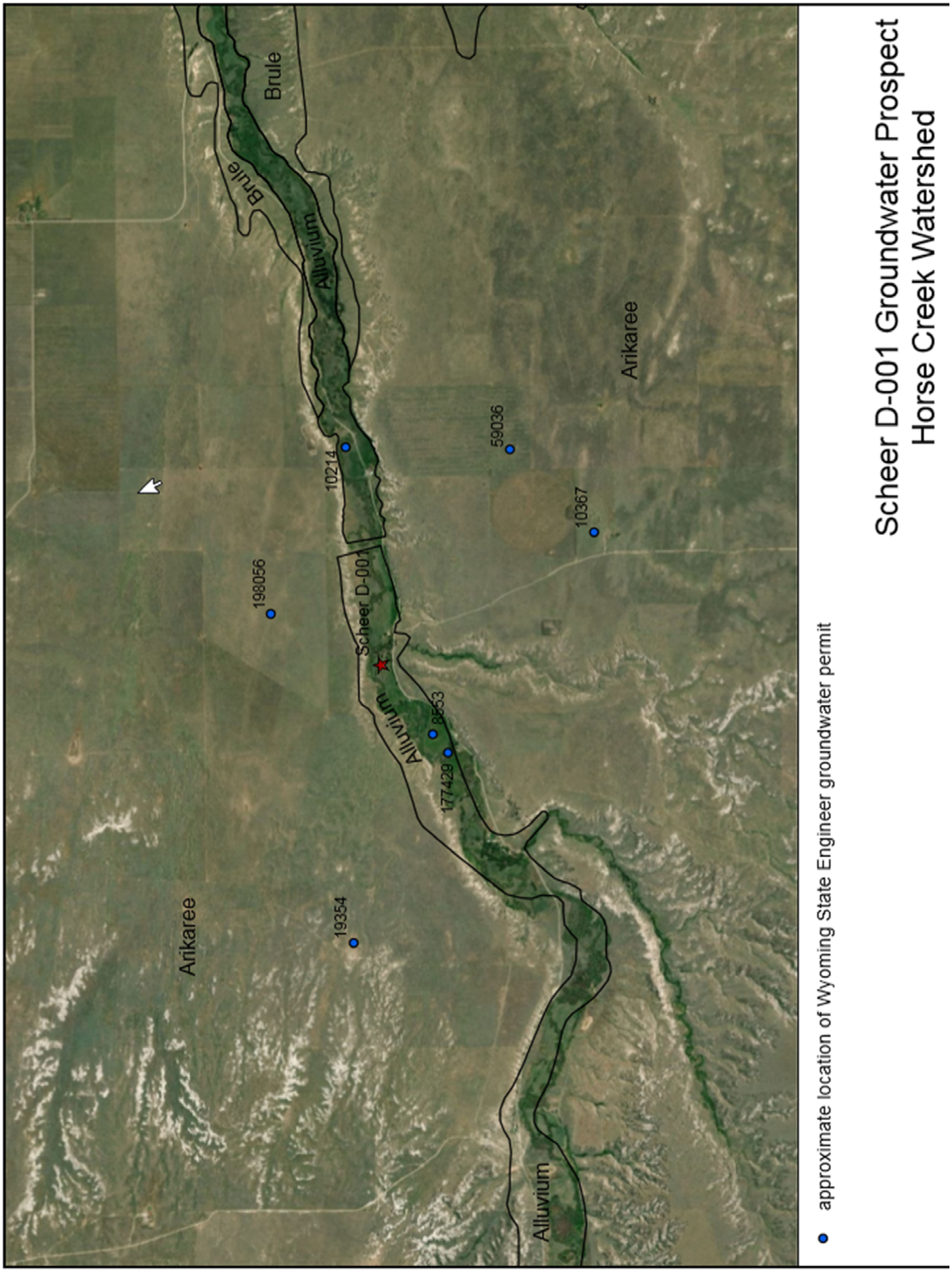
1. There is a chance of encountering a shallow, productive aquifer at this location, i.e. satisfactory production from a well < 100 feet deep, but the need to complete a well in the underlying bedrock is more likely.

[4]The Statement of Completion (and database listing) of this well lists 1000 gpm production. However, a test at 180 gpm with 89 feet of drawdown and a 10 HP pump are also listed. The "1000 gpm" is assumed to be an error.

2. In the latter case, production is a function of penetrating sufficient discrete water-bearing zones, so deeper drilling may be required to accumulate the desired total production. A depth on the order of 200 feet should be anticipated, with the possibility of another 100 feet if necessary.

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.


Scheer D-001 Groundwater Prospect
Horse Creek Watershed
approximate location of Wyoming State Engineer groundwater permit
Brule
Brule
Alluvium
Arikaree
59036
10214
10367
198056
Scheer D-001
8553
177429
Alluvium
Arikaree
19354
Alluvium

Watershed Plan Component: **L/W-024**
Project Name: **Scheer D. Well Construction Project**
Project Sponsor/Number: **ScheerD-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,095
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		$ -
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	650	$ 1,950
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 23,045
	Contingencies (15% of subtotal)				$ 3,457
	Engineering and technical assistance (10% of subtotal)				$ 2,305
	Estimated project cost				$ 28,806

L/W-025: Scheer D. Solar Platform Project (ScheerD-002)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well

Project Location:

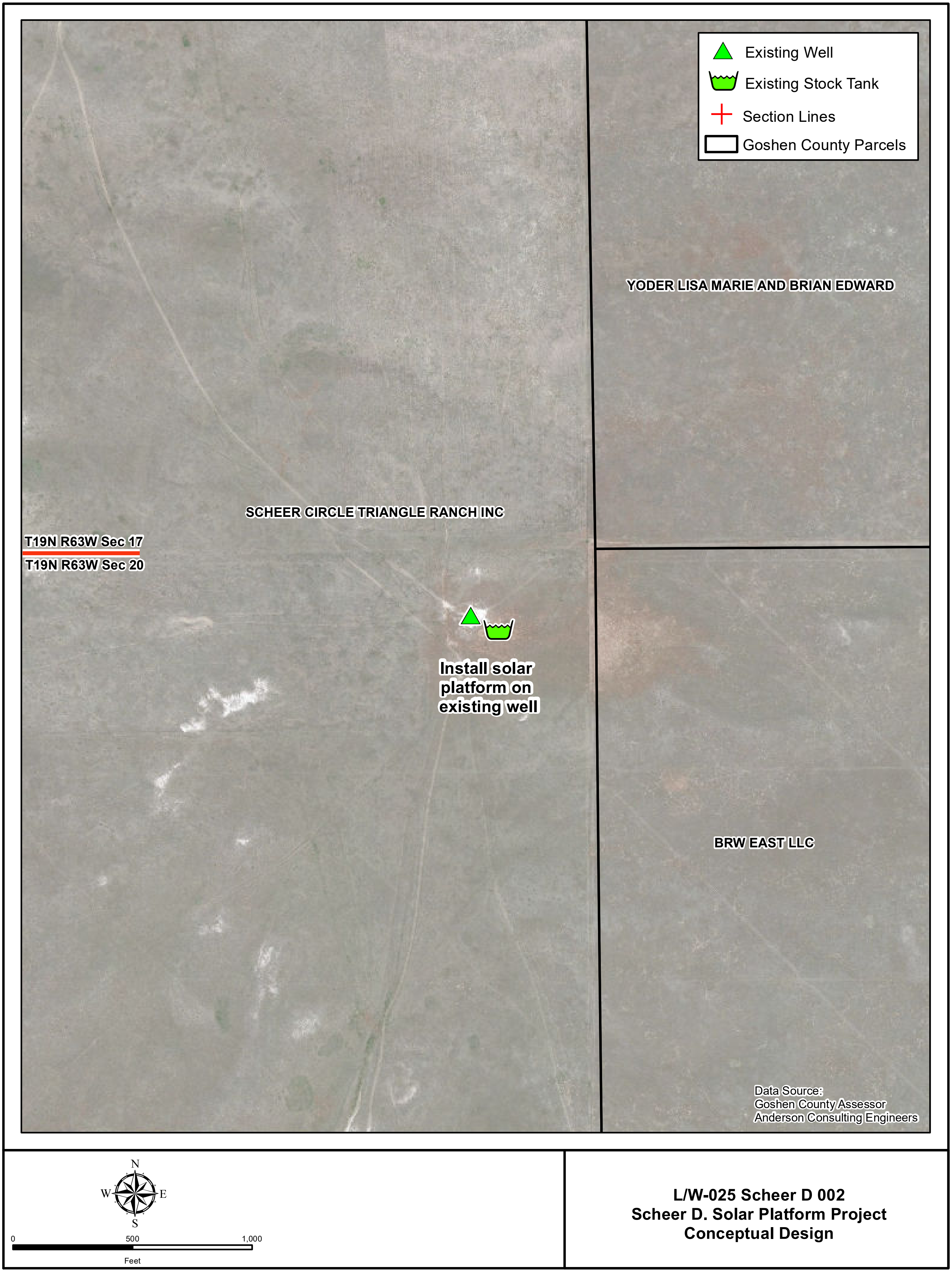
- Section 20, Township 19 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-025 Scheer D 002
Scheer D. Solar Platform Project
Conceptual Design

Watershed Plan Component: **L/W-025**
Project Name: **Scheer D. Solar Platform Project**
Project Sponsor/Number: **ScheerD-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,550
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 17,050
	Contingencies (15% of subtotal)				$ 2,558
	Engineering and technical assistance (10% of subtotal)				$ 1,705
	Estimated project cost				$ 21,313

L/W-026: Scheer J. Pipeline Project (ScheerJ-001)

This project involves extension of a buried pipeline from an existing well to a new stock tank. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing approximately 4,200 linear feet of buried 1 ½ inch diameter HDPE pipeline
- Installation of one 1,200 gallon rubber tire stock tanks (one at terminus of each pipeline).
- Installing solar platform and pump in an existing well

Project Location:

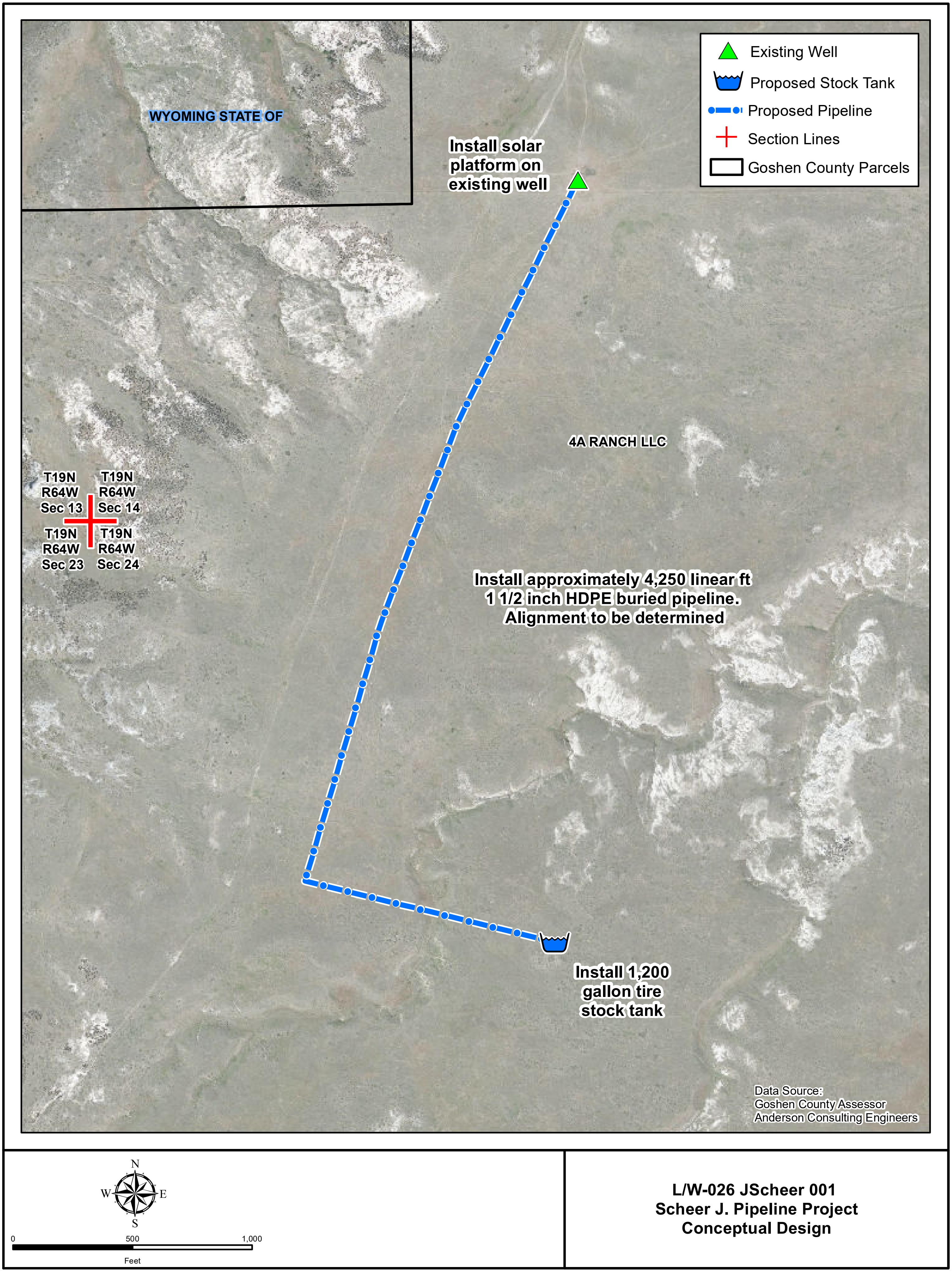
- Sections 13 and 24, Township 19 North, Range 64 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-026 JScheer 001
Scheer J. Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-026**
Project Name: **Scheer J. Pipeline Project**
Project Sponsor/Number: **ScheerJ-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 3,160
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		$ -
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	4200	$ 12,600
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 34,760
	Contingencies (15% of subtotal)				$ 5,214
	Engineering and technical assistance (10% of subtotal)				$ 3,476
	Estimated project cost				$ 43,450

L/W-027: Scheer J. Irrigation Pipeline Project (ScheerJ-002)

This project would consist of development of an existing spring and then conveying the water to an existing ditch for irrigation purposes. Completion of the project would result in conservation savings of water otherwise lost to evaporation and improved irrigation capabilities. Currently, the spring is undeveloped and flows across County Road 242 (Bear Creek Road). Historically, the water was then captured by an existing concrete lined ditch. Today, the ditch is filled with sediment and not usable.

Project components would include:

- Installing a spring development
- Installation of approximately 250 linear feet of 4-inch diameter buried HDPE pipeline
- Cleaning of sediment in an existing irrigation ditch
- Obtaining clearance from Platte County Road and Bridge department for consent to cross under the county road with the proposed pipeline.

Project Location:

- Section 18, Township 19 North, Range 64 West

Land Ownership (Surface):

- Private

Water Source:

- Spring to be developed

Horse Creek Watershed Study
Appendix 6A

N
W E
S

0 250 500
Feet

L/W-027 ScheerJ 002
Scheer J. Irrigation Pipeline Project
Conceptual Design

Watershed Plan Component: **L/W-027**
Project Name: **Scheer J. Irrigation Pipeline Project**
Project Sponsor/Number: **ScheerJ-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 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	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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12	250	$ 3,000
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 8,800
	Contingencies (15% of subtotal)				$ 1,320
	Engineering and technical assistance (10% of subtotal)				$ 880
	Estimated project cost				$ 11,000

L/W-028: Shimic Stock Reservoir Project (Shimic-001)

This project would involve construction of a new stock reservoir.Upon completion, the new stock reservoir would provide a reliable source of livestock and wildlife water as an alternative to riparian sources.

