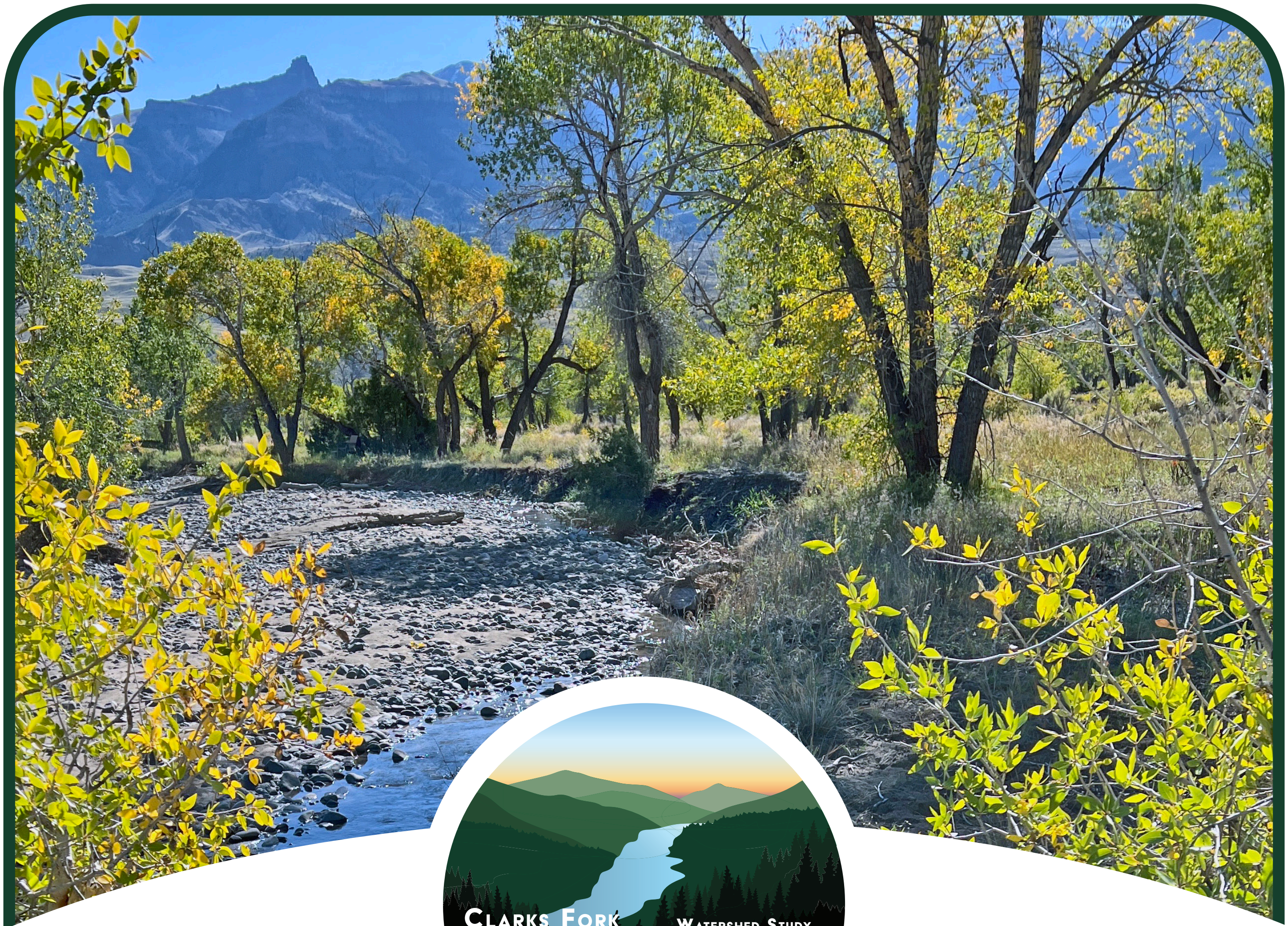

Clarks Fork/Upper Shoshone Watershed Level I Study

Draft Report

Prepared For:

Wyoming Water Development Commission | Cody Conservation District | Powell-Clarks Fork Conservation District

Prepared By:

Trihydro Corporation

In Association With:

Anderson Consulting Engineers, Inc. | Hinckley Consulting

RESPEC Company LLC | Wyoming Water Rights Consulting, Inc.

DRAFT FOR REVIEW

CLARKS FORK/UPPER SHOSHONE WATERSHED

LEVEL I STUDY

WYOMING WATER DEVELOPMENT COMMISSION

November 7, 2023

Project #: 006N-006-0010

SUBMITTED BY: Trihydro Corporation

1252 Commerce Drive, Laramie, WY 82070

IN ASSOCIATION WITH:

Anderson Consulting Engineers, Inc.

RESPEC Company LLC

Hinckley Consulting

Wyoming Water Rights Consulting, Inc.

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1.0 INTRODUCTION AND OVERVIEW

The Cody Conservation District and the Powell – Clarks Fork Conservation District, serving as sponsors (Sponsors), submitted a funding request to the Wyoming Water Development Commission (WWDC) to support the completion of a comprehensive watershed management plan for the Clarks Fork and Upper Shoshone River watersheds (Project) in 2021. The funding request's primary goal was to conduct a thorough watershed inventory, identifying key issues concerning land use and water resources. Subsequently, the plan aimed to develop strategies to address and mitigate these identified issues. The WWDC approved the funding request, and in October 2021, the Project was awarded to Trihydro Corporation (Trihydro). The Project team consists of Trihydro and subconsultants Anderson Consulting Engineers, Inc. (ACE), RESPEC Company LLC (RESPEC), Hinckley Consulting, Inc. (Hinckley), and Wyoming Water Rights Consulting, Inc. (WWRCI).

1.1 PROJECT OVERVIEW

The Clarks Fork/Upper Shoshone Watershed, Level I Study (Study) represents a comprehensive assessment and initial inventory of the water and land resources situated within the designated study area (Study Area). This Level I Study is instrumental in furnishing critical data the Sponsors and the WWDC can leverage in formulating water resource management strategies and implementing conservation practices aimed at addressing water and land resource concerns within the Study Area.

This Study delves into detailed descriptions of proposed water development projects, which have the potential to yield economic, ecological, and social benefits for the state of Wyoming and its residents. The primary report objective is to present the Study findings and outcomes.

1.2 STUDY AREAS

The Study Area is extensive; it covers over 2.3 million acres which converts to approximately 3,500 square miles. About 37.3 percent or 1,305 square miles comprise the Clarks Fork watershed and the remaining 62.7 percent (2195 square miles) is the Upper Shoshone River watershed. Appendix 1A: Map 1 identifies the Study Area, including the headwaters region upstream of Buffalo Bill Reservoir and easterly to Bitter Creek / Shoshone River Confluence within Park County. The Study Area includes the populated areas around Cody and Powell and smaller towns along the mainstem of the Shoshone River. It is relatively undeveloped and consists of National Forest, rangeland, irrigated lands, and other open spaces. Elevations within the watershed range from 4,015 feet above mean sea level at the downstream limit to 12,090 feet above mean sea level at the top of Fortress Mountain located in the Absaroka Range.

1.3 PROJECT PURPOSE AND SCOPE

The Study and rehabilitation plan purpose is to describe the Study Area's current conditions and identify resolutions for water-related issues that provide improvement opportunities. The WWDC watershed study objective statement is:

> *"The objective of a Watershed Study is to evaluate an individual watershed's existing conditions and, from collaboration with landowners, stakeholders, and public outreach, develop a Watershed Management and Rehabilitation Plan and identify projects that are eligible for funding from WWDC and other sources that may improve or maintain watershed function and systems."*

The Level I Study purpose was to combine the available data and information with the study-generated inventory data to develop a comprehensive watershed management and rehabilitation plan outlining 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 WWDC.
- Facilitate public participation through public meetings, open houses/workshops, and advertisements.
- Conduct a Study Area evaluation and description, including quantity and quality of surface water resources, and riparian/upland conditions.
- Inventory and describe irrigation systems, water storage, and flood control needs present.
- Conduct a geomorphic primary channel assessment and identify potential mitigation measures to improve impaired channel reaches.
- 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 improvement cost estimates.
- Complete an economic analysis and evaluate alternative funding sources.

Note: Appendix 1A includes Study Area maps referenced throughout this document.

2.0 TASK 1: SCOPING AND PROJECT MEETINGS

The Project team coordinated and participated in public scoping meetings, public Project meetings/workshops, and progress meetings. The Sponsors and WWDO staff also assisted coordinating and participating in the various meetings. The public meetings/workshops intent was to inform Study stakeholders and solicit input. Input from landowners, agencies, and other stakeholders was imperative to the overall Project success. The Project team's efforts to engage stakeholders through public outreach and a summary of Project meetings and site visits is discussed below.

2.1 PUBLIC OUTREACH

The public outreach effort objective was to increase public awareness and provide interested parties multiple avenues to gain Study information and/or to provide input. Public relations materials such as flyers, advertisements, emails, and social media graphics were developed that were visually appealing and consistent. This enabled the Project team to communicate Study information effectively. Public outreach components described below included developing Project branding, webpages, and mailings.

Project "branding" assisted in facilitating Project recognition. Figure 2-1 presents the Project team-created Study logo used throughout the Study. This brand was used in correspondence, flyers, webpages, and social media to present a consistent image. The objective was to generate a consistent appearance that was publicly recognizable.

FIGURE 2-1. PROJECT LOGO

Additional avenues used to advertise the Project and solicit participation included:

- A mailing list was developed using Park County Assessor's data. Letters describing the Project and meeting announcements were sent to owners of properties zoned "agricultural" and greater than 40 acres. This equated to 826 landowners.
- Radio ads were placed with KPOW and the five Big Horn Radio Network stations.
- Webpages were placed on both the Cody Conservation District and the Powell – Clarks Fork Conservation District websites and the Cody Conservation District Facebook page.
- Newspaper ads were placed in the Cody Enterprise and Powell Tribune (local newspapers).
- Flyers were posted by the Conservation Districts at select locations around Cody and Powell.

2.2 SCOPING AND PROJECT WORKSHOPS

The Project team coordinated meetings that typically included informal presentations conducted by the team and the Wyoming Water Development Office (WWDO).

The meeting objectives were to:

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

During these meetings, Project team members were readily available to engage in landowner and stakeholder one-on-one discussions. These interactions were instrumental in fostering dialogue and collaboration while also laying the foundation for the development of watershed plan alternatives. This direct and personalized approach allowed for a more comprehensive understanding of individual's concerns and perspectives, ultimately contributing to the watershed plan alternatives refinement.

Scoping meetings were conducted in both Cody and Powell with the aim of promoting broad participation. These meetings included a Project-team presentation, providing a Project overview and outlining stakeholder opportunities to actively engage. Subsequent to the presentation, there were extensive discussions among participants, focusing on the

Project's objectives, local concerns, and, importantly, the criteria for Project participation and eligibility for funding through the WWDC Small Water Project Program (SWPP).

Trihydro staff, the Sponsors, and WWDO staff were available for one-on-one landowner, stakeholder, or general public discussions at the Project workshops/open houses. These gatherings did not follow a formal presentation or structured agenda. Instead, they provided a platform for informal conversations where attendees could seek information, share insights, and explore the initiation of Project plans. These interactions often concluded with the commencement of Project planning activities or scheduling future on-site visits.

In addition, several additional meetings were held with WWDO staff. These were typically informal "virtual" meetings held to discuss Project issues, progress, and budgets.

The list below summarizes the public meetings and important meetings conducted with the Sponsors and WWDO staff:

- Project Kick-off Meeting, Virtual Meeting, May 4, 2022
- Project Scoping Meeting, Park County Public Library, June 1, 2022
- Project Scoping Meeting, Northwest College, Powell, June 2, 2022
- Public Workshop, Park County Public Library, September 1, 2022
- Project Progress Meeting: WWDO, Virtual Meeting, January 26, 2023
- Public Workshop, Park County Public Library, March 16, 2023

Appendix 2A contains copies of the meeting sign-in sheets.