Project components would include:

- Installing a new stock reservoir
- Incorporation of a reservoir outlet system such as the commercially available AgriDrain.
- Construction of a spillway to protect the structure in the event of significant runoff

Project Location:

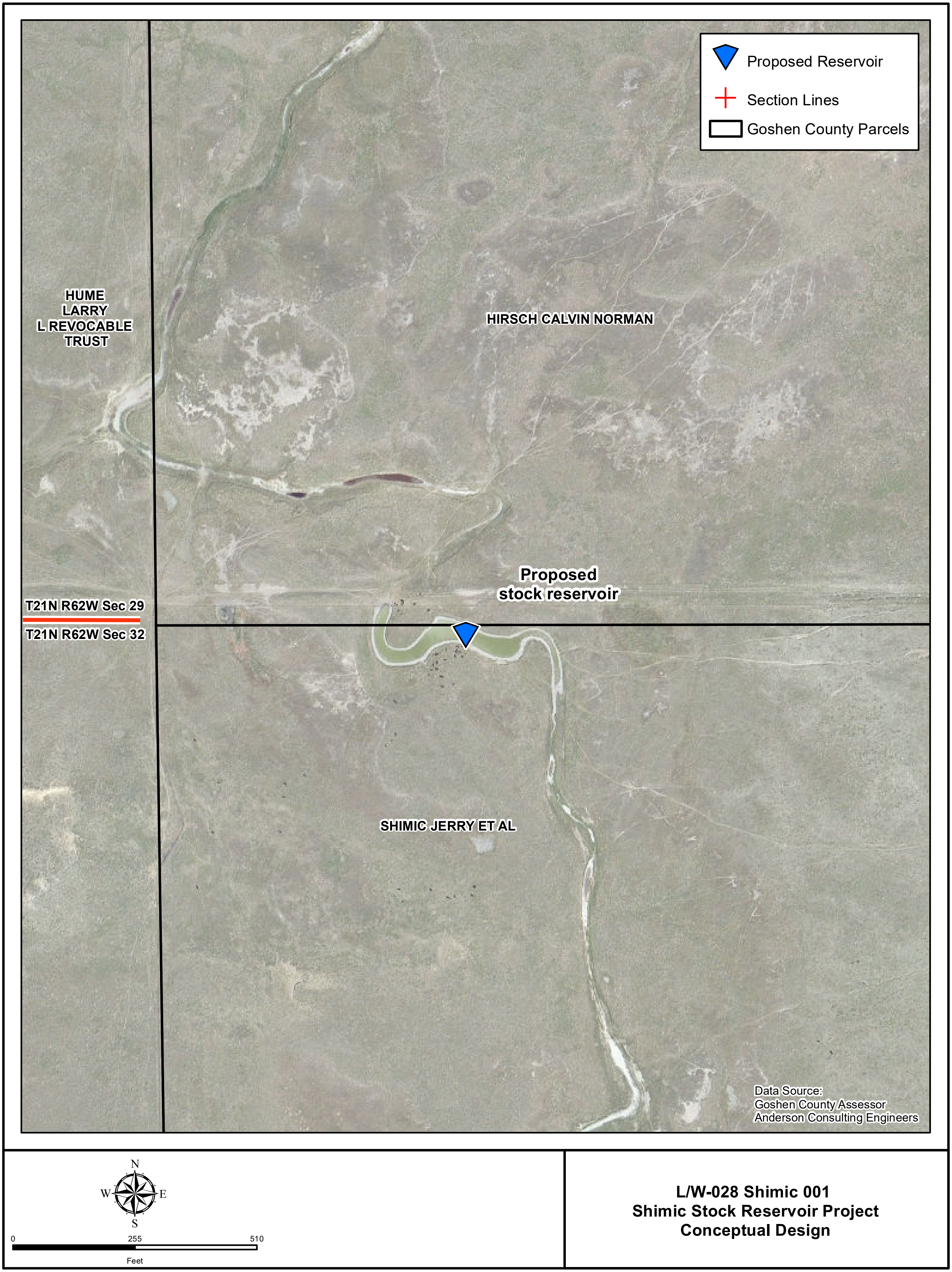
- Section 29 and 32, Township 21 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

Unnamed tributary to Lone Tree Creek which is tributary to Horse Creek



L/W-028 Shimic 001
Shimic Stock Reservoir Project
Conceptual Design

Watershed Plan Component: **L/W-028**
Project Name: **Shimic Stock Reservoir Project**
Project Sponsor/Number: **Shimic-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 4,990
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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		$ -
18	Excavation and Placement of Embankment Fill	CY	$ 7	3000	$ 19,500
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125	200	$ 25,000
21	Filter fabric under riprap	SY	$ 4	100	$ 400
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				$ 61,140
	Contingencies (15% of subtotal)				$ 9,171
	Engineering and technical assistance (10% of subtotal)				$ 6,114
	Estimated project cost				$ 76,425

L/W-029: Shoun Well Construction Project No. 1 (Shoun-001)

The proposed project would entail construction of a new well and installation of a solar platform/pump. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Construction of a new well approximately 200 feet deep
- Installing solar platform and pump
- Installing on 1,200 gallon rubber tire stock tank

Project Location:

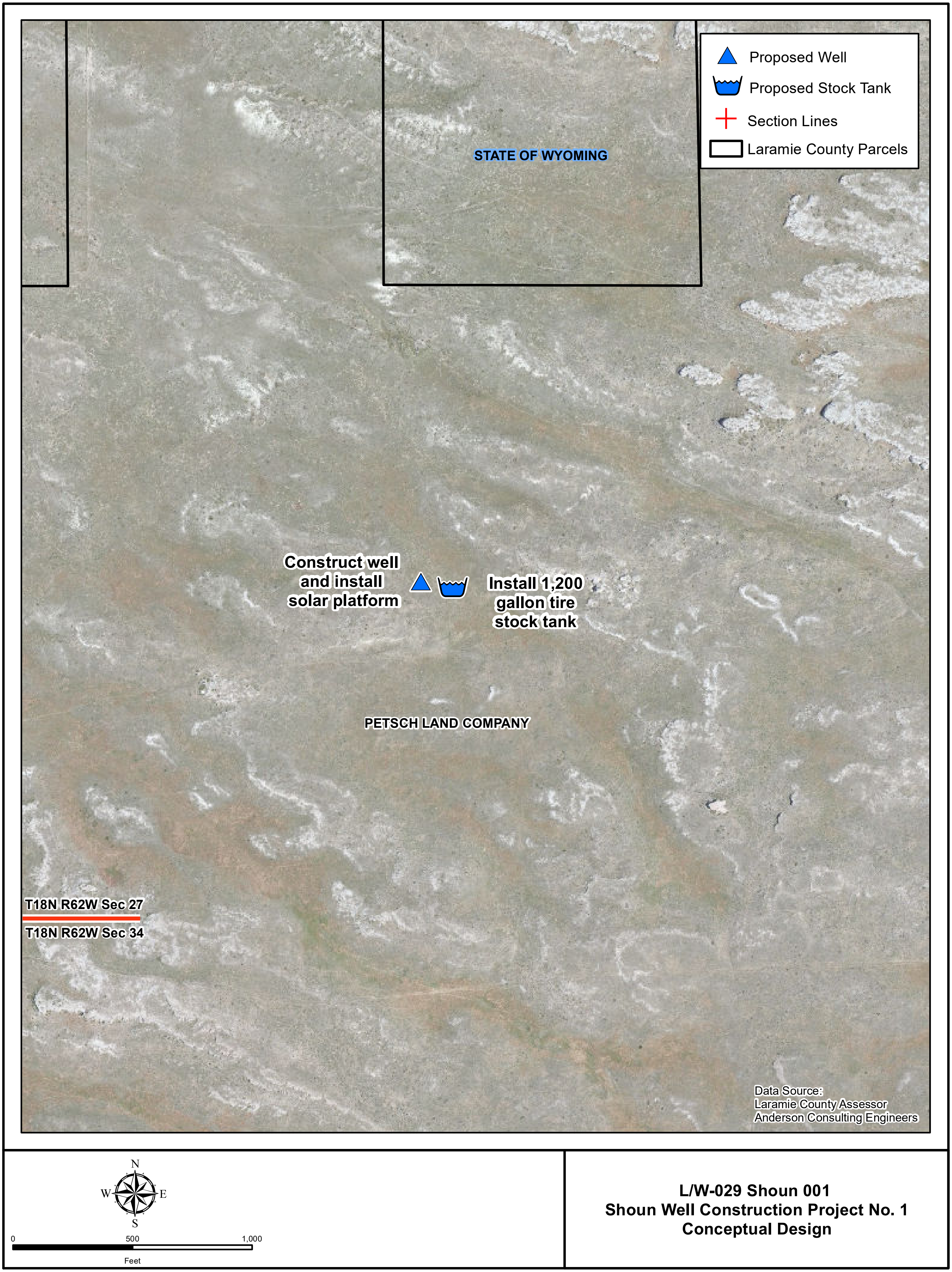
- Section 27, Township 18 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well



L/W-029 Shoun 001
Shoun Well Construction Project No. 1
Conceptual Design

Shoun-001 and Shoun-002

The Shoun-001 site is located in T18N, R62W, Sec. 23, at approximate elevation 4977 feet[1]. The Shoun-002 site is located in T18N, R62W, Sec. 27, at approximate elevation 5080 feet. These sites are 10-12 miles southwest of LaGrange.

The prospective wells are on the south slopes of the Horse Creek valley. The valley is carved into the Brule Member of the White River Formation at this point, with the overlying Arikaree Formation cropping out on the upper slopes and across the plateau area to the south. In the bottom of the valley, in a band along Horse and Mills Creeks, are the alluvial deposits produced by those streams.

The Arikaree Formation is generally more permeable than the Brule. The springs on the figure appear to be a function of that permeability contrast, as groundwater moving downward through the Arikaree encounters the lower permeability of the Brule and moves laterally (northward) to discharge at or above where that geologic contact intersects the ground surface. The springs east of the Shoun-002 prospect surface at approximately elevation 5050 feet.

There are 11 existing groundwater permits in the surrounding area. See the attached figure for locations[2].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
7275	Petsch Land Co.	10	Unknown	100
12670	Petsch Land Co.	20	20	100

[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.

7266	Petsch Farms, LLC	25		60
7276	Irvin Petsch	10	30	100
7277	Irvin Petsch	10	30	100
7278	Irvin Petsch	10	30	100
399	Petsch Land Co.	875	50	90
703	Petsch Land Co.	1450	25	80
110562	James Anderson	10	48	190
82288	James Anderson	25	18	210
18584	Little Horse Creek Cattle Co.	6	15	54
5567	Donahue & Rutledge, Inc.	5	20	137
18586	Little Horse Creek Cattle Co.	25	90	235
7279	Petsch Land Co.	5 - 10	Unknown	100

As can be seen on the figure, most of these wells are in the “bottom” of the drainage, along Horse Creek, Little Horse Creek, and the associated surface irrigation ditches. The standout wells in this list in terms of yield are #399 and #703. The logs for these two relatively shallow wells indicate completion in the Brule Formation rather than in the alluvial deposits of the creeks, but they may have encountered a local area of the type of “fracturing” in the upper Brule that creates the prolific LaGrange Aquifer downstream. This situation is not widespread, and should not be anticipated at the Shoun prospects.

While the permeability at wells #399 and #703 may be anomalous, the water levels should be representative of area conditions. Subtract of the reported depth-to-water from the surface elevation indicates a local groundwater level elevation of 4820 - 4845 feet. Given the northward gradient of groundwater flow, a static water level of approximately 130 feet can be anticipated at the Shoun-001 prospect (surface elevation minus groundwater elevation). Similarly, interpolation of water level elevations between the area of #5567 and #18586 (i.e. approximately 5300 feet) and the area of wells #399 and #703, suggests at the Shoun-002 prospect, a groundwater elevation of approximately 5050 feet (i.e. depth-to-water of 30-50 feet) may be anticipated. (This groundwater elevation is consistent with the nearby spring elevations discussed above.)

With respect to permeability (i.e. aquifer productivity), the Shoun-001 prospect is reliant on encountering either fracture zones or the occassional local sand layer within the Brule Formation. Local experience is perhaps best represented by wells #110562 and #82288, where penetration was more than 150 feet beyond the static water level. Thus, a total well depth of approximately 280 feet may be necessary to achieve production in the 10 - 20 gpm range. Favorable conditions may be encountered shallower, of course, and drilling should attempt to identify if that is the case as total depth decisions are made.

The Shoun-002 prospect may have somewhat more favorable conditions as it starts in the more generally permeable Arikaree Formation. If favorable conditions are not encountered in the first 100 feet, it will be necessary to proceed into the underlying Brule, where an additional 100 to 200 feet may be necessary to accumulate the target yield.

All of those well owners who opined on groundwater quality felt the quality was “good”, i.e. for the intended use of watering stock.

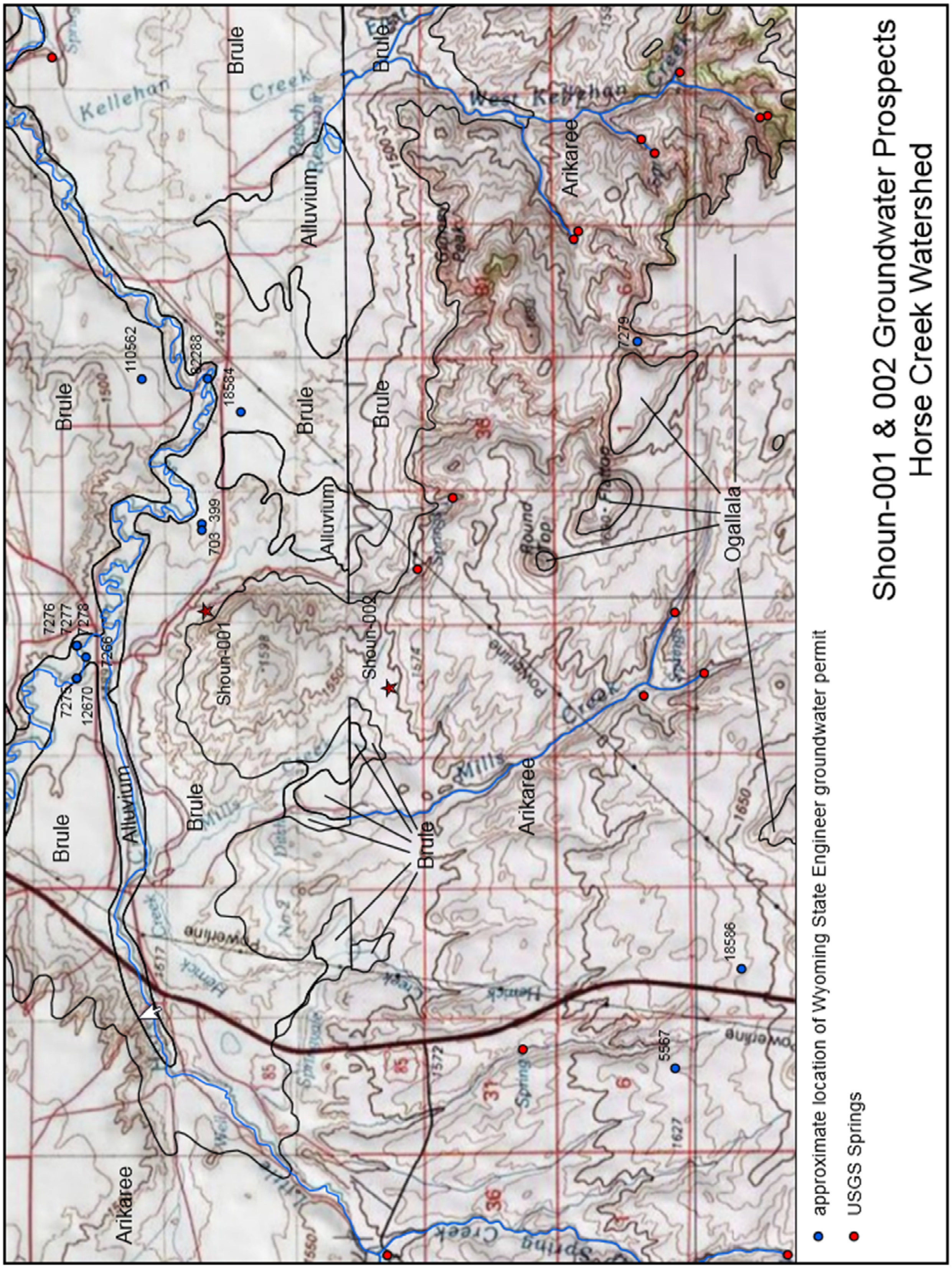
Conclusions:

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 and, at the Shoun -002 prospect, of encountering shallower groundwater in the basal Arikaree Formation strata.