2.3 SITE VISITS

Site visits were conducted with interested landowners to address their concerns regarding their specific water resource related issues. Key areas of concern included irrigation infrastructure, upland livestock/wildlife water opportunities, drainage issues and stream channel condition observations of. Each site visit also included a discussion of potential funding opportunities related to the landowner's project, particularly WWDC's SWPP procedures and eligibility requirements.

Visits generally consisted of a property tour with the landowner while discussing potential projects and solutions to water-related issues. During these property visits, initial planning and conceptual project designs were discussed for upland livestock/wildlife and irrigation water improvements. The Project team contacted approximately 80 contacts. 60 individuals/agencies were interviewed: some on multiple occasions.

Local ranchers, irrigators, and residents who invited the Project team to visit their properties demonstrated extensive watershed knowledge and valuable insight. The Project team was able to incorporate landowners' knowledge, insight, direction, and experience into the Study and provide a more effective watershed evaluation.

3.0 TASK 2: REVIEW OF BACKGROUND INFORMATION

3.1 COLLECTION OF EXISTING INFORMATION

There is a significant amount of information available pertaining to the project Study Area. 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. The acronyms listed in this section are used throughout this document.

- United States (US) Bureau of Land Management (BLM)
- US Bureau of Reclamation (BOR)
- US Geological Survey (USGS)
- US Department of Agriculture (USDA)/Natural Resources Conservation Service (NRCS)
- US Department of Agriculture (USDA)/Farm Service Agency (FSA)
- US Department of Agriculture (USDA)/Forest Service: Shoshone National Forest (USFS)
- US Environmental Protection Agency (EPA)
- US Fish and Wildlife Service (USFWS)
- US Department of Interior (DOI)
- US 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 STUDIES FUNDED BY THE WWDC

Several projects and studies have been completed through the WWDC within the Study Area. The Water Resources Data System (WRDS) serves as a repository for reports associated with these studies. Within the Project Study Area, there have been at least 45 individual investigations completed on behalf of the WWDC. These studies include irrigation system master plans, irrigation infrastructure assessments, municipal supply investigations, and groundwater investigations. These studies were reviewed, and pertinent information was incorporated into this report where appropriate. Map 2 shows a map of these previous study locations.

Basin-wide Projects/Studies:

- Big Horn Basin-Clarks Fork Level II Study (1986)
- Guidebook for Water Resources Management & Development, Big Horn & Clarks Fork Basins (1988)
- Wind/Bighorn River Basin Plan (2003)
- Wind-Bighorn Basin Plan Update (2010)
- Wind/Bighorn River Basin Water Plan Update Groundwater Study Level I (2012)
- Wind/Bighorn River Basin Plan Update Environmental and Recreational Water Use Analysis (2017)
- Park County Land Use Plan (2023)

Cody Area:

- Big Horn Basin Rural Water Supply, Phase I (1989)
- Big Horn Basin Rural Water Supply Phase II (1990)
- Cody Area Level II Water Supply Project (1996)
- City of Cody Raw Water System Analysis and Proposed Expansion Evaluation (1996)
- Cody Canal Irrigation District Rehabilitation and Hydropower Level II Study (2006)

- Cody Canal Irrigation District Purvis Drop Hydropower Level II, Phase II Study (2008)
- Cody Master Plan Level I Study (2009)
- Cody Canal Irrigation District Rehabilitation and GIS Level II Study (2009)
- Cody Canal Laterals Level II Study (2018)
- Treated Water, City of Cody Master Plan, Level 1 Study (2021)
- Raw Water, City of Cody Master Plan, Level 1 Study (2021)
- Cody Area (Lake View Irrigation)
- Report on Lakeview Irrigation District Consumptive Use and Irrigation Demand Cody, WY (1985)
- Report on Lakeview Irrigation District Value of Production with a Normal and Inadequate Water Supply at Cody, WY (1985)
- Shoshone/Lakeview Water Development Project (1985)
- Cody-Lakeview Irrigation Exchange Project Level II Investigation (1986)
- Lakeview Irrigation Master Plan Level II Study (2013)

Between Cody and Powell:

- Corbett Dam and Tunnel Rehabilitation Study (1983)
- Shoshone Municipal Water Supply Project Level II Investigation (1986)
- Shoshone Municipal Water Supply Pipelines, Level III (1986)
- Heart Mountain Irrigation District Return Flow Level I Study (2006)
- Heart Mountain Screens Level II Study (2007)
- Heart Mountain Irrigation District Master Plan Level II Study (2015)
- Heart Mountain Canal Rehabilitation Level II Study (2016)
- Heart Mountain Canal Rehabilitation Level II Study (2017)
- Level II Feasibility Study, Iron Creek Project Shoshone Irrigation District (1982)

Powell Area:

- Willwood Hydroelectric Project Report on Feasibility Study (1982)
- Willwood Dam Rehabilitation Project (1989)
- Irrigation Hydropower Study Level II (2003)
- Willwood Irrigation District Master Plan Level I Study (2006)
- Willwood Rehabilitation and GIS Level II Study (2009)
- Willwood Irrigation District Master Plan Update Level I Study (2015)
- Feasibility Study, Shoshone Municipal Pipeline Project (1983)
- Northend Water Users, Wellhead Protection Plan (1999)
- Powell Master Plan Level I Study (2000)
- Shoshone Irrigation District Rehabilitation and GIS Level II Study (2008)
- Northwest Rural Water District Master Plan Level I Study (2017)
- North End Water Users Study Level I Study (1999)
- Powell Airport Water Supply Level I Study (2010)

Clarks Fork Basin:

- Pre-Level I Analysis of Water Development Potential, Clarks Fork River (1983)

3.3 PROJECT GEOGRAPHIC INFORMATION SYSTEM

The geospatial data created in conjunction with this Project was incorporated into the Project geodatabase. Previously existing geospatial data used in throughout this Project was not included in the Project geodatabase to reduce redundancy of data. The Project geodatabase was developed using the WWDC geodatabase template for watershed studies.

The Geographic Information Systems (GIS) deliverables were developed following the guidelines and standards detailed in the WWDO GIS Standards Technical Memorandum, Version 3.1 (WWDO 2021). These standards were developed to increase consistency, reduce redundancy for WWDC funded projects. All data in the geodatabase include metadata that provides a detailed description of that data. The coordinate system for the geodatabase is a Geographic

Coordinate System (GCS) based on the North American Datum 1983 (NAD83). The geodatabase was delivered in the ESRI ArcGIS 10.8 format, as specified by the WWDO Project manager.

The existing geospatial data used throughout this Project was obtained from a variety of sources including the WWDO, USGS, WSEO, and SuiteWater GIS. Technological advances in GIS and web-based map servers have rapidly expanded the amount of spatial data available to inform watershed studies. The types of data include layers representing transportation, ownership, land use, climate, vegetation, irrigation, agriculture crops, ecological regions, wetlands, soils, geology, hydrology, wildlife, cultural resources among others. A list of available resources for GIS data is listed below:

- SuiteWater: GIS https://suitewater.wygisc.org/
- Park County, Wyoming GIS Server: https://parkcounty-wy.gov/online-services/
- Wyoming Geospatial Hub (WYGISC) https://geospatialhub.org/
- Wyoming Statewide Parcel Viewer: https://www.arcgis.com/apps/webappviewer/index.html?id=4bb9a66f7287402b8f650aa9f21d3fa5
- Wyoming State Geological Survey Wyoming State Geological Survey
- USGS TNM Download v2 (nationalmap.gov)
- Wyoming State Water Plan Wyoming State Water Plan GIS Standards and Information
- U.S. Fish & Wildlife Services Wetlands Mapper (fws.gov)
- Wyoming Game & Fish Wyoming Game and Fish Department - Geospatial Data
- NRCS Web Soil Survey Web Soil Survey (usda.gov)
- Nature Serve NatureServe | Unlocking the Power of Science to Guide Biodiversity Conservation

4.0 TASK 3: INVENTORY AND DESCRIPTIONS

This section presents an overview of natural resources within the Study Area and corresponding existing conditions. The discussion of various watershed attributes is organized into the following sections:

- Physical Systems
- Biological Systems
- Anthropogenic Systems

The primary goal of this task is to furnish the Sponsors with essential baseline information that can be used in subsequent planning and environmental permitting endeavors. Given the vast Study Area extents, this discussion may not encompass the detail level needed to address all future data requirements. Nevertheless, it does serve as the foundation for most screening and baseline resource assessment activities.

4.1 OVERVIEW

This report section contains concise descriptions of various disciplines, including vegetation, soils, wildlife, hydrology, and more. For each discipline, individual maps were generated within the Project's Geographic Information System (GIS), outlining the nature and extent of the respective watershed attribute. Initially, the Project team used SuiteWater, an online GIS system developed in collaboration between the Wyoming Association of Conservation Districts and the University of Wyoming, for reviewing and evaluating numerous datasets.

The maps presented in this document were subsequently created using Esri ArcGIS and can be found in Appendix 1A. In conjunction, summary tables and associated figures were prepared, offering tabulated information on various attributes related to the relevant watershed characteristics.

4.2 PHYSICAL SYSTEMS

The following section describes the watershed physical systems: climate, geology, groundwater, surface water, and geomorphology. The inventory and descriptions provide a snapshot of the existing conditions.

4.2.1 CLIMATE

The overall climactic conditions summary includes a description of Study Area precipitation, temperature, the growing season and frost-free periods, drought, snowfall and climate variability.

4.2.1.1 TEMPERATURE AND PRECIPITATION

Climate varies based on the wide range in topography and elevation. To characterize climatic conditions, historic data were downloaded from the Western Regional Climate Center (WRCC) for the seven National Oceanic and Atmospheric Administration (NOAA) Cooperative Weather Stations located in the watershed. Three stations contain over one hundred (100) years of data. Overall, the climate is classified as being semi-arid. Table 4-1 summarizes key climatic indicators for these stations:

- Monthly average maximum and minimum temperature, Fahrenheit (F)
- Total precipitation, inches (in.)
- Total snowfall, in.
- Snow depth, in.

Graphic climate data representations are shown in Figure 4-1. These data show that peak summer temperatures typically occur in July, with temperatures in the high 80's at lower elevations and the low 70's at higher elevations. Temperatures during winter months are highly elevation dependent, with the lower elevations having relatively mild temperatures and higher elevations having more extreme cold.

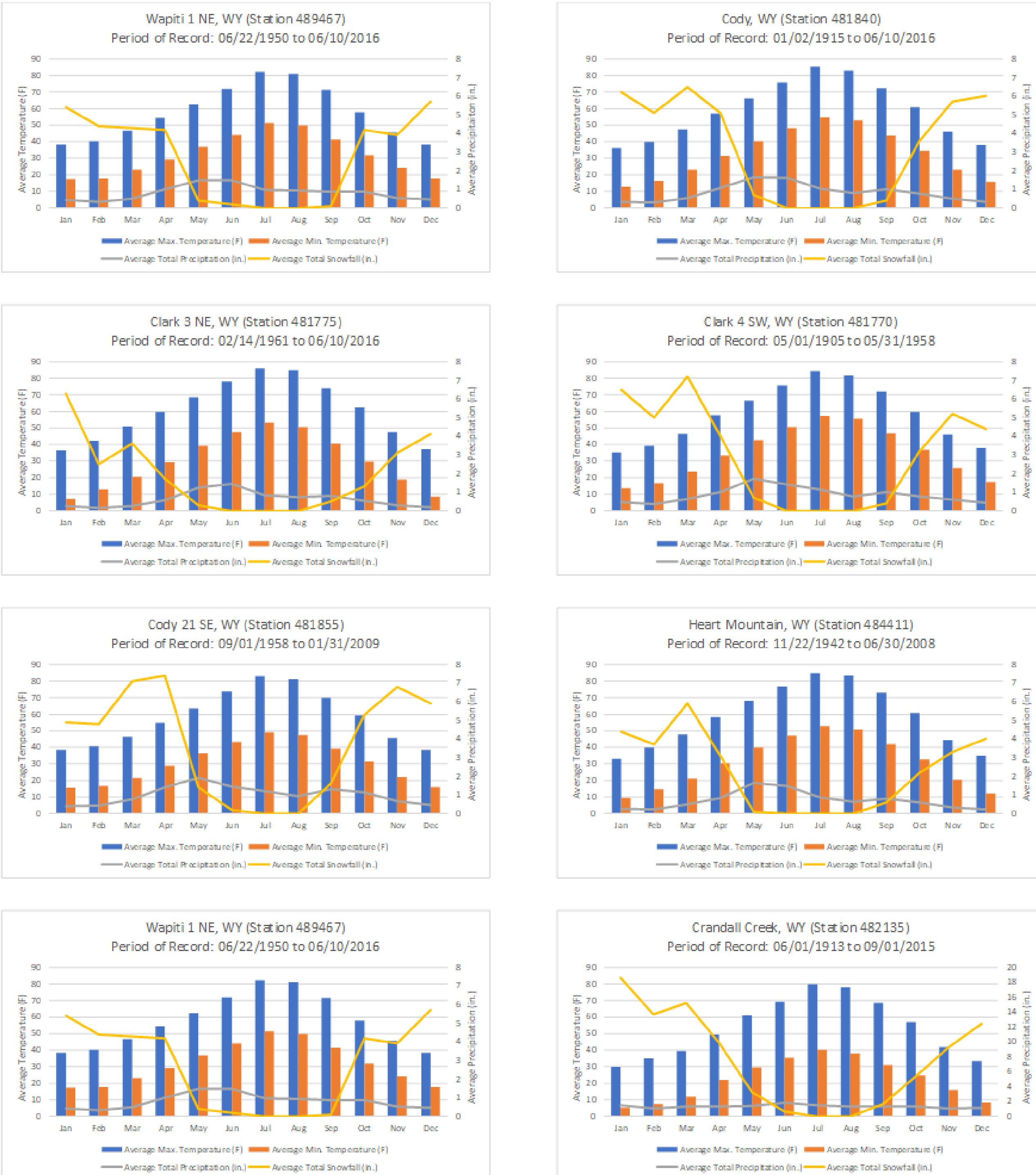
TABLE 4-1. MEAN MONTHLY TEMPERATURES AT PROJECT STUDY AREA WEATHER STATIONS

WEATHER PARAMETER	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Buffalo Bill Dam, WY (Station 481175): 01/01/1915 to 05/31/2016													
Average Max. Temperature (F)	35.7	39.0	45.0	53.7	61.7	70.2	78.4	78.0	70.0	59.6	46.4	37.8	56.3
Average Min. Temperature (F)	18.8	20.9	26.3	34.4	42.3	49.9	57.0	56.2	48.7	40.2	30.0	22.9	37.3
Average Total Precipitation (in.)	0.4	0.4	0.6	1.3	2.1	1.8	1.0	0.8	1.1	0.8	0.5	0.3	11.1
Average Total Snowfall (in.)	5.5	4.1	5.9	4.2	0.2	0.1	0.0	0.0	0.5	1.3	3.6	3.8	29.2
Average Snow Depth (in.)	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Clark 3 NE, WY (Station 481775): 02/14/1961 to 06/10/2016													
Average Max. Temperature (F)	36.3	42.3	50.9	59.8	68.5	77.8	86.1	84.7	74.0	62.2	47.3	37.2	60.6
Average Min. Temperature (F)	7.2	12.9	20.5	29.3	38.9	47.4	53.2	50.4	40.5	29.6	18.9	8.7	29.8
Average Total Precipitation (in.)	0.3	0.2	0.3	0.6	1.2	1.5	0.8	0.7	0.8	0.5	0.3	0.2	7.3
Average Total Snowfall (in.)	6.3	2.5	3.6	1.7	0.3	0.0	0.0	0.0	0.5	1.3	3.1	4.1	23.3

WEATHER PARAMETER	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Snow Depth (in.)	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0
Clark 4 SW, WY (Station 481770): 05/01/1905 to 05/31/1958													
Average Max. Temperature (F)	35.1	39.0	46.5	57.7	66.4	75.8	84.3	81.9	71.9	59.8	46.1	38.0	58.5
Average Min. Temperature (F)	13.5	16.7	23.4	33.5	42.4	50.6	57.2	55.4	46.6	36.6	25.6	17.5	34.9
Average Total Precipitation (in.)	0.5	0.4	0.6	1.0	1.7	1.4	1.2	0.8	1.0	0.8	0.6	0.4	10.3
Average Total Snowfall (in.)	6.5	5.0	7.2	4.0	0.7	0.0	0.0	0.0	0.4	3.2	5.2	4.4	36.7
Average Snow Depth (in.)	2.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
Cody, WY (Station 481840): 01/02/1915 to 06/10/2016													
Average Max. Temperature (F)	35.9	40.0	47.6	56.8	66.1	75.7	85.0	82.8	72.3	60.8	45.9	37.9	58.9
Average Min. Temperature (F)	12.9	16.3	22.9	31.4	40.1	48.1	54.8	52.7	43.6	34.5	23.2	15.7	33.0
Average Total Precipitation (in.)	0.3	0.3	0.5	1.1	1.7	1.6	1.0	0.8	1.0	0.8	0.5	0.3	9.9
Average Total Snowfall (in.)	6.2	5.1	6.5	5.1	0.7	0.0	0.0	0.0	0.4	3.6	5.7	6.0	39.3
Average Snow Depth (in.)	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cody 21 SE, WY (Station 481855): 09/01/1958 to 01/31/2009													
Average Max. Temperature (F)	38.3	40.7	46.4	54.7	63.4	73.7	82.8	81.1	70.1	59.3	45.5	38.3	57.9
Average Min. Temperature (F)	15.5	16.6	21.7	28.7	36.3	43.1	48.8	47.4	39.2	31.4	22.1	16.0	30.6
Average Total Precipitation (in.)	0.4	0.4	0.8	1.4	1.9	1.5	1.2	0.9	1.3	1.2	0.7	0.5	12.0
Average Total Snowfall (in.)	4.9	4.8	7.1	7.4	1.4	0.2	0.0	0.0	1.6	5.3	6.8	5.9	45.4
Average Snow Depth (in.)	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0
Crandall Creek, WY (Station 482135): 06/01/1913 to 09/01/2015													
Average Max. Temperature (F)	29.9	34.7	39.6	49.2	60.7	69.1	79.9	77.9	68.5	57.1	41.9	33.2	53.5
Average Min. Temperature (F)	5.0	7.5	11.5	21.8	29.6	35.3	40.3	38.0	31.1	24.6	15.9	8.1	22.4
Average Total Precipitation (in.)	1.5	1.1	1.3	1.3	1.4	1.8	1.5	1.3	1.3	1.3	1.0	1.1	16.0
Average Total Snowfall (in.)	18.6	13.7	15.2	9.9	3.3	0.6	0.0	0.0	1.7	5.4	9.3	12.4	90.3
Average Snow Depth (in.)	13.0	17.0	15.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	7.0	5.0

WEATHER PARAMETER	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Heart Mountain, WY (Station 484411): 11/22/1942 to 06/30/2008													
Average Max. Temperature (F)	32.8	39.8	48.0	58.3	67.9	76.9	84.9	83.1	72.8	60.8	44.3	34.9	58.7
Average Min. Temperature (F)	9.2	14.8	21.1	30.2	39.7	47.0	52.7	50.8	41.8	32.5	20.5	12.1	31.0
Average Total Precipitation (in.)	0.3	0.2	0.5	0.8	1.6	1.5	0.9	0.6	0.8	0.6	0.3	0.2	8.4
Average Total Snowfall (in.)	4.4	3.7	5.9	3.1	0.1	0.0	0.0	0.0	0.6	2.2	3.3	4.0	27.4
Average Snow Depth (in.)	No Data												
Wapiti 1 NE, WY (Station 489467): 06/22/1950 to 06/10/2016													
Average Max. Temperature (F)	38.5	40.3	46.7	54.4	62.2	71.8	82.3	80.9	71.6	57.6	45.4	38.3	57.5
Average Min. Temperature (F)	17.4	17.9	23.0	29.2	36.8	44.0	51.2	49.6	41.3	31.9	24.2	17.7	32.0
Average Total Precipitation (in.)	0.4	0.3	0.5	1.0	1.5	1.5	1.0	0.9	0.9	0.9	0.5	0.5	9.8
Average Total Snowfall (in.)	5.4	4.4	4.3	4.2	0.4	0.2	0.0	0.0	0.1	4.2	3.9	5.7	32.8
Average Snow Depth (in.)	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0

FIGURE 4-1. MEAN MONTHLY TEMPERATURES AT PROJECT STUDY AREA WEATHER STATIONS (WRCC 2023A, 2023B, 2023C, 2023D, 2023E, 2023F, 2023G, 2023H)

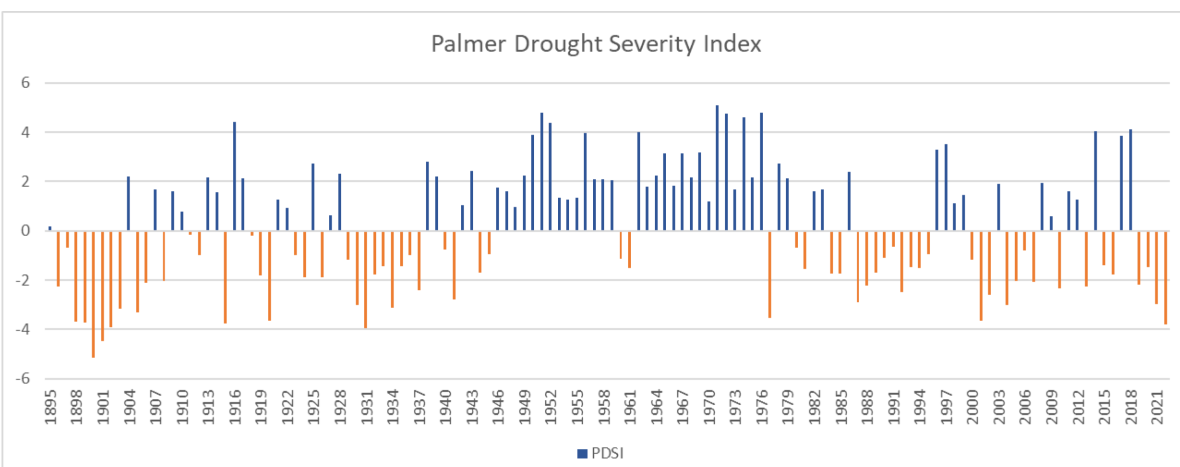


The 30-year mean annual precipitation can be found in Appendix 1A: Map 3. The data used in this map was obtained from the Wyoming Geographic Information Science. These data represent the results of PRISM spatial climate data generated at the Oregon Climate Center, Oregon State University (Northwest Alliance for Computational Science and Engineering 2023). As shown in the map, the mean average precipitation varies based on watershed topography. The lower elevations around Cody and Powell receive an average 6 to 15 inches of annual precipitation and higher elevations in the Absaroka Range in Shoshone National Forest receive an average of 24 to 36 inches of annual precipitation. Approximately twenty percent (20%) of the watershed receives at least 12 inches of precipitation annually. While daily and annual temperature and precipitation variations are common, these fluctuations have a strong impact on vegetation and land use options.