2. Groundwater quality at this location is likely adequate for stock use.

3. 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.

Horse Creek Watershed Study
Appendix 6A



Watershed Plan Component: **L/W-029**
Project Name: **Shoun Well Construction Project No. 1**
Project Sponsor/Number: **Shoun-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,800
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	200	$ 10,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000	1	$ 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	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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 30,800
	Contingencies (15% of subtotal)				$ 4,620
	Engineering and technical assistance (10% of subtotal)				$ 3,080
	Estimated project cost				$ 38,500

L/W-030: Shoun Well Construction Project No. 2 (Shoun-002)

The proposed project would entail construction of a new well and installation of a solar platform/pump. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Construction of a new well approximately 200 feet deep
- Installing solar platform and pump
- Installing on 1,200 gallon rubber tire stock tank

Project Location:

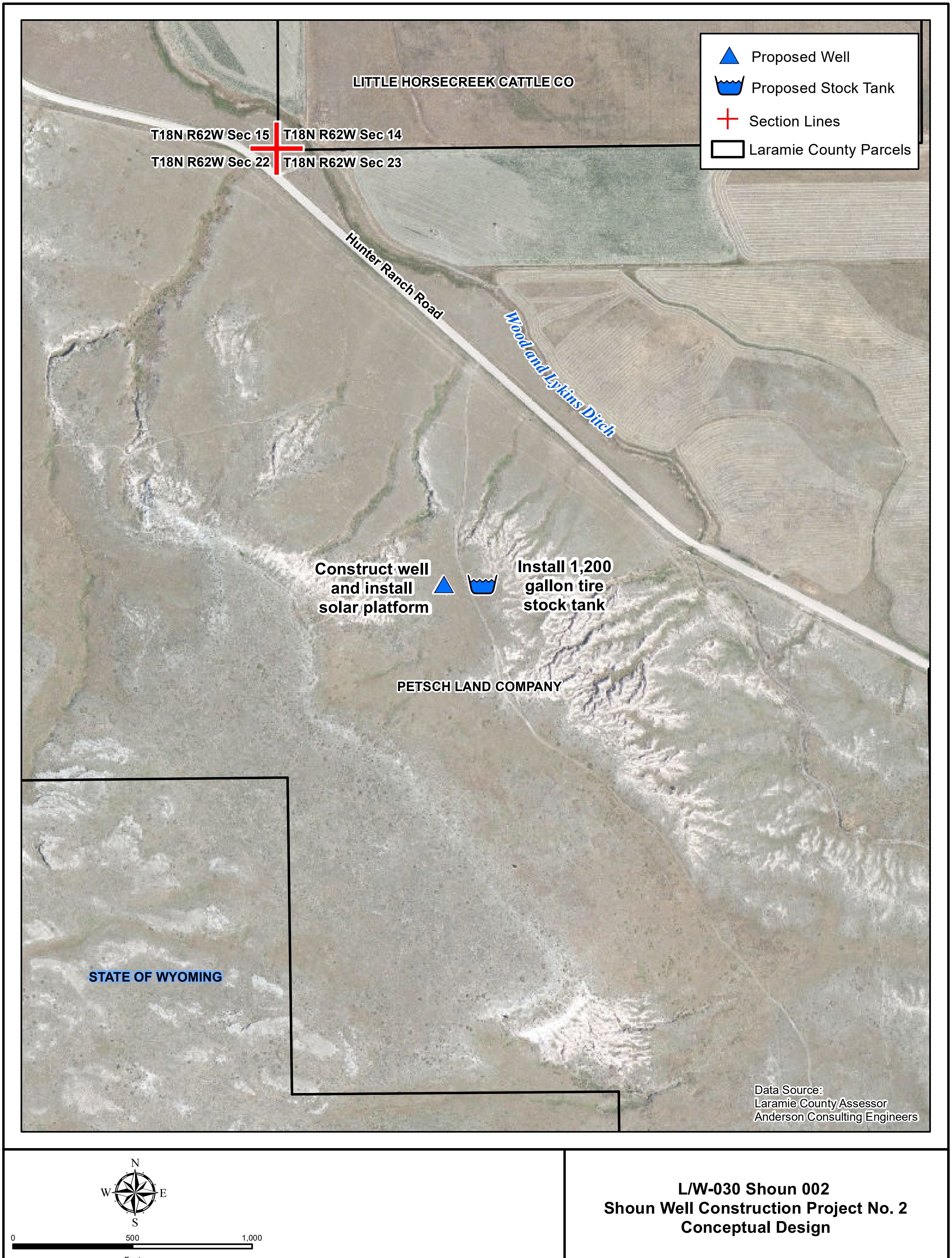
- Section 23, Township 18 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well



L/W-030 Shoun 002
Shoun Well Construction Project No. 2
Conceptual Design

Horse Creek Watershed Study
Appendix 6A

Shoun-001 and Shoun-002

The Shoun-001 site is located in T18N, R62W, Sec. 23, at approximate elevation 4977 feet[1]. The Shoun-002 site is located in T18N, R62W, Sec. 27, at approximate elevation 5080 feet. These sites are 10-12 miles southwest of LaGrange.

The prospective wells are on the south slopes of the Horse Creek valley. The valley is carved into the Brule Member of the White River Formation at this point, with the overlying Arikaree Formation cropping out on the upper slopes and across the plateau area to the south. In the bottom of the valley, in a band along Horse and Mills Creeks, are the alluvial deposits produced by those streams.

The Arikaree Formation is generally more permeable than the Brule. The springs on the figure appear to be a function of that permeability contrast, as groundwater moving downward through the Arikaree encounters the lower permeability of the Brule and moves laterally (northward) to discharge at or above where that geologic contact intersects the ground surface. The springs east of the Shoun-002 prospect surface at approximately elevation 5050 feet.

[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.

There are 11 existing groundwater permits in the surrounding area. See the attached figure for locations[2].

Permit	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
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12670	Petsch Land Co.	20	20	100
7266	Petsch Farms, LLC	25		60
7276	Irvin Petsch	10	30	100
7277	Irvin Petsch	10	30	100
7278	Irvin Petsch	10	30	100
399	Petsch Land Co.	875	50	90
703	Petsch Land Co.	1450	25	80
110562	James Anderson	10	48	190
82288	James Anderson	25	18	210
18584	Little Horse Creek Cattle Co.	6	15	54
5567	Donahue & Rutledge, Inc.	5	20	137
18586	Little Horse Creek Cattle Co.	25	90	235
7279	Petsch Land Co.	5 - 10	Unknown	100

As can be seen on the figure, most of these wells are in the "bottom" of the drainage, along Horse Creek, Little Horse Creek, and the associated surface irrigation ditches. The standout wells in this list in terms of yield are #399 and #703. The logs for these two relatively shallow wells indicate completion in the Brule Formation rather than in the alluvial deposits of the creeks, but they may have encountered a local area of the type of "fracturing" in the upper Brule that creates the

[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.

prolific LaGrange Aquifer downstream. This situation is not widespread, and should not be anticipated at the Shoun prospects.

While the permeability at wells #399 and #703 may be anomalous, the water levels should be representative of area conditions. Subtract of the reported depth-to-water from the surface elevation indicates a local groundwater level elevation of 4820 - 4845 feet. Given the northward gradient of groundwater flow, a static water level of approximately 130 feet can be anticipated at the Shoun-001 prospect (surface elevation minus groundwater elevation). Similarly, interpolation of water level elevations between the area of #5567 and #18586 (i.e. approximately 5300 feet) and the area of wells #399 and #703, suggests at the Shoun-002 prospect, a groundwater elevation of approximately 5050 feet (i.e. depth-to-water of 30-50 feet) may be anticipated. (This groundwater elevation is consistent with the nearby spring elevations discussed above.)

With respect to permeability (i.e. aquifer productivity), the Shoun-001 prospect is reliant on encountering either fracture zones or the occassional local sand layer within the Brule Formation. Local experience is perhaps best represented by wells #110562 and #82288, where penetration was more than 150 feet beyond the static water level. Thus, a total well depth of approximately 280 feet may be necessary to achieve production in the 10 - 20 gpm range. Favorable conditions may be encountered shallower, of course, and drilling should attempt to identify if that is the case as total depth decisions are made.

The Shoun-002 prospect may have somewhat more favorable conditions as it starts in the more generally permeable Arikaree Formation. If favorable conditions are not encountered in the first 100 feet, it will be necessary to proceed into the underlying Brule, where an additional 100 to 200 feet may be necessary to accumulate the target yield.

All of those well owners who opined on groundwater quality felt the quality was “good”, i.e. for the intended use of watering stock.

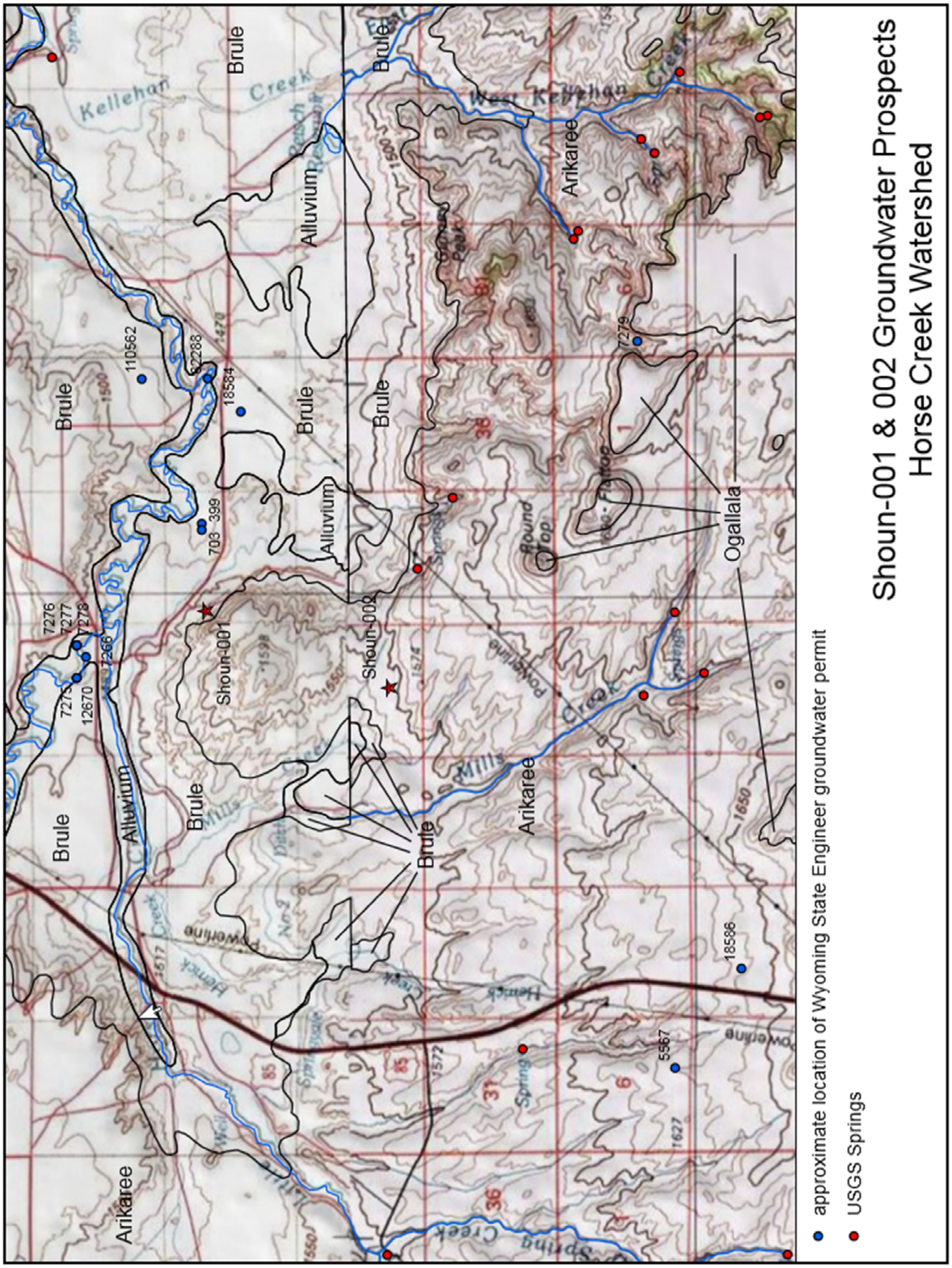
Conclusions:

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 and, at the Shoun -002 prospect, of encountering shallower groundwater in the basal Arikaree Formation strata.

2. Groundwater quality at this location is likely adequate for stock use.

3. 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.


Shoun-001 & 002 Groundwater Prospects
Horse Creek Watershed
approximate location of Wyoming State Engineer groundwater permit
USGS Springs
Shoun-001
Shoun-002
Brule
Alluvium
Arikaree
Ogallala
Round Top
West Kellehan Creek
Kellehan Creek
Mills Creek
Spring Creek

Watershed Plan Component: **L/W-030**
Project Name: **Shoun Well Construction Project No. 2**
Project Sponsor/Number: **Shoun-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,800
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	200	$ 10,000
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000	1	$ 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	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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 30,800
	Contingencies (15% of subtotal)				$ 4,620
	Engineering and technical assistance (10% of subtotal)				$ 3,080
	Estimated project cost				$ 38,500

L/W-031: Tomayer Stock Reservoir Rehabilitation Project No. 1 (Tomayer-002)

This project involves the rehabilitation of an existing reservoir which has become filled with sediment which limits its functionality.