4.2.1.2 PALMER DROUGHT SEVERITY INDEX

Figure 4-2 presents the Palmer Drought Severity Index (PDSI) for Wyoming, Climate Division 4 (Big Horn Division), which encompasses approximately seventy percent (70%) of the Study Area. The PDSI is a measure that signifies prolonged and abnormal moisture deficiency or excess in a region. It serves as a crucial climatological tool for assessing the extent, severity, and frequency of extended periods of abnormally dry or wet weather. Moreover, this index aids in delineating disaster-prone areas and provides insights into the availability of irrigation water supplies, reservoir levels, range conditions, stock water amounts, and the potential intensity of forest fires. In terms of interpretation, negative values in the PDSI indicate dry conditions, while positive values denote wet conditions. A PDSI of plus or minus two signifies moderate conditions, plus or minus three indicates severe conditions, and any value exceeding plus or minus four indicates extreme conditions.

FIGURE 4-2. PALMER DROUGHT SEVERITY INDEX, 1985 – 2021 (NOAA 2023)



Similarly, wet cycles have been observed historically and are expected to repeat. Notably, a prolonged wet cycle was recorded from approximately 1946 until 1973, whereas recent years have witnessed drought conditions at the extreme end of the scale.

4.2.1.3 FROST-FREE PERIODS

The "frost-free period", or the time between the last spring freeze and first fall freeze, is used to approximate the agricultural growing season. The average date of the last spring freeze, first fall freeze, and the number of frost-free days for each NOAA cooperative station can be found in Table 4-2. The threshold temperature of 32°F indicates the "safe" period for younger plants while the 28°F threshold can be fatal to most vegetation regardless of maturity. Table 4-2 displays the average number of frost-free days according to both thresholds.

TABLE 4-2. AVERAGE FROST-FREE PERIODS (WRCC, 2023)

Weather Station	Temperature	Average Last Spring Freeze	Average First Fall Freeze	Average Number of Non-Freeze Days
Buffalo Bill Dam	28°F	27-Apr	21-Oct	177
	32°F	8-May	7-Oct	152
Clark 3 NE	28°F	8-May	23-Sep	138
	32°F	21-May	17-Sep	119
Clark 4 SW	28°F	27-Apr	7-Oct	163
	32°F	6-May	29-Sep	146
Cody	28°F	2-May	2-Oct	153
	32°F	13-May	20-Sep	130
Cody 21 SE	28°F	17-May	20-Sep	126
	32°F	9-Jun	11-Sep	94
Crandall Creek	28°F	16-Jun	4-Sep	80
	32°F	8-Jul	18-Aug	41
Heart Mountain	28°F	9-May	27-Sep	141
	32°F	20-May	18-Sep	121
Wapiti 1 NE	28°F	14-May	25-Sep	134
	32°F	28-May	16-Sep	111

4.2.1.4 CLIMATE VARIABILITY

According to the National Aeronautics and Space Administration (NASA), "Scientific evidence continues to show that human activities have warmed Earth's surface and its ocean basins, which in turn have continued to impact Earth's climate. This is based on over a century of scientific evidence forming the structural backbone of today's civilization." (NASA 2023)

The timing and quantity of precipitation will result in direct changes in streamflow quantities and timing. The following text is extracted from the United States Environmental Protection Agency document entitled *What Climate Change Means for Wyoming* (EPA 2016), providing a brief narrative of potential impacts to the state.

> ***"Precipitation and Water Resources***
> *The changing climate is likely to increase the need for water without necessarily increasing the supply. Rising temperatures increase the rate at which water evaporates (or transpires) into the air from soils, plants, and surface waters. Irrigated farmland would thus need more water. But less water is likely to be available in the Green River Basin, because precipitation is unlikely to increase enough to make up for the additional water lost to evaporation. In other parts of the state, annual rainfall is to increase on average, but soils are likely to become drier, and periods without rain may become longer, making droughts more severe. In southeastern Wyoming, drier soils could lead farmers to withdraw more water from the High Plains Aquifer, which is already being depleted in other parts of the Great Plains.*
>
> *The decline in snowpack could further limit the supply of water. Mountain snowpacks are natural reservoirs that collect the snow that falls during winter and release water when the snow melts during spring and summer. Dams capture most meltwater and retain it for use later in the year. But as the snowpack declines, less water is available upstream of these dams during droughts for ecosystems, water-based recreation, and riparian landowners who draw water directly from a natural lake or flowing river.*
>
> ***Agriculture***
> *Rising temperatures, drier soils, and changing water availability are likely to present challenges for Wyoming's farms and cattle ranches. Hot weather causes cows to eat less and grow more slowly, and it can threaten their health. Reduced water availability would create challenges for ranchers, as well as farmers who irrigate crops. Although warmer and shorter winters may allow for a longer growing season, they may also promote the growth of weeds and pests, and shorten the dormancy for many winter crops, which creates the potential for crop losses due to spring freezes.*
>
> ***Wildfires***
> *Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires in Wyoming, which could harm property, livelihoods, and human health. On average, about 1.4*

percent of the land in the state has burned per decade since 1984. Wildfire smoke pollutes the air and can increase medical visits for chest pains, respiratory problems, and heart problems.

Forests

Longer growing seasons and increased carbon dioxide concentrations could increase the productivity of forests, but warmer, drier conditions also make forests more susceptible to pests. Temperature controls the life cycle and winter mortality rates of pests such as bark beetles, which have infested millions of acres and killed millions of trees across the West in recent decades. With higher winter temperatures, some pests can persist year-round, and new pests and diseases may become established. Drought also reduces the ability of trees to mount a defense against attacks from beetles and other pest."

4.2.2 GEOLOGY

The Study Area foundation is the geology. The relative erosion resistance of the geologic strata exposed at the surface defines every detail of the natural topography, with hard granitic rocks creating the core of the Beartooth Range at elevations over 12,000 feet. In contrast, the Clarks Fork River leaves Wyoming at an elevation barely over 4,200 feet, and the Shoshone River leaves the Study Area at just over 4,100 feet, in both cases flowing across alluvial deposits filling within channels eroded into the soft sandstones and mudstones of the underlying Fort Union 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.

4.2.2.1 SURFICIAL GEOLOGY

The surficial deposits mapped within the Study Area are presented on Appendix 1A: Map 4. 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 Appendix 1A: Map 4 includes 106 individual units. These have been grouped into 12 broader categories for presentation purposes. The boundary lines within the major units reflect finer subdivisions, see the cited reference for details. The largest fraction of the Study Area has been mapped as "colluvium" (35% of the total area). Colluvium is simply material formed from the weathering of the underlying bedrock, which has moved downhill to some extent under the pull of gravity. Appendix 1A: Map 5 identifies the specific bedrock formations immediately beneath the surface. Such movement may be slow, e.g., "soil creep", or dramatic, e.g., landslides. Soluble bedrock components may have been partially removed by surface water and groundwater. The remaining, insoluble bedrock portions 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. Given the widespread mapping of "colluvium," and its characterization being more mechanical than compositional, soils mapping should be reviewed if more detailed information is needed.

Second to colluvium in areal coverage are "residuum" and "exposed bedrock" (24% 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.

Next most common are "terrace", "alluvial" [alluvium] and "bench" deposits (14% 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 floodplains 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 may provide abundant local recharge to aquifer materials, particularly through applied irrigation water. In either case, where saturated, these materials can produce attractive groundwater development opportunities and commonly produce the relatively gentle slopes suitable for irrigated agriculture.

Glacial deposits are mapped across 12% of the Study Area. These deposits occur in the mountainous western watershed area, where massive glaciers accumulated during the Pleistocene-age "ice ages". For the most part, these are chaotic bodies of boulders, sand, silt, and clay which may have been deposited directly from melting ice as moraines of various types or may be the result of sediment-laden glacial meltwater creating “outwash plains”. Groundwater accumulations tend to be local and poorly connected, providing limited development opportunities, for small-scale use.

Like “colluvium”, landslides are primarily locally derived expressions of relatively shallow earth movement, but transport may be over substantial distance and may occur catastrophically rather than gradually. Landslides are mapped across 11% of the watershed surface. Due to the exacerbating factors of high-slope, high moisture content, and weak substrate, landslides are most common in the mountainous areas underlain by volcanic rocks, and in the weak shale formations where those formations are found on steep slopes along the mountain front.

Other surficial geology deposits mapped on Appendix 1A: Map 4 include:

“Alluvial Fan Deposits” (4%). 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 if recharged from upstream areas.

“Sand [eolian] deposits” and “grus” (0.5% of the total area, very minor coverage). 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 Beartooth Range. In terms of groundwater, these are deposits that readily accept infiltration, but the underlying material is only able to store (and provide to wells) small quantities of groundwater in local fracture systems.

“Playa Deposits” (0.01%, very minor coverage). These are small areas without external drainage in which silt and clay accumulate, e.g., shallow ephemeral ponds.

4.2.2.2 BEDROCK GEOLOGY

The following paragraphs outline the basic geology 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 groundwater projects. A detailed description of the geology complexities is beyond the scope of this investigation. Significant groundwater development opportunities are generally limited in this watershed compared to many other areas of the state (and even other areas of the Bighorn Basin), but there is substantially more potentially relevant information available than can be presented here. A primary compilation is that of Taucher et al. (2012) who present a copious discussion and bibliography for the entire Bighorn and Wind River Basins. At a local scale, detailed geologic mapping is provided by US Geological Survey work on individual 1:25,000-scale quadrangles in select areas, and individual subdivisions throughout Wyoming are required to prepare site-specific water and wastewater suitability studies under the provisions of WDEQ Chapter 23 regulations.

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.

Appendix 1A: Map 5 provides a bedrock geologic map developed from standard mapping by the US Geological Survey at 1:500,000 scale (Love and Christiansen 1985). Only the map units with significant coverage are labeled. Appendix 4A expands on the figure key and provides basic descriptions of all the geologic units of the Study Area, as identified by Love and Christiansen (1985). The watershed formations are listed top down from youngest to oldest on the Map 5 key. As presented in Appendix 1A: Map 6, there is considerably more geologic detail available at larger scale (1:25,000) for 8 "Geologic Quadrangle" maps in the geologically complex mountain front portion of the watershed. These maps are the best source, short of direct field observations, for the details of the geology for the mapped areas. Much of the mapping of this quadrangle series was also published in a less formal map at 1:250,000 scale (Pierce 1978).

4.2.2.3 STRATIGRAPHY

The geologic formations that underlie the Study Area range in age from Precambrian (>600 million years old) to the alluvial deposits currently being laid down by the action of the Shoshone and Clarks Fork Rivers and their tributaries. Bedrock units exposed at the surface over the western two thirds of the watershed are primarily the Precambrian-age rocks making up the Beartooth Range, part of the "Laramide" uplift that laid the foundation for the Wyoming river basins, and the coalescing volcanic cones, flows, mudflows, and associated pyroclastic deposits constituting the Tertiary-age volcanic rocks that make up the Absaroka Range. In both cases, Beartooths and Absarokas, the great bulk of these areas are under National Forest management, are quite thinly populated, and have little groundwater development pressure or potential.

In a north-south band through the central part of the watershed, i.e., along the mountain front, are outcrops of the older bedrock sedimentary formations, typically dipping steeply eastward so they are present only at considerable depth beneath the eastern watershed. To the west, these formations are either truncated (commonly by large displacement thrust faults) against the much older rocks of the Beartooth Mountains or are deeply covered by the Absaroka volcanics (rendering their presence, location and structure obscure). To the east, these formations are overlain by Cretaceous-age formations (colored green on Map 5). The Cretaceous section is dominated by thick shale sequences with little groundwater-development potential but include interlayered sandstones which provide local groundwater opportunities.

East of the Cretaceous outcrops, the bulk of the occupied portion of the watershed, is underlain by the early Cenozoic (Paleocene and Eocene) Fort Union and Willwood Formations, which constitute the sedimentary "fill" of the Bighorn Basin.

Finally, in terms of chronology, the bedrock units described above are locally overlain by a relatively young (<2.5 million) mantle of alluvial deposits deposited by ancient streams (the "terrace deposits") and by current streams (the "alluvium" along the floodplains of the Shoshone and Clarks Fork Rivers and their tributaries).

There is a large gap in time reflected in the ages of the youngest bedrock deposits in the watershed - the Willwood Formation - and the unconsolidated deposits of Quaternary age. In between, the Bighorn Basin was filled with sediments that have since been eroded away. This erosion likely began approximately 3 million years ago, a result of the overall elevation of the entire western United States in response to plate tectonics relationships along North America's west coast.

Those formations of Cenozoic age were either deposited contemporaneously with the uplift and erosion of the mountains to the west (Paleocene) or subsequent to that uplift as the Bighorn Basin was slowly filled with erosional debris (Eocene). Most recently (Quaternary age) streams running eastward and northeastward through the watershed have transported sediment downstream in a series of channel cutting and filling episodes in response to continual changes in the sediment / streamflow balance that continues to this day. Notable in this regard are the broad terraces that have been developed along the present Shoshone River - the "Cody" and "Powell" terraces that support irrigated agriculture, and along ancient stream courses of the Shoshone River - the Polecat Bench, and along Pat O'Hara Creek - the Chapman Bench.

Appendix 4A provides descriptions of the geologic strata present in the Study Area, in age order (youngest to oldest), compiled from the US Geological Survey 1:25,000-scale mapping. 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 Study Area are in the Paleozoic-age formations, the individual sandstone units within the younger bedrock formations, and the terrace/alluvial deposits where they receive sufficient recharge from adjacent streams and/or overlying irrigation. The latter is the most consistent source of groundwater in the watershed, basically acting as an extension of the surface water / irrigation system.

4.2.2.4 GEOLOGIC STRUCTURE

In the case of the Study Area, the hydrologic basin, defined by surface topography, is a subset of the larger geologic basin. The Beartooth and Absaroka Ranges mark the western boundary of the Study Area and of the geologic Bighorn Basin, which was largely created by the uplift of the surrounding mountain blocks during the Laramide Orogeny (60 - 80 million years ago), i.e., the Beartooth, Pryor, Bighorn, and Owl Creek Mountains. The basin enclosure was complete with the emplacement of the extensive Absaroka volcanic field in the west and southwest portion of the basis during the Eocene Epoch (35 - 50 million years ago).

The previous section described the various formations found exposed across the surface and present in the subsurface of the Study Area. These descriptions present the “stratigraphy” of the watershed. How those formations have been tilted, folded, broken, and faulted constitute the geologic “structure”, which is the subject of the present section.

Those formations of Precambrian, Paleozoic, and Mesozoic age pre-date the mountain uplifts, and were largely deposited in relatively horizontal layers at low elevations. They were subsequently caught up in the massive faulting and folding accompanying mountain building, leaving them dipping eastward along the mountain flank, commonly at very high angles, or completely overturned. This basic structure creates the geologic outcrop patterns on Appendix 1A: Map 5, i.e., upland areas to the west bordered by strata dipping downward to the east, gently dipping through the middle of the watershed, and with progressively younger formations exposed across the eastern watershed. The appearance of Cretaceous-age rocks in the northeast corner of the watershed reflects a series of smaller folds (much smaller than the major mountain blocks) in the strata, bringing deeper formations to the surface and creating the very productive Elk Basin and related oilfields.

Figure 4-3 provides a series of west-to-east cross sections along the mountain front to illustrate the details of these relationships in specific locations. The section lines are included on Appendix 1A: Map 5. With respect to groundwater, the impacts of geologic structure are threefold:

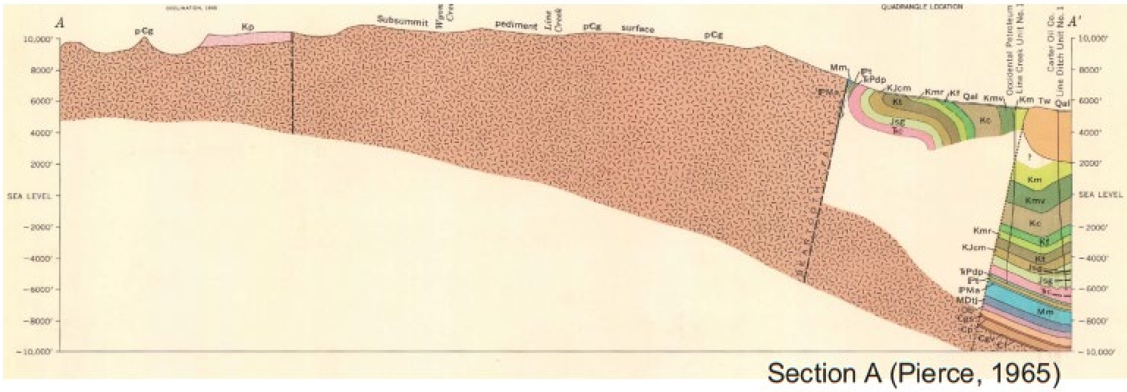
First, the geologic structure of the watershed, i.e., the rate at which formations dip from shallower to deeper areas, controls the depth to which one must construct wells to extract groundwater from a given formation. Examining the cross-sections of Figure 4-3 from north to south, along the Beartooth front one finds the sedimentary rocks likely to provide useful aquifers have been so deformed by folding and faulting, that they are virtually inaccessible anywhere but beneath or immediately adjacent to the narrow bands where they outcrop at the surface.   Further south, formation dips are gentler and, at least for the older formations, there are limited areas east of outcrop where a formation may be present at economically feasible depths.

Further south yet, one finds a combination of complexly folded and faulted formations west of Rattlesnake Mountain, with more gently dipping formations to the east.   This section also intersects a fold in the strata, one of the many anticlines of the Bighorn Basin which have been exploited for their oil-trapping geometries.

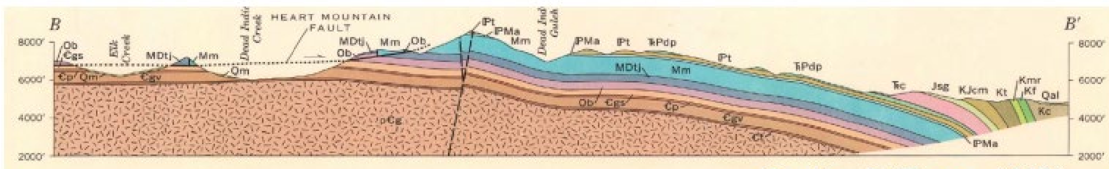
The final cross section of Figure 4-3 presents a situation typical of the east side of the Bighorn Basin and of many Rocky Mountain uplifts, i.e., sedimentary formations dipping downslope from mountain uplifts, with the dips decreasing downslope and with gentler dips in younger formations. In the case of the Fort Union and Willwood Formations that form the surface in the eastern portion of the Study Area, the strata are nearly horizontal over much of their outcrop area. Given the substantial thickness of these formations, the geologic structure largely confines groundwater development opportunities across the eastern portion of the watershed to these formation (i.e., where mapped on Map 5).

Second, the watershed structure may substantially modify the permeability of the formations through the fracturing associated with folding and faulting. The permeability of a rock due to its basic composition is termed, “primary” permeability.   Gravels and sands have relatively high primary permeability as groundwater can move freely between the mineral grains. The permeability of a rock due to the development of cracks, fissures, faults, etc. is termed “secondary” permeability, and is largely a function of the formation structure (i.e., how it has been broken, folded, and fractured).

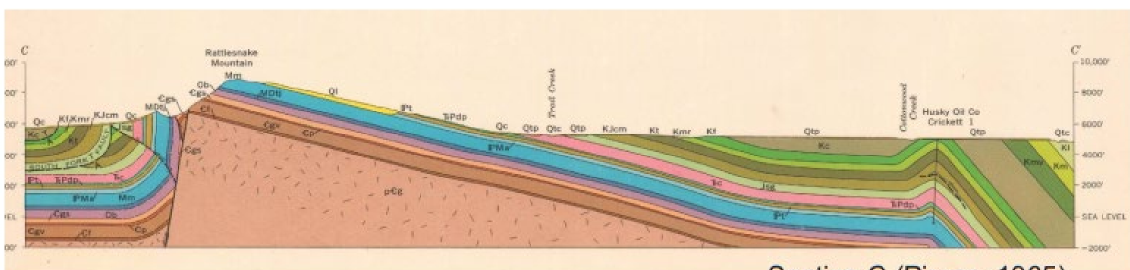
FIGURE 4-3. GEOLOGIC CROSS SECTIONS (SEE MAP 5 FOR LOCATIONS)



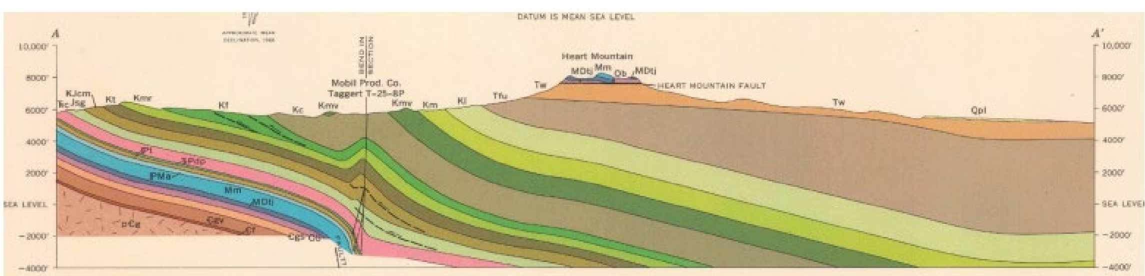
Section A (Pierce, 1965)



Section B (Pierce, 1965)



Section C (Pierce, 1965)



Section D (Pierce, 1965)

For example, undisturbed limestone is virtually impermeable, basically consisting of recrystallized calcium carbonate. Limestone is a relative brittle rock, however, and when subjected to the stresses of deformation, may develop extensive fracture networks and provide one of the most productive aquifers in the state. The Madison Limestone wells along the crest of the Paintrock Anticline north of Worland, for example, are reported to have initially flowed 14,000 gallons per minute (gpm) under artesian pressure. Similarly, well-cemented sandstones and matrix-supported conglomerates may have grain-size distributions conducive to groundwater flow but have relatively low permeabilities absent fracturing because the space between the mineral grains is filled with natural cement.

Structural enhancement of permeability most commonly develops along folds and faults. The major faults of the watershed are mapped on Appendix 1A: Map 5; but Figure 4-3 shows how pervasive and complex both faults and folds are at a more local scale. Because these are commonly quite local features, useful generalizations are difficult. Basically, the more deformed the rocks are, the more likely secondary permeability has developed in those specific areas. See Appendix 1A: Map 6 for the detailed coverage of 1:25,000 scale mapping within the Study Area.

The most interesting geologic structure of the Study Area is the world-famous Heart Mountain Detachment Fault. The basic field relationships of this feature are presented on Figure 4-4 as mapped in the 1960s and 1970s. The mechanism(s) of creation have been debated for decades (and continue to be). Of potential relevance to this groundwater investigation is the complex disruption of subsurface flow patterns created by such a large-scale horizontal displacement.