Project components would include:

- Removing accumulated sediment from the existing reservoir

Project Location:

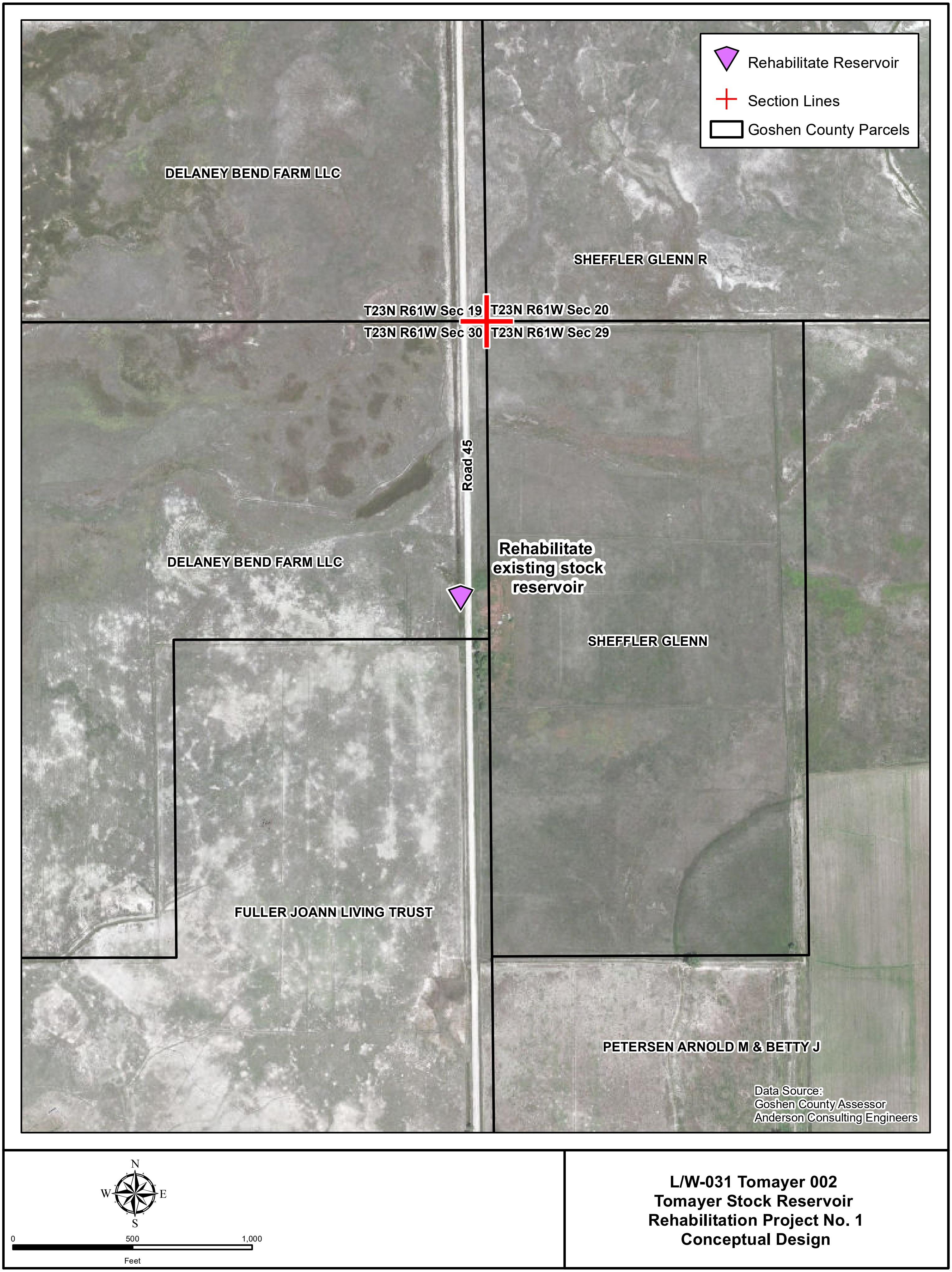
- Section 27, Township 22 North, Range 62 West

Land Ownership (Surface):

- Private

Water Source:

- Unnamed tributary



L/W-031 Tomayer 002
Tomayer Stock Reservoir
Rehabilitation Project No. 1
Conceptual Design

Watershed Plan Component: **L/W-031**
Project Name: **Tomayer Stock Reservoir Rehabilitation Project No. 1**
Project Sponsor/Number: **Tomayer-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 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		$ -
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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	2000	$ 8,000
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				$ 8,800
	Contingencies (15% of subtotal)				$ 1,320
	Engineering and technical assistance (10% of subtotal)				$ 880
	Estimated project cost				$ 11,000

L/W-032: Tomayer Stock Reservoir Rehabilitation Project No. 2 (Tomayer-003)

This project involves removal of sediment accumulated in an existing ditch and construction of a new stock reservoir.

Project components would include:

- Installing sediment removal from an existing earthen ditch
- Excavation and construction of a livestock reservoir adjacent to the ditch

Project Location:

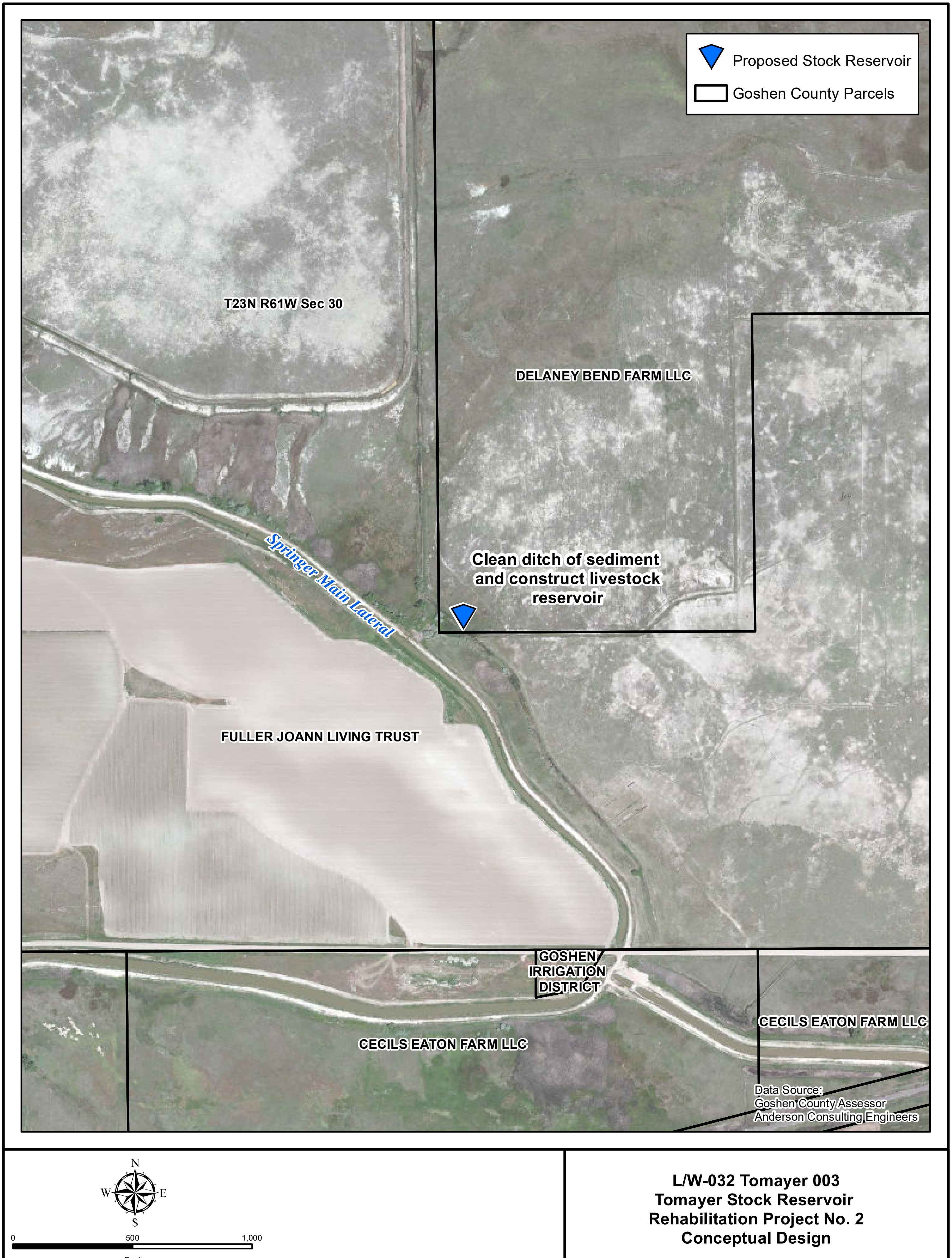
- Section 30, Township 23 North, Range 61 West

Land Ownership (Surface):

- Private

Water Source:

- NA



L/W-032 Tomayer 003
Tomayer Stock Reservoir
Rehabilitation Project No. 2
Conceptual Design

Watershed Plan Component: **L/W-032**
Project Name: **Tomayer Stock Reservoir Rehabilitation Project No. 2**
Project Sponsor/Number: **Tomayer-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,850
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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	3000	$ 19,500
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				$ 37,600
	Contingencies (15% of subtotal)				$ 5,640
	Engineering and technical assistance (10% of subtotal)				$ 3,760
	Estimated project cost				$ 47,000

L/W-033: Tremain Solar Platform Project No. 1 (Tremain-001)

This project would involve drilling a new well to replace an existing well in poor condition and installing a solar platform / pump. The existing stock tank would be used and not replaced. Completion of the project would provide a reliable source of water to livestock and wildlife.

Project components would include:

- Installing a new well approximately 250 feet deep.
- Installing new solar platform, pump and requisite fittings in the new well.
- Abandonment of existing well.

Project Location:

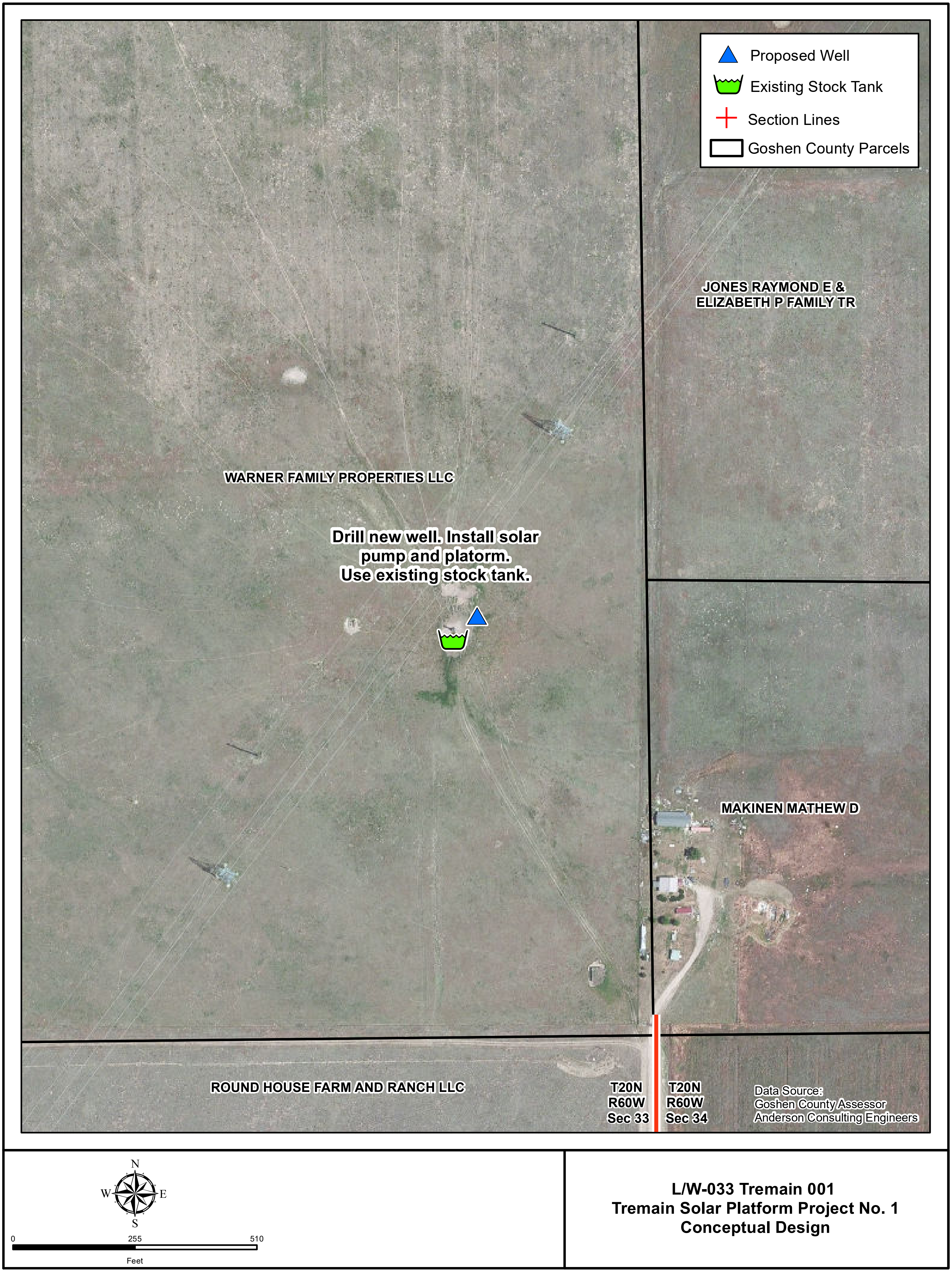
- Section 34, Township 20 North, Range 60 West

Land Ownership (Surface):

- Private

Water Source:

- New well construction



L/W-033 Tremain 001
Tremain Solar Platform Project No. 1
Conceptual Design

Hydrogeologic Report

Tremain-001

The Tremain-001 site is located in T20N, R60W, Sec. 33, 5 miles ENE of LaGrange, at approximate elevation 4588 feet. The site is actually just outside (east of) the Horse Creek watershed, in the upper Pumpkin Creek drainage basin. The prospect is to replace an existing well at this site in which the casing has apparently collapsed. No permit has been located for the existing well (although this may be a function of location ambiguity for permits in the area rather than clear determination that the well has not received a permit).

This prospect is in an area directly underlain by the Brule Member of the White River Formation, just east of the LaGrange Aquifer. The Arikaree Formation caps the Sixty-Six Mountain to the north of the site. Unlike in the LaGrange area, the Brule is not commonly fractured in this area, and groundwater production reflects its basic, much-less-permeable, siltstone character. Similarly, because the site is remote from the areas of active surface-water irrigation to the west, it is dependent upon local precipitation for recharge.

There are 6 existing groundwater permits in this area, listed in order of proximity to the Tremain-001 site. See the attached figure for locations[1].

Permit[2]	Permit-listed Owner	Reported Yield (gpm)	Depth to Water (ft)	Total Depth (ft)
4518	Clyde Warner	7.5	30	70
171435	David Johnson	8	48	125
4519	Clyde Warner	7.5	30	80

[1]The location of the prospective well is accurate; the locations of the State Engineer's Office groundwater permits may be only approximate, e.g. the center of the 1/4 1/4 Section in which the permit is located, rather than the exact location.

[2]Full scans of permit documents for most wells are available electronically at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

150301	Raymond Jones	10	46	95
36209	Harold Nighswonger	15	195	225
36210	Harold Nighswonger	15	195	225

The closest existing groundwater permit with a lithologic log is #171435, which was completed open hole from 20 to 125 feet. That the hole would stand open, i.e. without casing holding back the formation, indicates well-indurated bedrock. However, if the existing well at the Tremain-001 site was constructed in the same manner, it may be that its collapse was the result of not having been fully cased.

This open interval in #171435 was described as "firm Brule", water bearing in "broken areas - medium sand" from 30 to 60 feet, and in "sandy clay" from 60 to 100 feet. Few data are available for the other wells in the area, all of which are completed in the Brule based on the reported depths. That #36209 and #36210 had to drill so deep to develop a useful water supply and that the pumps are set at 220 and 222 feet, respectively, demonstrates the variable productivity of the Brule in the surrounding area. (Similarly, for the successful #17135, it is reported that it's original location ½ mile west "did not provide a well with sufficient water".) Given the success, at the very modest level required for stock and domestic wells, of the collapsed well at the Tremain-001 site and of the two closest permitted wells, however, recovery of that level of production seems secure.