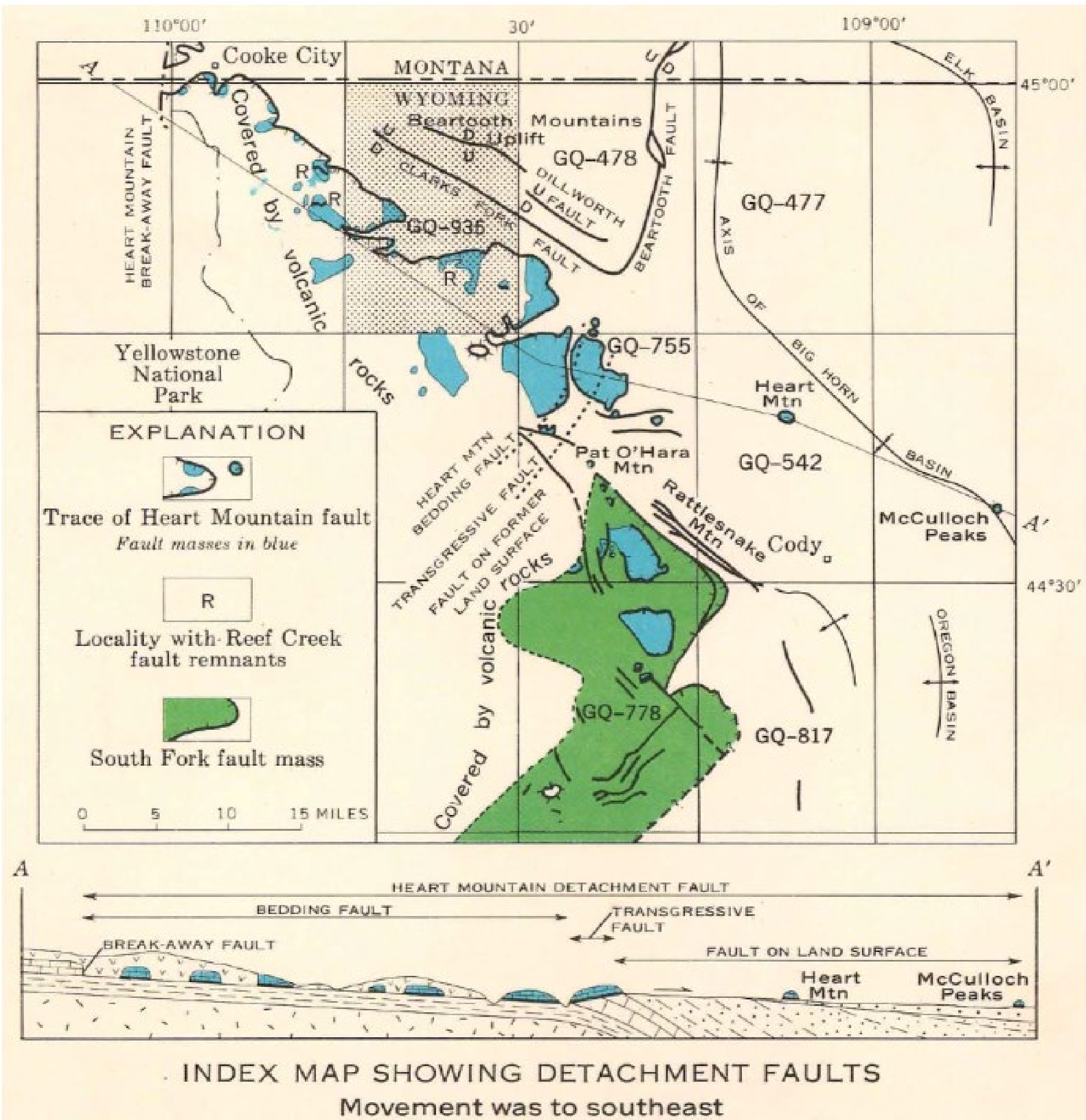
Thirdly, the watershed structure, in combination with the way the surface has been shaped by erosion, determines the availability of recharge and the subsequent groundwater flow patterns. Rainfall, snowmelt, and streamflow that infiltrates past the root zone makes their way to the water table, providing the groundwater that fills the pore space and fractures of the formations. Groundwater subsequently moves through the geologic section, guided by the overall distribution of permeability within and between strata, and by the gradients founded in the elevation of recharge processes. Groundwater, like surface water, ultimately flows "downhill". As can be seen on the cross sections of Figure 4-3, in some cases, faulting has entirely severed a formation, precluding continued groundwater flow from upland recharge areas. In some cases, the juxtaposition of higher-permeability materials against lower-permeability materials greatly inhibits groundwater flow. And, as discussed above, the creation of fracture zones along folds and faults may both greatly enhance local permeability and serve to channel the groundwater flow along these features.

In summary, the geologic structure of the Study Area is relatively straightforward in the east and west, and extraordinarily complex in the middle. The stratigraphic / lithologic characteristics of the geologic deposits dominate groundwater-development potential in the east and west. Local structural displacements and enhancements of permeability dominate groundwater-development potential in a north-south band through the middle of the watershed (i.e., along the mountain front).

4.2.2.5 GEOLOGIC HAZARDS - EARTHQUAKES AND LANDSLIDES

With rare exceptions, deformation and faulting within the Study Area is the result of activity in the distant geologic past. While the fracturing associated with faults can usefully enhance permeability and groundwater production, this fault activity does not represent a current-day constraint on development activity with respect to earthquakes.

FIGURE 4-4. HEART MOUNTAIN DISPLACEMENT (PIERCE AND NELSON 1970)



Based on review of the earthquake records maintained by the National Earthquake Information Center (USGS 2023), there have been two recorded earthquakes of magnitude 3.0 or greater in the Study Area. A magnitude 3.0 earthquake is just into the range that can be felt. Both were at the western edge of the watershed, i.e., bordering Yellowstone National Park, as plotted on Appendix 1A: Map 7. Yellowstone is an area of nearly continuous seismic activity, associated with the magma chamber at relatively shallow depth which has been the source of massive caldera formation events over the last million years. Thus, there is some “spill over” of Yellowstone-based seismic effects into the Study Area, but virtually none of that activity is generated by faulting within the watershed.

Seismic hazard mapping by the USGS (Petersen et al. 2015) concludes a peak horizontal acceleration of 5-7% of gravity has a 10% chance of exceedance in 50 years for the Study Area along and east of the mountain front. That 10% chance acceleration increases to the west (i.e., towards Yellowstone) to high values around 20% of gravity along the western edge of the Study Area. For perspective, this value varies between <1 and >100% for the coterminous United States, and between 2 and 30% across Wyoming, placing the Study Area at the lower end of the scale.

Landslides, conversely, are common throughout the mountainous portion of the watershed. This is partially due to the presence of low-stability shales in the Cambrian-age section, which, as discussed above, is present at the surface along the mountain front where steep slopes are most common. For example, these shales are notorious sources of road failures where the Chief Joseph Highway (Wy Hwy 296) traverses the Paleozoic shale formations over Dead Indian Hill.

Mapped landslide deposits are presented on Appendix 1A: Map 7. The order on the figure is to lay the most extensive mapping on the bottom, with successively less extensive layers stacked on top. Otherwise, all less extensive coverages would be masked by the more extensive coverage. However, there is little difference between the Love and Christensen (1985) mapping and the WRDS (2004) mapping, i.e., the “red” is present beneath the “orange” at most locations on Appendix 1A: Map 7.

The extensive landslide deposits in the south-central portion of the watershed were mapped in detail by Pierce (1970), who subdivided them into: Heterogeneous deposits of rock debris: QI - undifferentiated landslide deposits; Qly - younger landslide deposits, bordering Carter Mountain; and Qlo - older landslide deposits on the lower flank of Carter Mountain. The formations underlying these landslide deposits are exposed in isolated outcrops, showing them to be predominantly in the Cretaceous section (Cody Shale, Frontier, Cloverly, and Morrison Formations, and, on the flanks of Carter Mountain, units of the Absaroka volcanic field).

Landslides are less common in the “lowland” portions of the watershed, but anywhere relatively weak geologic materials (e.g., shales and clays) are subject to periodic saturation, even on modest slopes, there is the potential for local slope failure. Canals and ditches with substantial downslope embankments are obvious candidates.

4.2.3 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 Study Area. For copious data, bibliography, illustrations, and analysis of the entire Bighorn / Wind River Basin, the reader is directed to the extensive 2012 Wyoming Water Development Commission report, "Wind/Bighorn River Basin Water Plan Update Groundwater Study – Level 1 (2008–2011) – Available Groundwater Determination" by Taucher et al. (2012).

Because groundwater is not as important a water source for this watershed as it is in other Wyoming watersheds (even in other portions of the Bighorn Basin), there have been relatively few specific groundwater investigations conducted. The only USGS Water Supply Paper, for example, is Swenson (1957) a detailed study of a portion of the Heart Mountain Canal irrigation system. Individual water / wastewater suitability studies are conducted under the provisions of WDEQ Chapter 23 for individual subdivisions, but these are tightly focused on potential septic system impacts in small areas and are only publicly available through specific public records requests to the WDEQ at https://wydeq.nextrequest.com/.

In 1993, the USGS completed a general study of the "Hydrology of Park County, Wyoming, Exclusive of Yellowstone National Park" (Lowry et al. 1993) in cooperation with the Wyoming State Engineer that offered the following general conclusions regarding groundwater resources in Park County (all of which apply to the Study Area):

1. With respect to unconsolidated deposits, i.e., the Quaternary-age strata of the present report, "Flow is Entirely Within Local Systems. Deposits underlying areas that are not irrigated and occur above stream level are dry."
2. With respect to the bedrock formations, "Permeability of Bedrock is Both Primary and Secondary. Some movement of water is regional, but most is local. The bedrock geologic units also are discontinuous, and, as in the unconsolidated deposits, occurrence and movement of water is severely restricted within the county."

Given the critical importance of local conditions (e.g., stratigraphy, structure, and recharge) to the occurrence of and development constraints on groundwater, presentations at watershed scale are inherently more discussions of principles and general relationships than focused targeting investigations.

4.2.3.1 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, but are ultimately part of the same overall system.

Groundwater originates when rainfall, snowmelt, streamflow, and, particularly important in the Study Area, irrigation water, infiltrate into geologic materials. This constitutes groundwater "recharge". Natural 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 via irrigation is a function of crop water requirements, water availability, irrigation management, and the types of irrigation facilities employed.

Groundwater recharge varies widely across the watershed. It is highest where water available to provide recharge is most abundant, e.g., at higher altitudes, along stream channels, where infiltration rates can readily accept available recharge, e.g., sandy surfaces, and most importantly for the Study Area, where water is distributed across the surface via the extensive irrigation systems supplied by those two rivers. As noted by Lowry et al. (1993), "Unconsolidated deposits are a principal source of ground water in Park County. However, the presence of water in deposits topographically higher than stream level depends on recharge from surface water used for irrigation. Terraces that are not irrigated, such as Polecat Bench, do not have saturated deposits from which water can be obtained. "

Natural recharge is highly variable temporally, typically most abundant in spring and relatively scarce in late-fall. In contrast, irrigation-water recharge is exclusive to the irrigation season, typically from late April to mid-September.

The generalized annual natural recharge rates developed by Hamerlinck and Arneson (1998) are shown on Appendix 1A: Map 8. These were developed with a grid system incorporating estimates of infiltration rates, soil characteristics, and annual precipitation. The highest estimated recharge rates - 27 to 45 inches - correspond with the highest elevations, i.e., the watershed headwaters in the Beartooth and Absaroka Ranges. Much of the watershed was estimated to receive an inch or less of natural groundwater recharge. Routine assumptions for groundwater models are that 5-10% of precipitation becomes aquifer recharge, in which case the "lowland" areas of this watershed would be at less than ½ inch per year. Given the very low precipitation across these areas, zero natural groundwater recharge would not be an unreasonable assumption in many cases, as precipitation is quickly lost to evaporation, vegetation evapotranspiration and runoff.

Included on Appendix 1A: Map 8 are the areas receiving surface water irrigation. In these areas, irrigation may apply several feet of water over the course of a season. Irrigation "efficiency" (the fraction of applied irrigation water that is consumed by crop evapotranspiration) in these predominantly flood-irrigation systems is typically accounted as no more than 50%, leaving the remainder to infiltrate below the root zone and provide groundwater recharge or run off. The obvious manifestation of irrigation recharge is the prevalence of agricultural drains - both open and subsurface - that have been installed to prevent high groundwater levels from interfering with crop production and management. Agricultural drains also serve as evidence of the presence of low-permeability soils and bedrock, as infiltrating water does not flow readily away from the focused recharge sites provided by irrigation.