Subtraction of the reported depths to water at #171435 and #4518 from their surface elevations (approx. 4590 feet) indicates a groundwater elevation of approximately 4540 feet. At the Tremain-001 site, this places the depth to water at approximately 48 feet.

All of those well owners who opined on groundwater quality felt the quality was "good", i.e. for the intended use of watering stock.

Conclusions:

1. The aquifer at the Tremain-001 site has been demonstrated to be sufficiently productive and of sufficient groundwater quality to support the desired use.

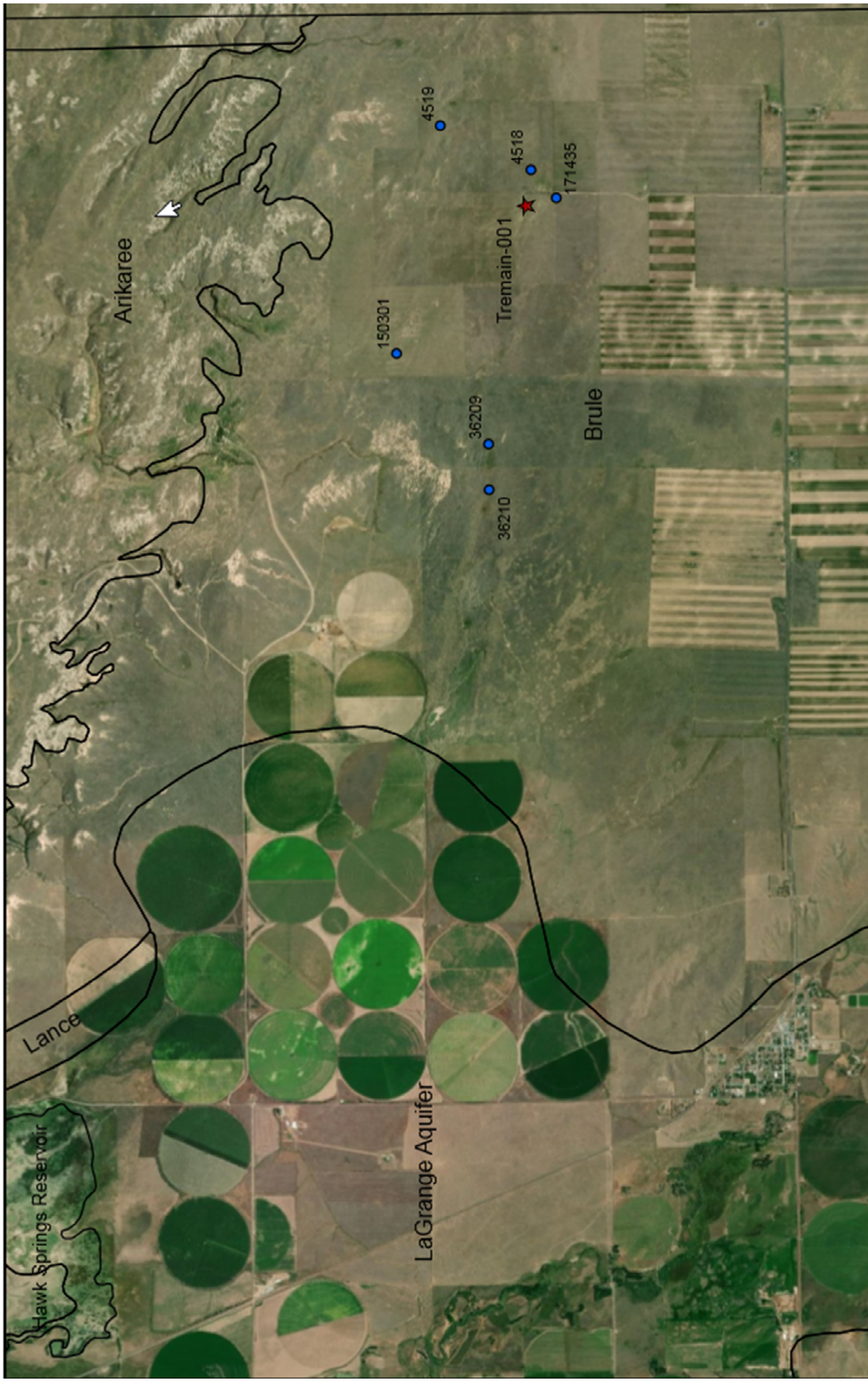
2. The failure of the existing well at the site may be due to formation collapse rather than casing failure. Replacement with a cased well is recommended.

3. A well of approximately 150 feet depth can be expected to perform satisfactorily and to provide ample available drawdown to accommodate seasonal and long-term fluctuations in the groundwater table.

4. Although hydrogeologic conditions may vary substantially over short distances in these strata, those variations are insufficiently understood to provide detailed siting criteria. Precise well locations should be governed by access and engineering convenience.

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.

Horse Creek Watershed Study
Appendix 6A



● approximate location of Wyoming State Engineer groundwater permit

Tremain-001 Groundwater Prospect
Horse Creek Watershed

Watershed Plan Component: **L/W-033**
Project Name: **Tremain Solar Platform Project No. 1**
Project Sponsor/Number: **Tremain-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,775
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	1	$ 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	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	250	$ 750
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 30,525
	Contingencies (15% of subtotal)				$ 4,579
	Engineering and technical assistance (10% of subtotal)				$ 3,053
	Estimated project cost				$ 38,156

L/W-034: Tremain Solar Platform Project No. 2 (Tremain-002)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well

Project Location:

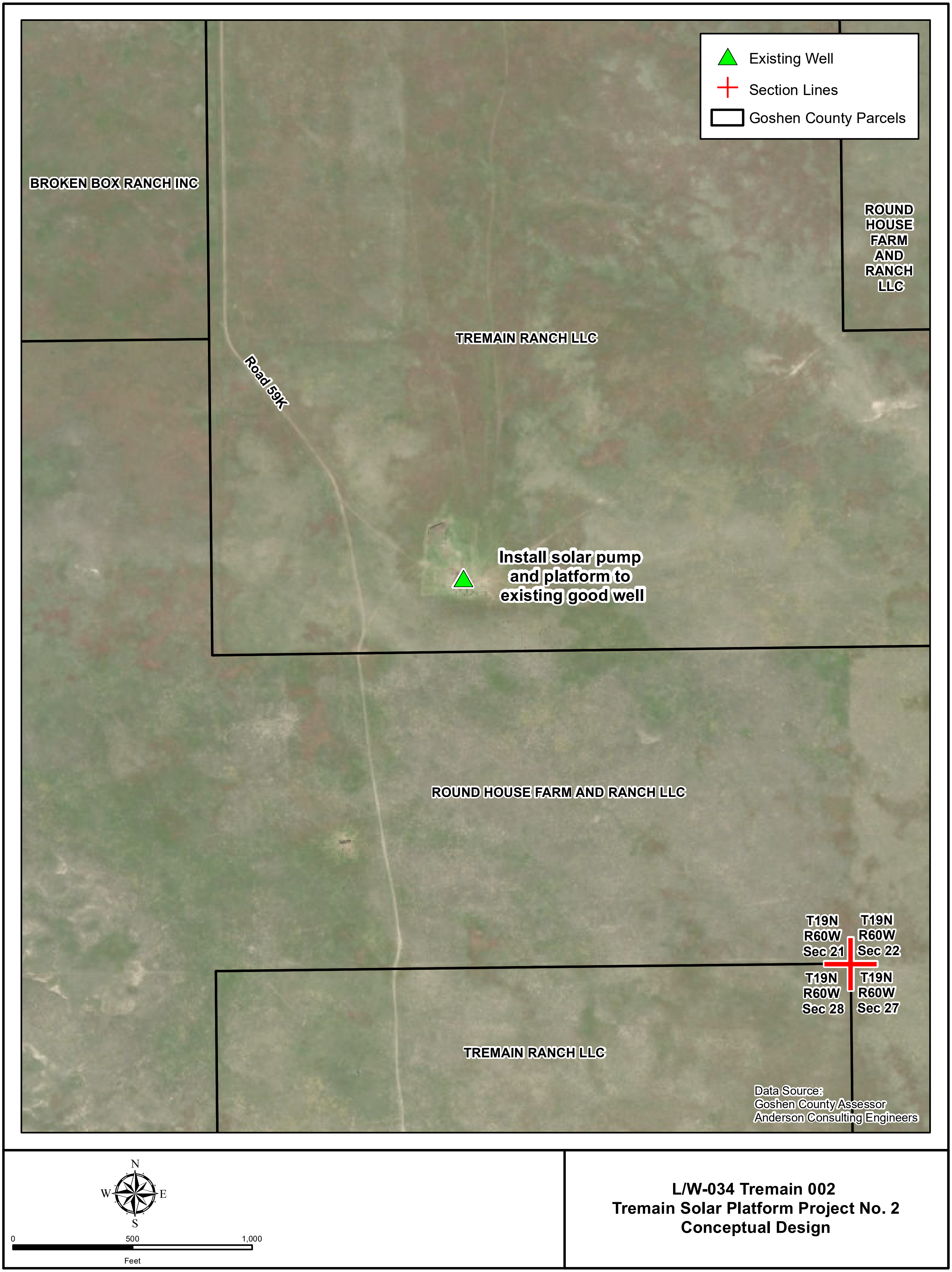
- Section 21, Township 19 North, Range 60 West

Land Ownership (Surface):

- Private

Water Source:

- Existing Well



L/W-034 Tremain 002
Tremain Solar Platform Project No. 2
Conceptual Design

Watershed Plan Component: **L/W-034**
Project Name: **Tremain Solar Platform Project No. 2**
Project Sponsor/Number: **Tremain-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,550
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		$ -
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 17,050
	Contingencies (15% of subtotal)				$ 2,558
	Engineering and technical assistance (10% of subtotal)				$ 1,705
	Estimated project cost				$ 21,313

L/W-035: Tremain Solar Platform Project No. 3 (Tremain-003)

The proposed project would entail installation of a solar platform/pump in an existing well. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing solar platform and pump in an existing well

Project Location:

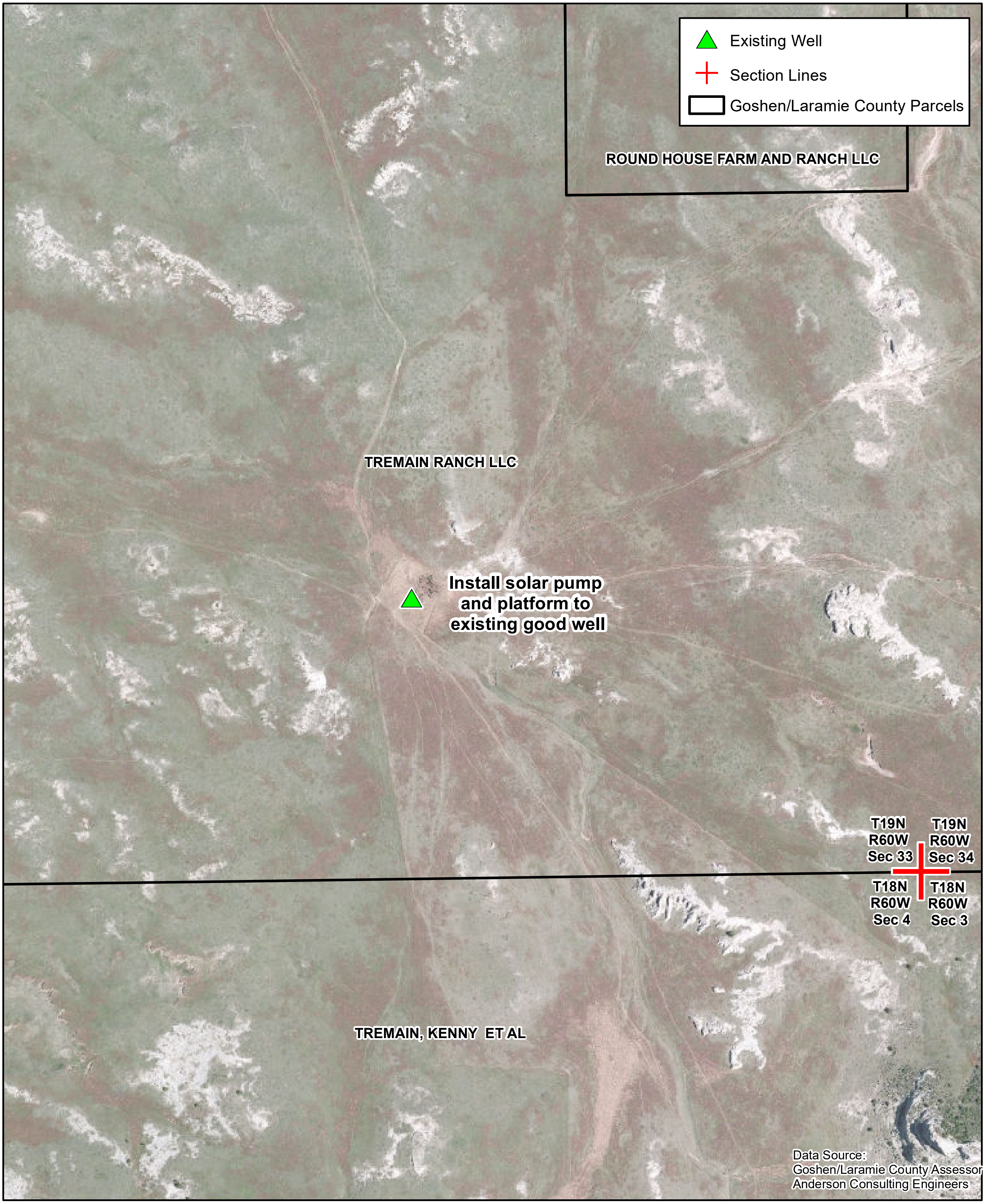
- Section 33, Township 19 North, Range 60 West

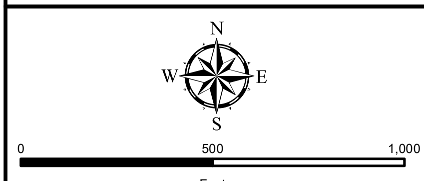
Land Ownership (Surface):

- Private

Water Source:

- Existing well





L/W-035 Tremain 003
Tremain Solar Platform Project No. 3
Conceptual Design

Watershed Plan Component: **L/W-035**
Project Name: **Tremain Solar Platform Project No. 3**
Project Sponsor/Number: **Tremain-003**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,450
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		$ -
2b	Spring Development	LS	$ 5,000		$ -
3a	Solar Pump System - less than 250' TDH	LS	$ 11,000	1	$ 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	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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 15,950
	Contingencies (15% of subtotal)				$ 2,393
	Engineering and technical assistance (10% of subtotal)				$ 1,595
	Estimated project cost				$ 19,938

L/W-036: Yeik Pipeline Project No. 1 (Yeik-001)

This project involves extension of buried pipelines from an existing well to a new stock tank. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing approximately 3,725 linear feet of buried 1 ½ inch diameter HDPE pipeline aligned to the north.
- Installation of one 1,200 gallon rubber tire stock tank.

Project Location:

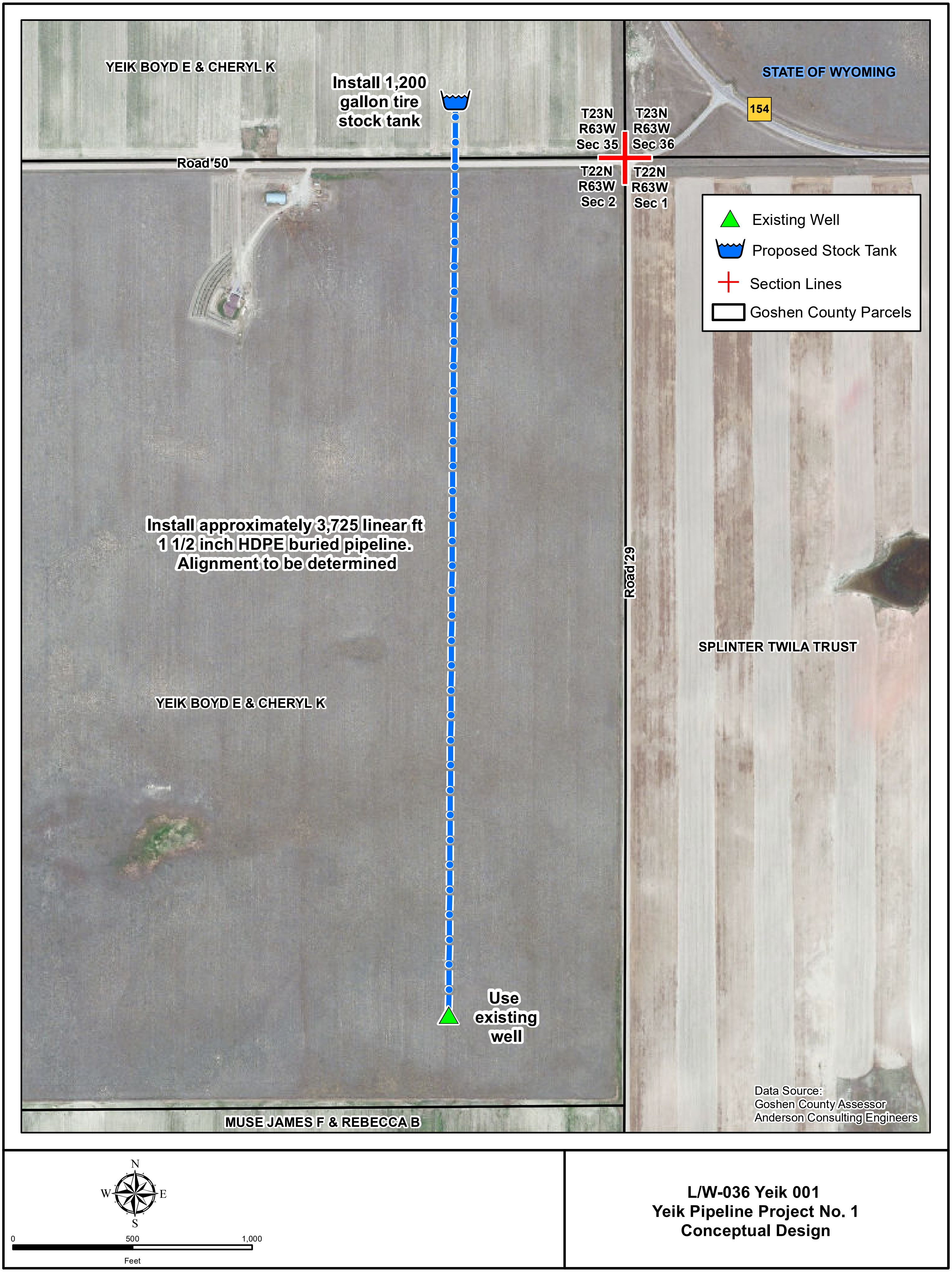
- Section 35, Township 23 North, Range 63 West
- Section 2, Township 22 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-036 Yeik 001
Yeik Pipeline Project No. 1
Conceptual Design

Watershed Plan Component: **L/W-036**
Project Name: **Yeik Pipeline Project No. 1**
Project Sponsor/Number: **Yeik-001**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,468
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	3725	$ 11,175
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 16,143
	Contingencies (15% of subtotal)				$ 2,421
	Engineering and technical assistance (10% of subtotal)				$ 1,614
	Estimated project cost				$ 20,178

L/W-037: Yeik Pipeline Project No. 2 (Yeik-002)

This project involves extension of buried pipelines from an existing well to a new stock tank. Completion of the project would result in reliable sources of water for livestock and wildlife in an area without alternate sources. The project would also facilitate greater grazing management flexibility.

Project components would include:

- Installing approximately 4,100 linear feet of buried 1 ½ inch diameter HDPE pipeline aligned to the north.
- Installation of one 1,200 gallon rubber tire stock tank.

Project Location:

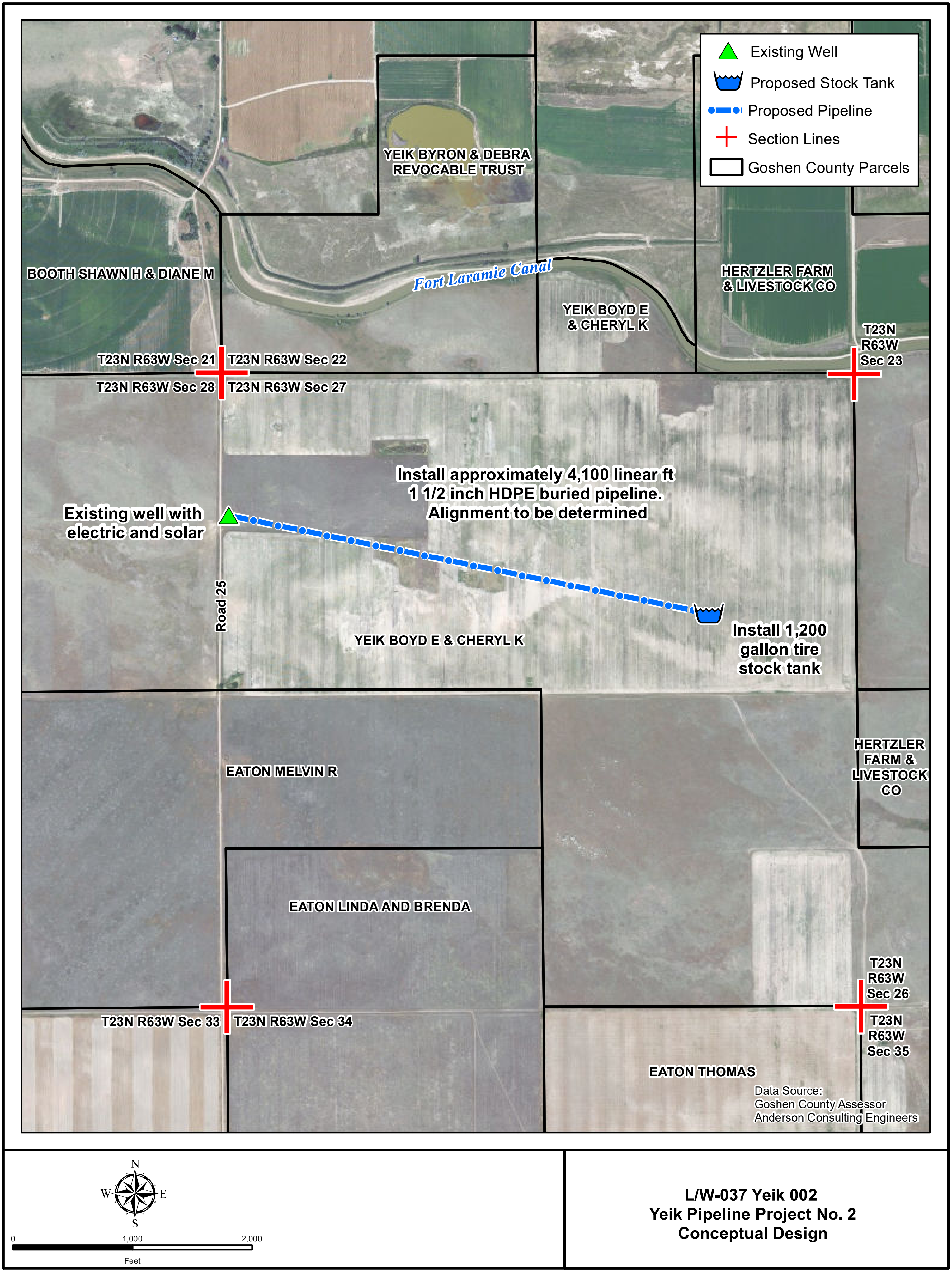
- Section 27, Township 23 North, Range 63 West

Land Ownership (Surface):

- Private

Water Source:

- Existing well



L/W-037 Yeik 002
Yeik Pipeline Project No. 2
Conceptual Design

Watershed Plan Component: **L/W-037**
Project Name: **Yeik Pipeline Project No. 2**
Project Sponsor/Number: **Yeik-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,580
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	4100	$ 12,300
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 17,380
	Contingencies (15% of subtotal)				$ 2,607
	Engineering and technical assistance (10% of subtotal)				$ 1,738
	Estimated project cost				$ 21,725

L/W-038: Zimmerer Spring Development (Zimmerer-001)

The proposed project would involve development of an existing spring.

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 spring development system.
- Installing 1,200-gallon rubber tire stock tank
- Installing approximately 300 LF of 1.5" diameter buried HDPE pipeline
- Installation of a solar platform / pump to pump the water upslope approximately 55 vertical feet.

Project Location:

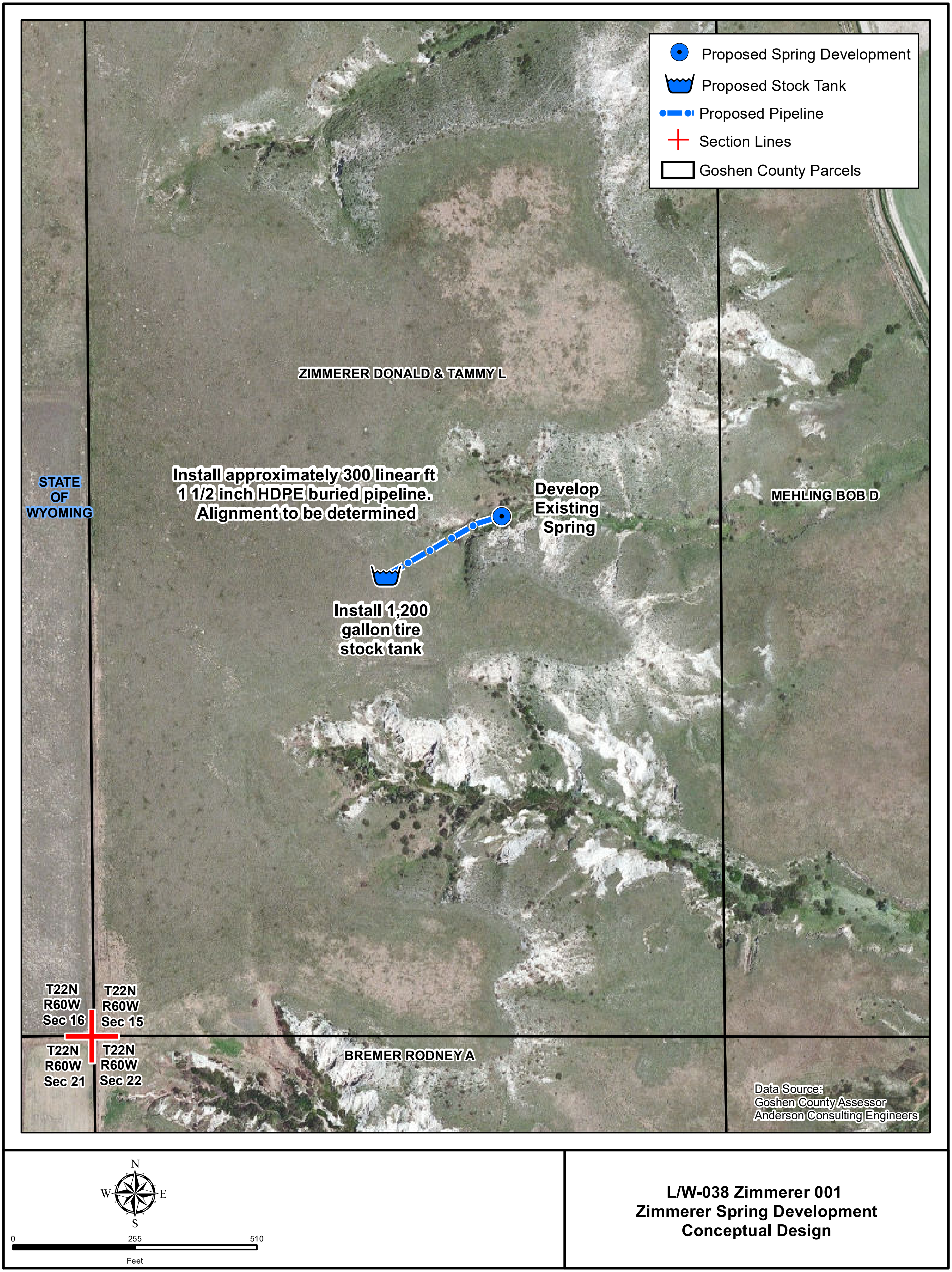
- Section 15, Township 22 North, Range 60 West

Land Ownership (Surface):

- Private

Water Source:

- Existing spring



L/W-038 Zimmerer 001
Zimmerer Spring Development
Conceptual Design

Watershed Plan Component: **L/W-038**
Project Name: **Zimmerer Spring Development**
Project Sponsor/Number: **Zimmerer**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 2,390
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	1	$ 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	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	300	$ 900
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 26,290
	Contingencies (15% of subtotal)				$ 3,944
	Engineering and technical assistance (10% of subtotal)				$ 2,629
	Estimated project cost				$ 32,863

ENV-001: Buchaults Check Structure - Horse Creek (Buchaults-002)

This project would involve construction of a rock check structure on Horse Creek. The purpose of the structure would be to provide the adequate water surface elevation to facilitate diversion.

Project components would include:

- Installing a rock vortex weir.

Project Location:

Section 30, Township 21 North, Range 61 West

Land Ownership (Surface):

Private

Water Source:

Horse Creek

ENV-001 Buckhaults 002 Buckhaults Check Structure - Horse Creek Conceptual Design

Watershed Plan Component: **ENV-001**
Project Name: **Buchaults Check Structure - Horse Creek**
Project Sponsor/Number: **Buchaults-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 12,500
1A	Lump sum based on other information	LS			$ 125,000
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 137,500
	Contingencies (15% of subtotal)				$ 20,625
	Engineering and technical assistance (10% of subtotal)				$ 13,750
	Estimated project cost				$ 171,875

Horse Creek Watershed Study
Appendix 6A

ENV-002: Horse Creek Bank Stabilization Project (Frank-002)

This project involves stabilization of an actively eroding stream bank on Horse Creek. Currently, the stream is impinging upon the right bank and nearing County Road 236.