Irrigation recharge is a complicated issue in the watershed because it "cuts both ways". On one hand, as noted by Lowry et al. (1993), "The conversion of irrigated agricultural land to urban development poses problems in some areas because yields of water-supply wells will be adversely affected by reduced recharge." On the other hand, the seasonal high-water tables created by irrigation recharge create continuing problems with flooded basements, particularly as residential development moves into rural areas formerly the exclusive domain of irrigated agriculture. Recent lawsuits on this point include, "James F Dunkerley, Jr. and Linda Del Toro v. Cody Canal Irrigation District, Park County Civil No. 29842"; and "Reed v. Cloninger, 2006 WY 37".

4.2.3.2 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 groundwater quantities. In the absence of contemporaneous storm runoff or snowmelt, most of the flow in Wyoming's streams comes from groundwater discharge at some point upstream.

The Wyoming State Engineer's Office maintains no routine groundwater level monitoring in Park County. Groundwater levels at most locations are expected to seasonally vary somewhat, rising in with spring snowmelt, precipitation, and streamflow under natural conditions and rising with the advent of local irrigation in agricultural areas. Groundwater levels likely decline somewhat in the late fall and through the winter in most areas.

In their overview of the hydrology of Park County, Lowry et al. (1993) concluded (correctly, in our opinion) that for the unconsolidated (i.e., Quaternary-age) deposits, groundwater "flow is entirely within local systems." Thus, groundwater recharged naturally across the landscape flows "downhill" to discharge via local springs or as local stream gains. Individual streams mark small local groundwater flow systems in which groundwater converges on the topographic low created by the stream channel.

With respect to the deeper, bedrock deposits carrying groundwater, Lowry et al. (1993) made the same structural observation as discussed above in the present report, i.e., "Movement of water in the sedimentary rocks in the mountains also is local, because continuity with basin sedimentary rocks mostly has been interrupted by faulting." and "Regional flow in the sedimentary rocks in the basin is more likely than in the mountains, because the formations are continuous from the outcrops on the flanks of the mountains into the basin, beyond the county."

Lowry et al. further assumed that the small regional-level groundwater flow in the portion of the watershed east of the mountain front likely corresponds with the potentiometric surface developed for the Tensleep Sandstone by Bredehoeft and Bennett (1972). This surface suggests flow generally to the northwest from beneath the Study Area.

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 major, local impacts of active irrigation. Thus, under natural conditions, groundwater levels will typically be highest in the spring, as snowmelt and precipitation infiltrate to recharge aquifers. Irrigation recharge, of course, is concentrated somewhat later, as precipitation falls short of crop water demands.

4.2.3.3 GROUNDWATER DISCHARGE

As noted above, streamflow in the watershed is sustained by groundwater discharge. As observed by Lowry et al. (1993), "Major streams originating in the mountains have sustained flow between periods of precipitation because of melting snow from the near-permanent snowpack and because of ground-water discharge. Streams that originate in badlands and plains and do not receive return flow from irrigation have long periods of no flow."

Both groundwater recharge and the resulting discharge were changed dramatically with the advent of irrigation in the watershed. As observed by Lowry et al. (1993), "Low flow of some streams changed as a result of developing the water for irrigation. Perennial flow in Bitter Creek (northeastern Park County) is due primarily to return flow from irrigation."

Appendix 1A: Map 9 includes perennial streams in the Study Area as mapped by the U.S. Geological Survey at a scale of 1:100,000. The higher density of perennial streams in the western portion of the watershed reflects the higher precipitation and the lower infiltration rates in the high elevation and low-permeability rocks of the Beartooth and Absaroka Ranges. Downstream, there is less precipitation to sustain local streamflow and infiltration rates are generally higher. Thus, except for locally supported irrigation drains, only the major streams, accumulating surface runoff from wide areas and supplied by relatively deep-seated groundwater, maintain significant flows year-round.

Where groundwater discharges at a discrete point, rather than simply as distributed gains to streamflow, a spring is created. 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 drought periods, and seasonally variable evaporation and evapotranspiration near the spring site. The flows can be concentrated or diffuse, again depending on the nature of the geologic conditions causing the spring.

Appendix 1A: Map 9 presents mapped springs for the Study Area. 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). 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 way they were compiled.

Those springs on Appendix 1A: Map 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" springs on Map 9 where the two coincide. Consult the relevant electronic GIS files to discriminate.) Within the SEO "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". Additionally, 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 of Study Area "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. Eighty-one percent (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.

A specific spring of note in the Study Area is the DeMaris Hot Spring on the north bank of the Shoshone River west of Cody. This small set of springs flow an estimated 1,700 gpm of water at up to 98°F from the Phosphoria Formation. Their origin has been attributed to deep groundwater circulation through the Madison and Tensleep Formations along the flanks of the Rattlesnake Mountain anticline (i.e., rather than to any process associated with the long-dormant Absaroka volcanics or the active geothermal systems of Yellowstone Park) (Breckenridge, Hinckley, and Terrell 1978). The sulphurous smell of these springs and a companion set now submerged by Buffalo Bill Reservoir on the west side of Rattlesnake Mountain provided the original name of the Shoshone River - the "Stinkingwater River".

As suggested by the wide distribution of springs, 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.

Finally, groundwater is discharged to the surface through the construction and operation of wells. These are discussed in detail below, under "Groundwater Use".

4.2.3.4 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 (WWDO 2007) offered general classifications of the strata of Wyoming as between “major” and “minor” aquifers and aquicludes (formations that largely inhibit rather than provide groundwater flow). That terminology has been adopted for Appendix 1A: Map 10, with customization to better match conditions in the Study Area. 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 siltstone/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 Study Area are the Quaternary-age deposits (to the extent they receive sufficient recharge to be partially saturated) and the carbonate (limestone and dolomite) and sandstone formations of Paleozoic age. But even these units are not universally productive. While hosting wells with production rates over 1,000 gpm elsewhere in Wyoming, in this watershed, the highest permitted yield is a mere 25 gpm.

In the case of the alluvial deposits covering the Polecat and Chapman Benches (Map 5), Appendix 1A: Map 10 strips those away and classifies the underlying bedrock formations. This is because the terrace deposits are just a veneer, which in the absence of irrigation deliveries, are dry and thus, while permeable, provide no useful groundwater supply.

Otherwise, terrace and floodplain deposits along the Shoshone and Clarks Fork Rivers host broad areas of relatively level topography and fertile soils, ideally suited to the development of irrigated agriculture. That irrigation provides abundant groundwater recharge to these deposits, creating a productive local aquifer well matched to the location of the rural residences of the farming families.

A study of the alluvial deposits in the Ralston area of the Heart Mountain Canal is provided by Swenson (1957). They found deposits in pockets up to 100 feet thick. Granite Engineering (2021) provided a study of the 23-lot Buck Creek Subdivision, a residential expansion of use on the Powell Terrace (Quaternary deposits overlying Willwood Formation) on the north side of the Shoshone River just upstream of Willwood Dam. The individual well completion reports compiled for this subdivision investigation are likely typical of what is found over much of the irrigated terraces of the watershed. The thickness of the alluvial deposits is reported to vary from 10 to 50 feet. Many of the wells failed to find useful water in thin Quaternary deposits and were drilled on into the discontinuous sandstone beds of the Willwood Formation. This situation generates a wide variety of depths-to-water, i.e., from 60 feet below surface to flowing at the surface.

The laboratory analysis provided with this subdivision report found total dissolved solids of 1280 milligrams per liter (mg/l), sulphates of 588 mg/l. While these values are above the United States Environmental Protection Agency (EPA) Secondary Standards for public water supplies (which are based on aesthetic rather than health criteria), the groundwater was judged to "meet drinking water standards". The well originally sampled for this Project failed to meet total coliform criteria, but follow-up sampling of a nearby well found no coliform contamination and the previous result was judged to be a "well" problem rather than an "aquifer" problem.

The level of detail extracted from Granite Engineering (2021) is well beyond the scope of this watershed-level report but is presented as an example of the site-specific information potentially available through individual subdivision permitting files for those interested in the hydrogeology of specific areas.

4.2.3.5 GROUNDWATER QUALITY/SENSITIVITY

As noted above, the most important aquifers in the Study Area are the unconsolidated materials of Quaternary age that receive abundant recharge through irrigation. The quality of groundwater in these deposits is thus related to the quality of the applied irrigation water, as modified by contributions from the underlying bedrock formations and mineral deposits extracted from the alluvial deposits themselves. Where the original stream water quality 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 and perhaps filtering to be suitable for consumption.

Lowry et al. (1993) wrote, "Ground water suitable for domestic use is difficult to obtain in some areas where it is needed because of poor yields and poor quality in shallow aquifers. Large areas suitable for urban development are underlain by thick shales that have low well yields and poor water quality.", "Water in the unconsolidated deposits, although dependent upon infiltration of applied surface water, is of poorer quality than the applied surface water because of solution of salts as the water moves through the soil.", and "water in unconsolidated deposits is at shallow depths, thus, the trend toward urban development increases the risk of contamination from septic tanks, petroleum products, and accidental spills of toxic and hazardous wastes."

Basically, the most productive aquifer of the watershed, the irrigated terrace gravels, is commonly compromised in terms of water quality for the above reasons.

Quaternary-age aquifers not associated with irrigation, e.g., along Sunlight Creek, the Clarks Fork River and the North Fork and upper reaches of the South Fork of the Shoshone River, typically receive recharge from adjacent hillsides, local boggy areas, and local streams. Where the surface association is intimate, groundwater mineral content is typically minimal, but bacteriological and sediment issues may be substantial.

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 recharge areas may be of relatively high quality, regardless of the host formation. As water moves deeper, it becomes somewhat more mineralized. An exception is the crystalline rocks (i.e., the Precambrian rocks of the Beartooth Range) in which quality is generally good throughout 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.

In 1998, the University of Wyoming completed a statewide study of groundwater contamination potential (Hamerlinck and Arneson 1998) that assessed seven factors, including depth to groundwater and recharge rates, to produce 1:100,000 scale county-by-county maps. Appendix 1A: Map 11 presents this mapping of "Aquifer Sensitivity" for the Study Area. 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. Surface water bodies themselves, e.g., the ponds and reservoirs of the watershed, are also quite vulnerable. The alluvia aquifers are most sensitive, i.e., along the rivers and perennial streams. These rankings are hypothetical to some extent. For example, the soils of Polecat Bench suggest high sensitivity to the application of agricultural chemicals, but the bench receives no irrigation water, so no exposure to such chemicals.

4.2.3.6 GROUNDWATER USE

All water diversions or extractions in Wyoming, both surface and groundwater, require permitting through the Wyoming State Engineer's Office (WSEO). 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 4,456 groundwater permits in good standing in the Study Area (including monitor and test wells and cancelled permits and enlargements), i.e., 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 standard WSEO 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, the following taxonomy have been applied:

- 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. Note that permit yields are the maximum discharge rate allowed and may or may not represent the actual yield available. Permit yields are rarely pumped on a sustained basis, and particularly for low-yield wells, may significantly overstate the groundwater 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 routine groundwater extraction 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 (which are most commonly classified as "MISC"), wetlands maintenance, etc.).

The location of groundwater permits in the Study Area are presented in Appendix 1A: Maps 12 through 15. The base map for these figures is the aquifer classification map of Appendix 1A: Map 10. As with the springs discussed above, the location 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. Note, none of these locations have been field verified for this report.