Project components would include:

- Reducing the steep slope to a more stable configuration
- Placing compacted fill material
- Installing j-hook rock vanes

Project Location:

- Section 24, Township 18 North, Range 62 West

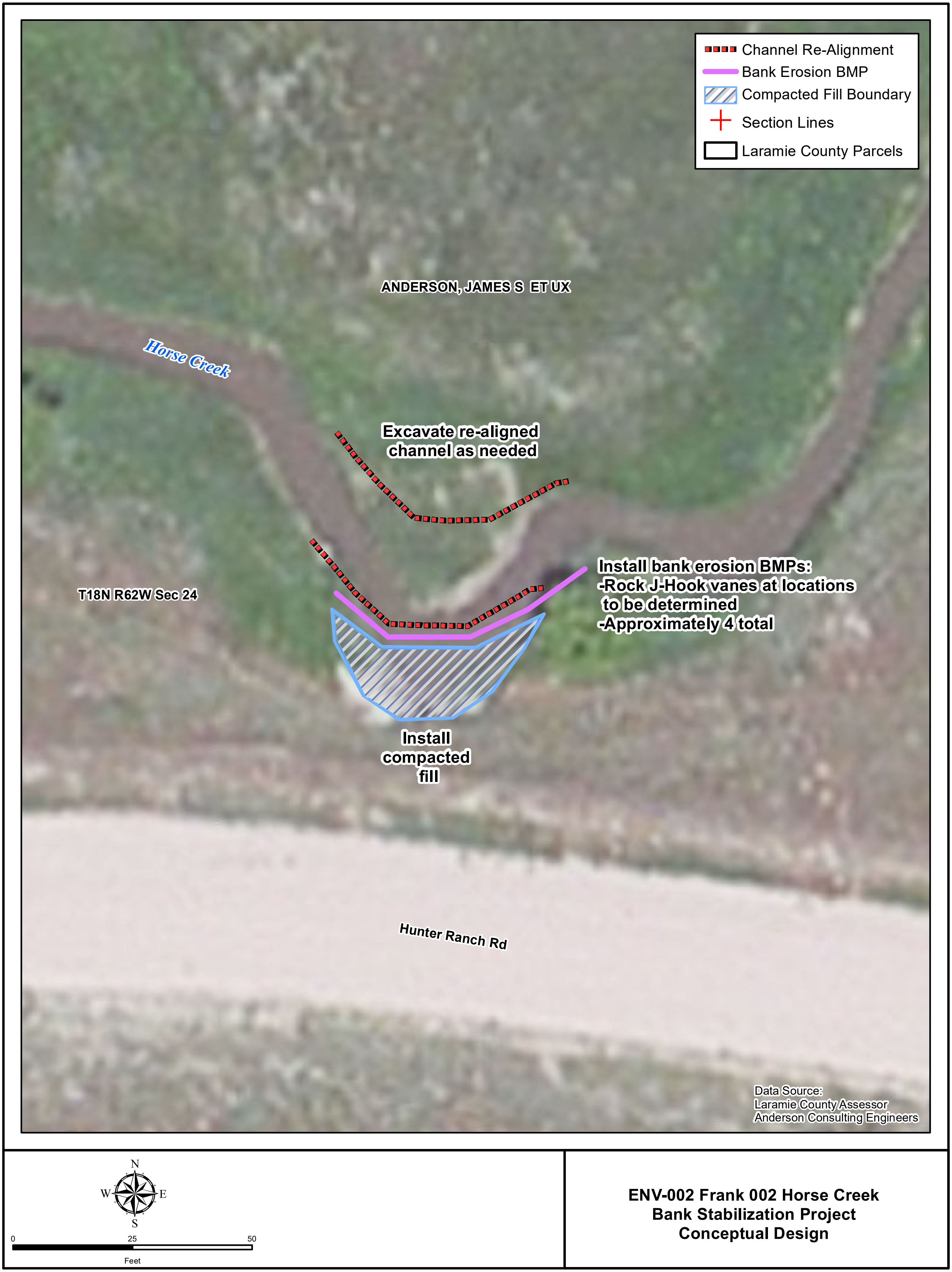
Land Ownership (Surface):

- Private

Water Source:

- Horse Creek

Horse Creek Watershed Study
Appendix 6A



ENV-002 Frank 002 Horse Creek
Bank Stabilization Project
Conceptual Design

Watershed Plan Component: **ENV-002**
Project Name: **Horse Creek Bank Stabilization Project**
Project Sponsor/Number: **Frank-002**

Bid Item	Description	Unit	Unit Price	Quantiy	Item Total
1	Mobilization - assume 10% of other costs	LS			$ 1,780
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	1	$ 9,000
12	Irrigation turnout structure / Waterman 18-inch gate	Ea	$ 4,000		$ -
13a	Irrigation pipe HDPE 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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	200	$ 800
18	Excavation and Placement of Embankment Fill	CY	$ 7	400	$ 2,600
19	Special backfill around pipes. Compaction around and min. 2' cover ov	CY	$ 12		$ -
20	Riprap - 8" Nominal sized rock 12" thick	CY	$ 125	40	$ 5,000
21	Filter fabric under riprap	SY	$ 4	100	$ 400
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	1	$ 1,250
28	Miscellaneous work - road and fencing	LS	$ 2,000		$ -
	Project Subtotal				$ 20,830
	Contingencies (15% of subtotal)				$ 3,125
	Engineering and technical assistance (10% of subtotal)				$ 2,083
	Estimated project cost				$ 26,038

ENV-003: Bear Creek Sedimentation Project (Kessler-001)

This project would involve restoration of a stable stream channel in the vicinity of the Bear Creek Ditch headgate. Currently, Bear Creek appears to be aggrading with sediment deposition. Field investigations indicate that the source of sediment appears to be channel degradation and stream bank erosion in upstream reaches. Sediment deposition in this area where stream energy is insufficient to transport it has apparently caused the stream bed to aggrade, or to build up. The result is a boggy section where there is no well-defined channel. Mitigation of this situation would require an in-depth investigation of the system.

Initial mitigation concepts include excavation of a new stream channel mimicking the original stream alignment based upon historic aerial photographs. This solution would be, however, temporary as without reduction in the sediment supply from upstream, the problem would persist.

Consequently, a channel stability evaluation is recommended for Bear Creek. The study would include:

- Comparison of historic aerial photographs to evaluate changes in channel alignment and the time associated with them.
- Survey of existing channel profile and cross sections
- Mapping of stream bank erosion, headcuts, and other indicators of channel instability
- Geomorphic evaluation of potential solutions to restore stability to the Bear Creek system.

Project Location:

Section 36, Township 20 North, Range 63 West

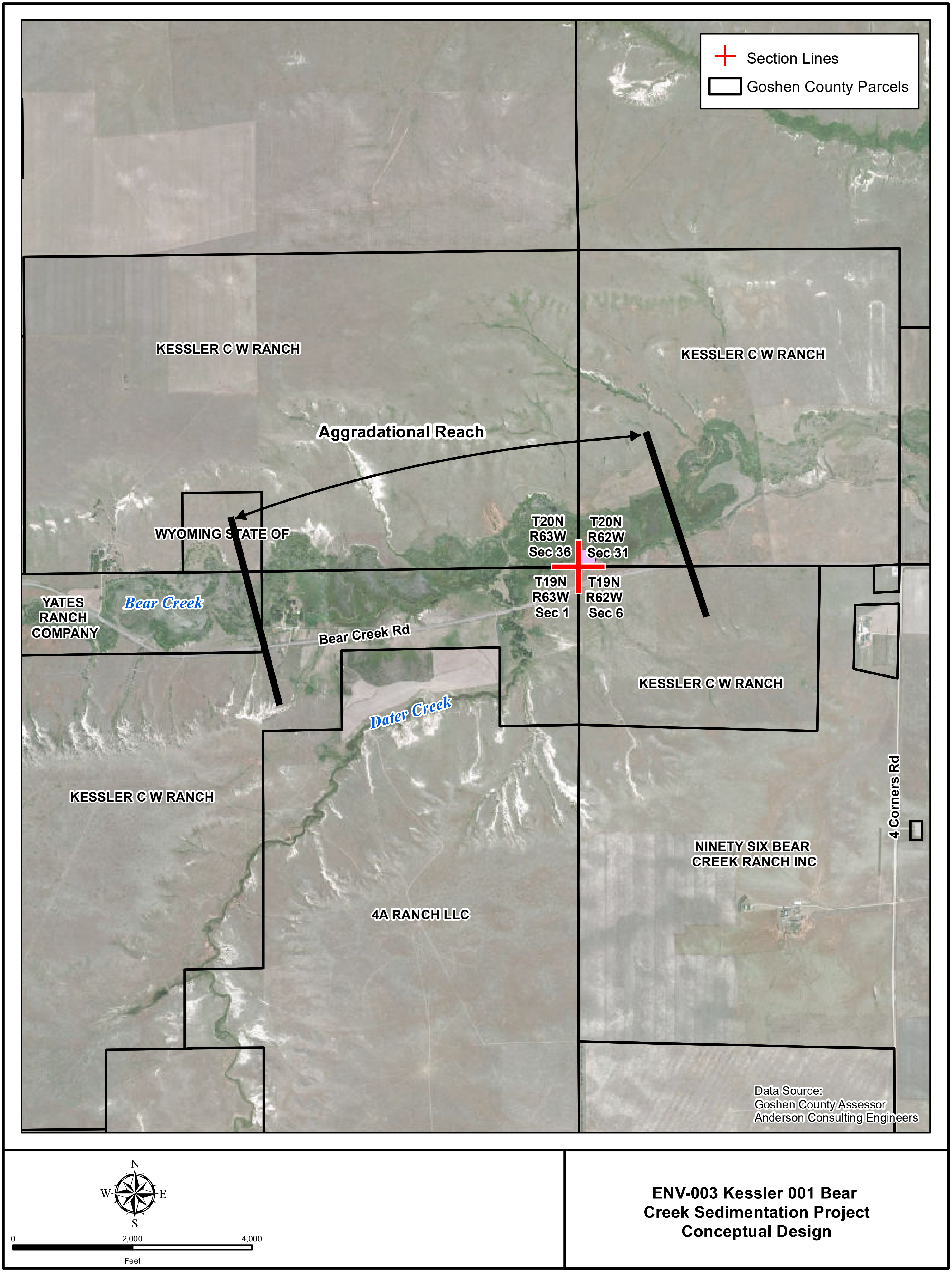
Section 1, Township 19 North, Range 63 West

Land Ownership (Surface):

Private

Water Source:

Bear Creek



ENV-003 Kessler 001 Bear Creek Sedimentation Project Conceptual Design

Watershed Plan Component: **ENV-003**
Project Name: **Bear Creek Sedimentation Project**
Project Sponsor/Number: **Kessler-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			$ 45,000
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 24-inch diameter	LF	$ 40		$ -
13b	Irrigation pipe HDPE 18-inch diameter	LF	$ 20		$ -
13c	Irrigation pipe HDPE 8-inch diameter	LF	$ 12		$ -
13d	Irrigation Misc. Structure Small	Ea	$ 4,500		$ -
13e	Irrigation Misc. Structure Medium	Ea	$ 9,000		$ -
13f	Irrigation Misc. Structure Large	Ea	$ 18,000		$ -
13g	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				$ 45,000
	Contingencies (15% of subtotal)				$ 6,750
	Engineering and technical assistance (10% of subtotal)				$ 4,500
	Estimated project cost				$ 56,250

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 3.4.5.5 and Figure 3.3-12. 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 Horse Creek 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 nine 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 in Figure 4.10-1. As shown in this figure, 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 38 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 4.10-2. 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 4.10-3. 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 4.10-4. 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

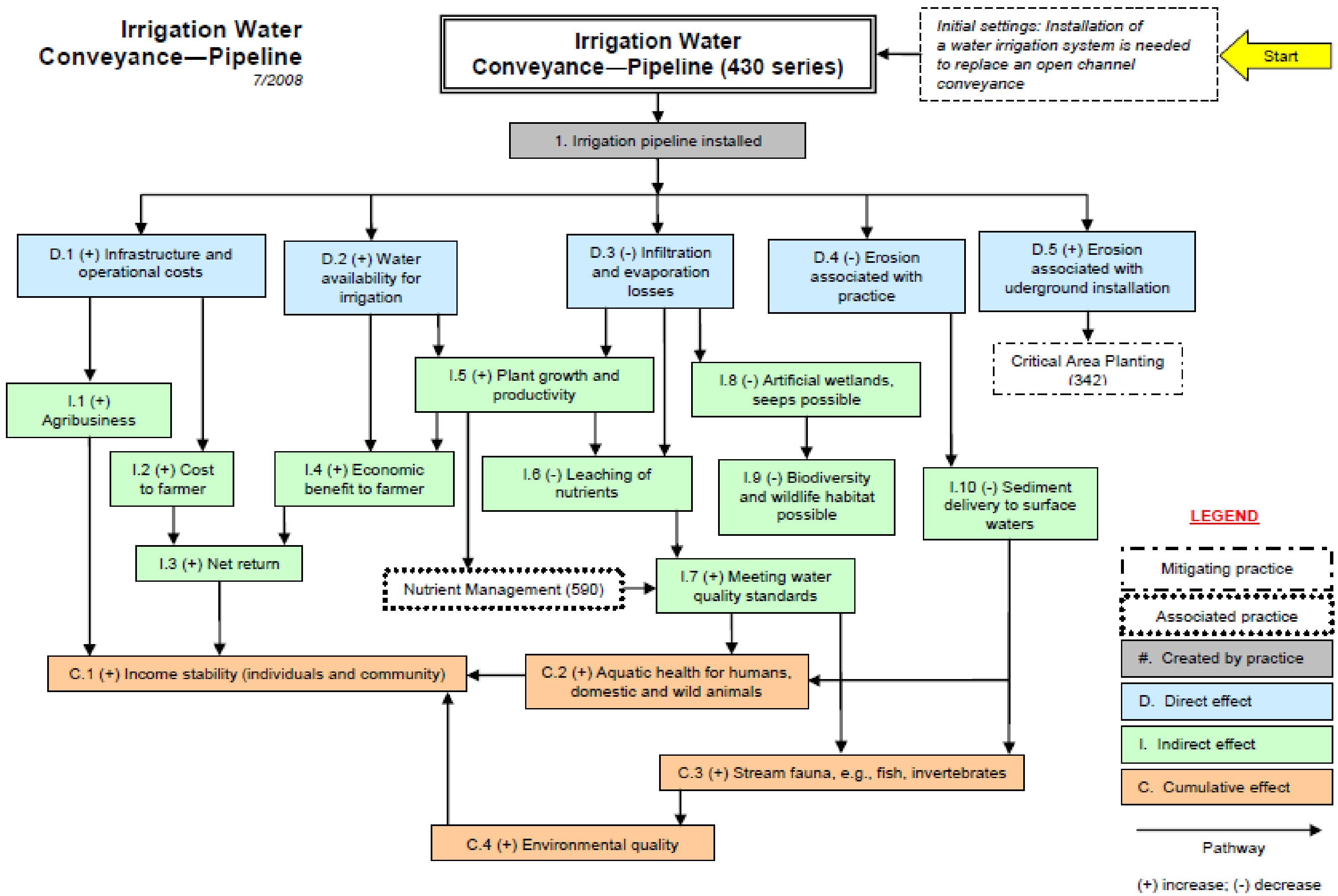
Cumulative benefits of implementing streambank and shoreline protection could include:

- 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

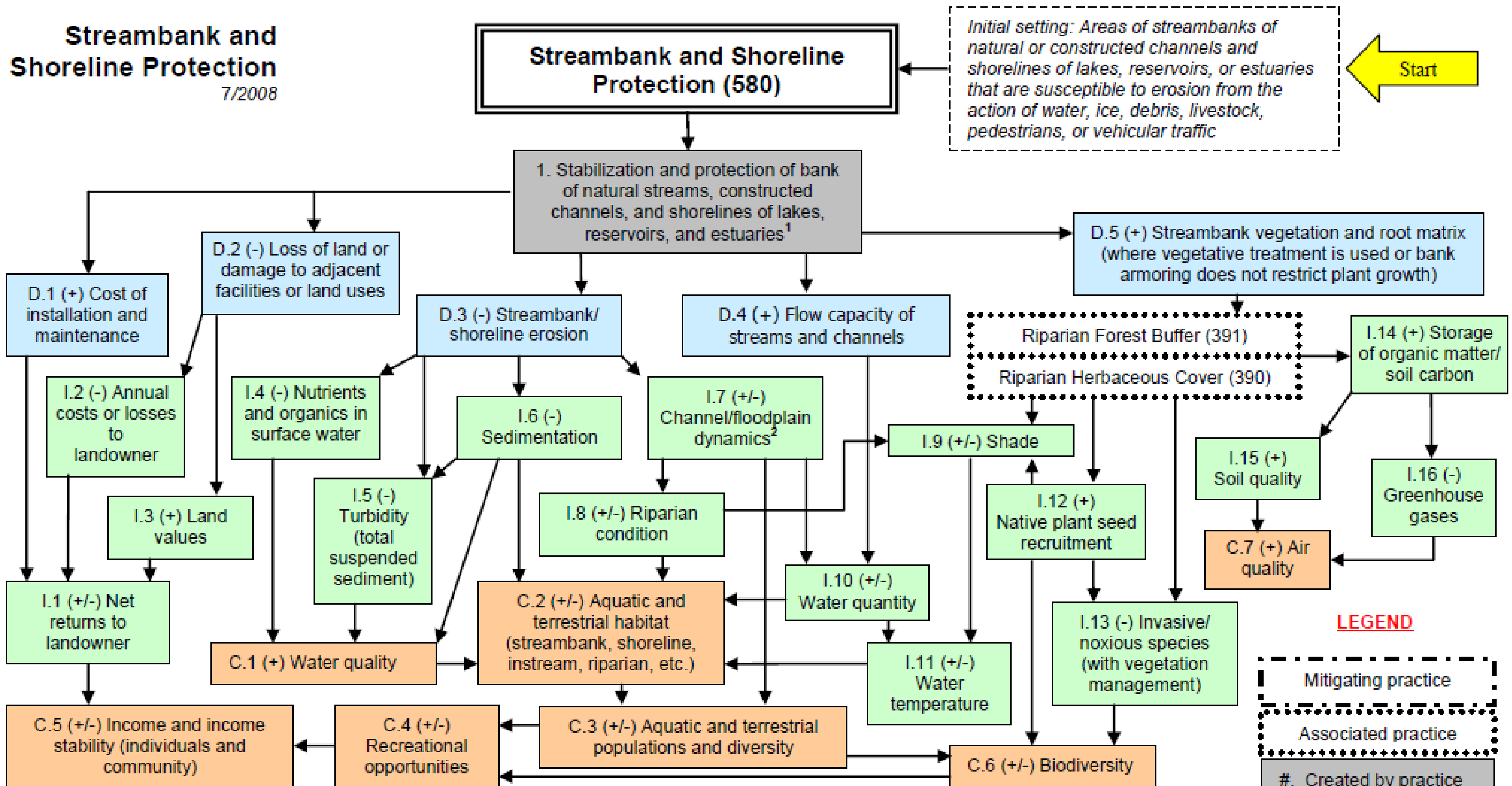
Benefits of storage facilities and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 4.10-5. As shown in this figure, direct and indirect benefits associated with this BMP include:

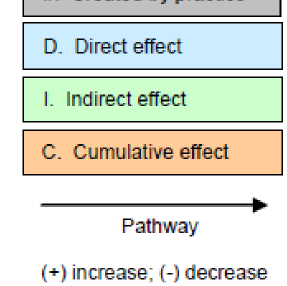
- Storage of water for late season irrigation supply
- Storage of water for municipal and industrial use
- Supply of flow augmentation
- Flood control and attenuation of peak flows downstream
- Wetland enhancement and development
- Sediment management
- Aquatic habitat
- Recreation opportunities



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.6-1 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.

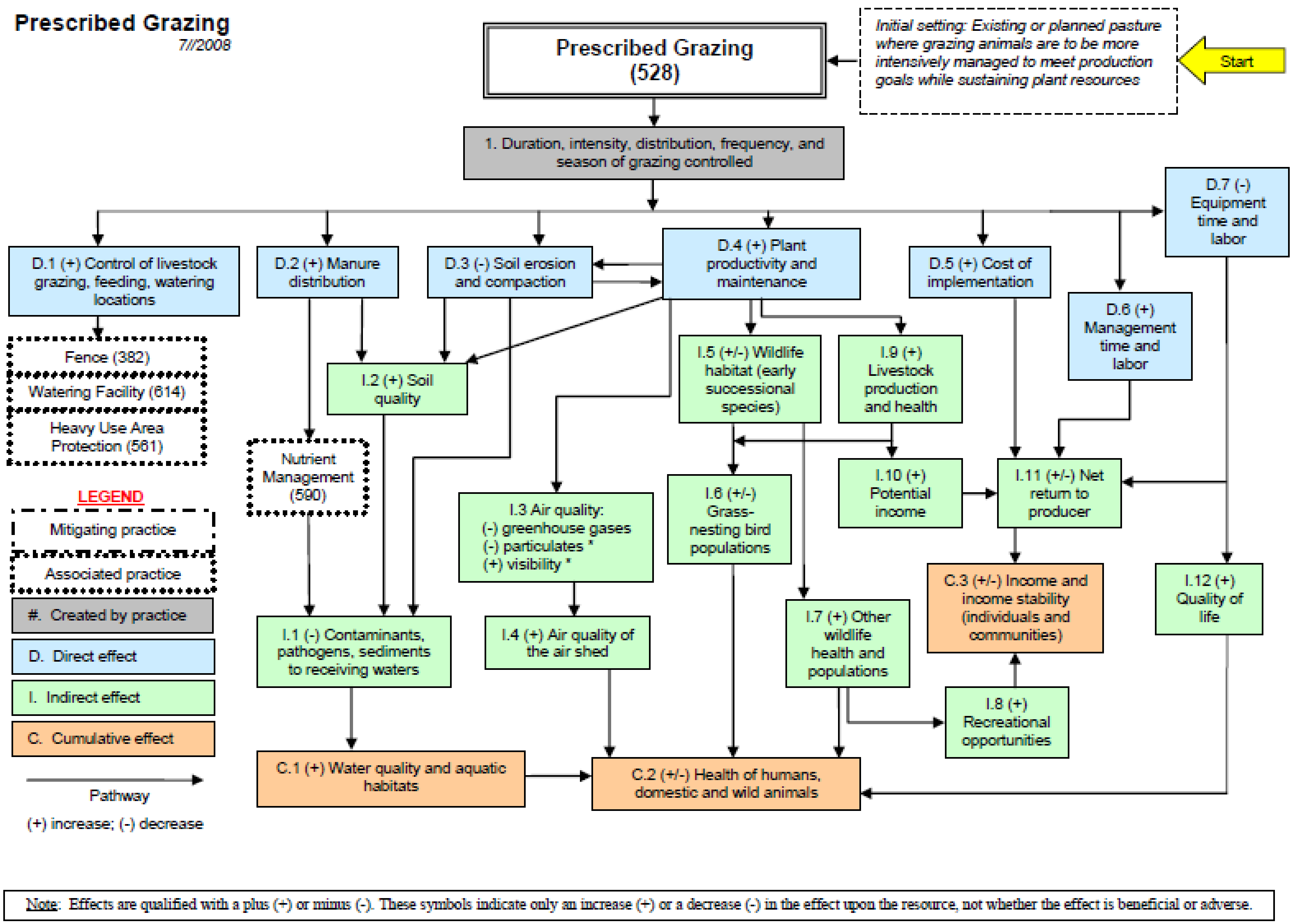
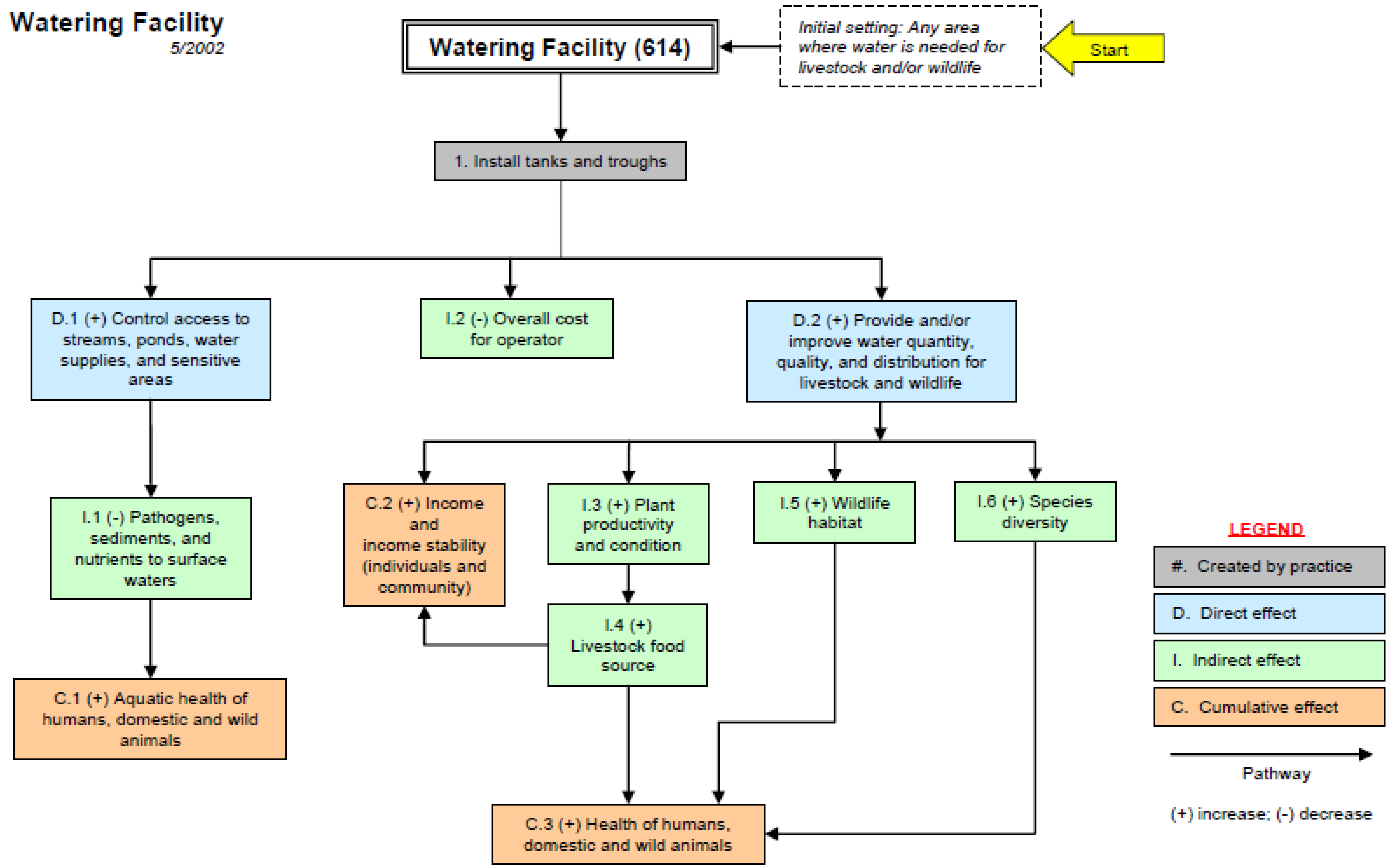


Figure 6B.6-3 Network Effects Diagram for Prescribed Grazing.



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

LIVESTOCK AND WILDLIFE WATER SOURCE IMPROVEMENTS

APPENDIX 6C - LIVESTOCK AND WILDLIFE WATER SOURCE IMPROVEMENTS

6C.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 6C.1 shows a typical spring development scheme.

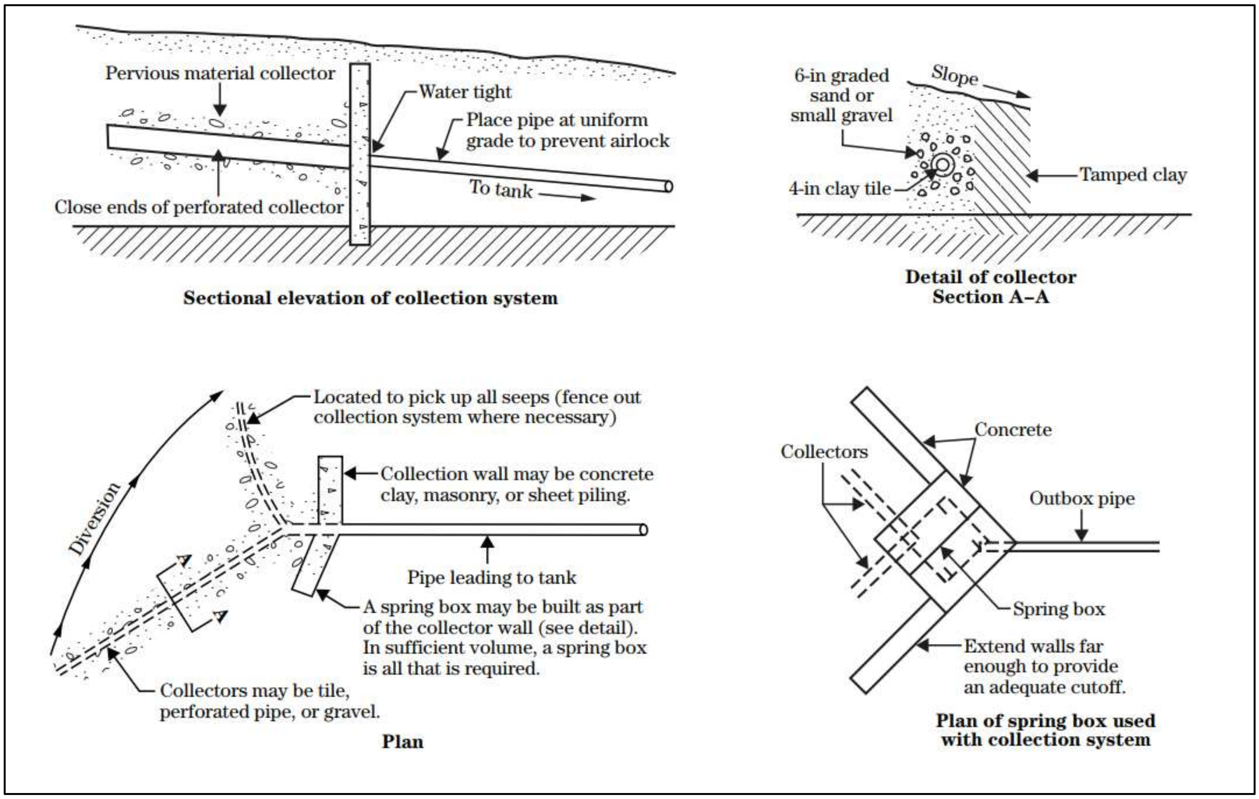


Figure 6C.1 Typical Spring Collection System

6C.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.

6C.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.

6C.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.

6C.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.

6C.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.

6C.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 6C.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 6C.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 6C.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/.

6C.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 Goshen and Albany Counties

Goshen and Albany Counties have adopted regulations for land use zoning, aquifer protection, wastewater, and floodplain development within the project area. Both 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:

- Goshen County Planning and GIS by telephone (307) 532-3852
  Website: https://goshencounty.org/welcome-to-planning-and-gis/
- Albany County Land Use Department at (307) 721-2568
  Website: http://www.co.albany.wy.us/planning.aspx

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