Additional details for all groundwater permits (total depth, water level, lithology, use, etc.) are typically listed on the individual Statement of Completion, available electronically by individual permit number at: http://seoweb.wyo.gov/e-Permit/common/login.aspx?ReturnUrl=%2fe-Permit%2f

An easily accessible, well-organized geographic presentation of groundwater permits with various associated data layers has been developed by the Wyoming State Geological Survey. It is available for free public use at: Wyoming Groundwater Atlas" on their website at: https://www.wsgs.wyo.gov/

The Geological Survey database includes some of the basic well information, but importantly, includes the permit numbers. Given an individual permit number, one can go to the WSEO website listed above and inspect a complete scan of the permitting and well-completion documents.

The most common groundwater permits in the Study Area have been constructed for domestic and stock use, of course (See Table 4-3). At a minimum, a domestic well is called upon to supply the culinary and sanitary needs of a household. These can typically be met with production rates as low as 5 gpm and daily average withdrawal rates under 1 gpm. Stock demands may be even smaller. Wells called upon to meet landscaping demands require far greater production, but in irrigated areas, landscape water requirements are commonly met through ditch diversions.

TABLE 4-3. DOMESTIC-USE GROUNDWATER PERMITS – CLARKS FORK / UPPER SHOSHONE WATERSHED

	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
Surface Formation	**min**	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**
Quaternary (3691)	1	52	1086	0.5	15	327	0.03	18	350
Willwood (185)	1	110	2260	4	40	798	0.5	12	25
Fort Union (117)	4	100	450	2	26	270	0.06	17	25
Volcanics (35)	2	65	600	1	29.5	232	0.5	15	25
Mesozoic (398)	2	80	1635	1	30	205	1	15	60
Paleozoic (23)	3	65	620	4	24.5	470	1	20	25
preCambrian (7)	11	35	427	6	12	38	2	15	25

Note: includes DOM/STK permits

To a significant extent, the distribution of domestic wells (Map 12) reflects the distribution of the rural population of the watershed, which is largely a reflection of the distribution of irrigated agriculture (e.g., see Map 8). This distribution is not a sign of the presence of productive aquifers, or even of groundwater quality, but simply a function of where residents have needed water for domestic purposes. This situation is demonstrated on Appendix 1A: Map 12 by the strong concentration of domestic wells on the Quaternary-age deposits of the river floodplains and alluvial terraces. The great majority of these wells are less than 100 feet deep and have encountered groundwater at less than 50 feet. Addition of the drawdown necessary to draw the desired quantity of water into the well will, of course, drop the pumping water level below, perhaps substantially below, the depth at which groundwater is first encountered.

As noted above, however, not all the potentially productive Quaternary deposits are sufficiently saturated to support even the small demands of domestic wells. Except for the cross sections of Figure 4-3, the geologic figures of this report are all based on the geologic formation present at the surface. In the case of the Quaternary deposits, they are typically relatively thin, so a deep well plotting on these map units, is likely drawing water from an underlying formation. Where the shallow deposits are either insufficiently saturated or of unacceptable water quality, a homeowner has little choice but to continue to deeper units in hopes of encountering better groundwater conditions. The domestic wells of Table 4-3 and Appendix 1A: Map 12 deeper than 150 feet are quite likely completed in bedrock units beneath the Quaternary deposits. In some cases, a deep well constructed for oil and gas exploration may be re-permitted as a water supply well.

Table 4-4 and Appendix 1A: Map 13 present the same information for wells permitted only for stock use. The distribution, depth, depth-to-water, and permit yield for these wells are very similar to those wells permitted for domestic and stock use. The latter may be somewhat more broadly distributed as stock-growing operations range more widely than rural residential uses, but the differences are small.

TABLE 4-4. STOCK-USE GROUNDWATER PERMITS – CLARKS FORK / UPPER SHOSHONE WATERSHED

	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
Surface Formation	**min**	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**
Quaternary (169)	1	20	601	1.0	10	220	0.50	10	25
Willwood (27)	2.5	5	280	1	5	80	0.5	5	25
Fort Union (15)	2	150	250	3	62	140	1	10	25
Volcanics (12)	2	3	125	2	4	110	2.5	5	23
Mesozoic (77)	1	4.5	1744	1	4	575	0.5	8	25
Paleozoic (11)	3	6	1210	1	5	1000	1	4	25
preCambrian (0)	No permits in preCambrian rocks								

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 4-5 provides summary data for municipal wells in the Study Area. Powell is the only municipality in the watershed with “municipal” use wells (Map 14). Situated on an alluvial terrace amid a large area of flood irrigation, it is no surprise that high yields are available at shallow depths from wells of modest total depth. Wet basements have long been an issue for homes situated on the fringes of Powell adjacent to active irrigation.

TABLE 4-5. MUNICIPAL-USE GROUNDWATER PERMITS – CLARKS FORK / UPPER SHOSHONE WATERSHED

Name	Owner	Surface Formation	Depth (ft)	Depth to Water (ft)	Permit Yield (gpm)	Permit No.
Powell Well #1	City of Powell	Quaternary	12	8	800	P511C
Powell Well #2	City of Powell	Quaternary	20	5	2030	P512C
Powell Well #4	City of Powell	Quaternary	35	10	125	P519G
Powell Well #5	City of Powell	Quaternary	27	12	120	P520G
Water Collector Gallery #1 Well #7	City of Powell	Quaternary	29	8	1500	P496W
West Side Park Well #10	City of Powell	Quaternary	45	10	202	P37559W
Northwest Community College Well #11	City of Powell	Quaternary	45	10	300	P37560W
Homesteader Park Well #12	City of Powell	Quaternary	40	10	255	P37561W

For the most densely populated portion of the watershed, i.e., the Cody - Powell corridor, both municipal water systems and increasingly, rural water service districts, have come to be supplied from the Shoshone Municipal Pipeline and the extensive Northwest Rural Water District. This system is based on diversion and treatment of water from the Shoshone River west of Cody. It replaced a century's constellation of individual wells and small, local water systems, providing a consistent, high-quality water supply not subject to the vagaries of irrigation recharge, exposure to shallow-groundwater contamination, and individual well maintenance issues.

Appendix 1A: Map 14 also presents the location of the wells permitted for industrial use (Table 4-6). These are mostly associated with oil production from the anticlines along the eastern watershed edge, most notably the water flood of the mammoth Elk Basin Field in the northeast corner of the watershed.

TABLE 4-6. INDUSTRIAL-USE GROUNDWATER PERMITS – CLARKS FORK / UPPER SHOSHONE WATERSHED

	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
Surface Formation	**min**	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**
Quaternary (9)	19	37.5	8319	8.5	17.3	1350	7	80	150
Willwood (0)	No permits in Willwood Formation								
Fort Union (1)	unknown			unknown			25	25	25
Volcanics (0)	No permits in Volcanics								
Mesozoic (16)	60	60	8060	30	34	1200	20	82.5	650
Paleozoic (0)	No permits in Paleozoic rocks								
preCambrian (0)	No permits in preCambrian rocks								

Finally, Table 4-7 and Appendix 1A: Map 15 present summary information and the locations of wells permitted for irrigation use.   With few exceptions, these are not remarkably productive wells, reflective of the coincidence if irrigable lands with the general marginal groundwater productivity of the Willwood and Ft. Union Formations underlying Quaternary deposits.

TABLE 4-7. IRRIGATION-USE GROUNDWATER PERMITS – CLARKS FORK / UPPER SHOSHONE WATERSHED

	Well Depth (ft)			Depth to Water (ft)			Permit Yield (gpm)		
Surface Formation	**min**	**med**	**max**	**min**	**med**	**max**	**min**	**med**	**max**
Quaternary (21)	7	68.2	145	4	27.3	100	10	60	1200
Willwood (0)	No permits in Willwood Formation								
Fort Union (2)	28	29	30	7	14.5	22	30	77.5	125
Volcanics (1)	6	6	6	flowing			900	900	900
Mesozoic (5)	15	119	865	6	16	66	50	65	220
Paleozoic (0)	No permits in Paleozoic rocks								
preCambrian (0)	No permits in preCambrian rocks								

The 900-gpm irrigation permit listed in the "volcanics" aquifer group on Table 4-6 is "4,000 feet of perforated plastic drainpipe approx. 6 feet deep". Thus, it has little to do with the productivity of the volcanic rocks and everything to do with surface irrigation from adjacent Sunlight Creek. The 1,200-gpm irrigation permit from Quaternary deposits appears to be a similar situation. This yet-to-be-completed project (the permit is dated 2023) is for a shallow well to recover surface irrigation recharge alongside the North Fork of the Shoshone River.

4.2.3.7 GROUNDWATER RIGHTS AND ADMINISTRATION

Surface water use in Wyoming has long been administered under the priority system, i.e. "First in time is first in right". Wyoming groundwater administration has sought to bring groundwater under the same principles as groundwater administration has developed over the last half century. Thus, all groundwater use, like all surface water use in Wyoming, is only legal under a permit from the State Engineer's Office that identifies the location, rate, and type of use. Additional conditions may be applied based on specific circumstances.

A senior (i.e., earlier permit) groundwater use 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 under their permit.

State Statute 41-3-911. - Authority to order interfering appropriator to cease withdrawals of water, hearing complaints by appropriators.

> *(a) Whenever a well withdrawing water for beneficial purposes shall interfere unreasonably with an adequate well developed solely for domestic or stock uses as defined in W.S. 41-3-907, whether in a control area or not, the state engineer may, on complaint of the operator of the stock or domestic well, order the interfering appropriator to cease or reduce withdrawals of underground water, unless such appropriator shall furnish at his own expense, sufficient water at the former place of use to meet the need for domestic or stock use. In case of interference between two (2) wells utilizing water for stock or domestic use as defined in W.S. 41-3-907, the appropriation with the earliest priority shall have the better right.*
>
> *41-3-916. Priority of rights when 1 source of supply. Where underground waters in different aquifers are so interconnected as to constitute in fact one source of supply, or where underground waters and the waters of surface streams are so interconnected as to constitute in fact one source of supply, priorities of rights to the use of all such interconnected waters shall be correlated and such single schedule of priorities shall relate to the whole common water supply. The state engineer may by order adopt any of the corrective controls specified in W.S. 41-3-915.*

In practice, groundwater is troublesome to administer in priority because the impact of one well's pumping on another well's water level (or on a connected stream's flow) may take weeks, months, or year to develop. Similarly, if the impacted well owner is not deemed to have made adequate efforts (e.g., well depth, pump depth) to obtain the groundwater to which they are entitled, their requests for relief may not be granted.

The 1950 Yellowstone River Compact between Wyoming, Montana, and North Dakota provides for the interstate allocation of waters of the Yellowstone River basin - including the Clarks Fork / Upper Shoshone Watershed. The compact was the subject of litigation between the three states from 2014 through 2018 (United States Supreme Court No. 137, Original). That case resulted in a 2018 U.S. Supreme Court ruling interpreting various provisions of the compact. With respect to groundwater resources, the court ruled that, "Article V(A) of the Yellowstone River Compact (Compact) protects pre-1950 appropriative rights to the beneficial uses of water of the Yellowstone River System in Montana from diversions and withdrawals of surface water and groundwater in Wyoming ..." [emphasis added]. While the primary area of this dispute was on the Tongue River, a Yellowstone River tributary rising in Sheridan County, Wyoming, the principles are assumed to apply throughout the Yellowstone River watershed. How this may impact future administration of groundwater rights in the Study Area is unknown.

4.2.4 SURFACE WATER

The following sections provide an outline of surface water hydrography, water quality, and recommendations for site-specific evaluation of development opportunities in the Study Area. Note that Chapter 5 of this report contains detailed evaluation of stream hydrology.

4.2.4.1 HYDROGRAPHY

Streams are classified based upon the existence of streamflow and their runoff patterns. Briefly, there are three streamflow regimes:

- 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 and are dry the majority of normal years.

The USGS provides classification of streams in the Study Area and indicates their assessment on their published topographic maps. Most of the 12,500 miles of mapped stream channels within the Study Area are classified as intermittent, with only about 2,960 miles (23%) mapped as perennial. Appendix 1A: Map 16 displays perennial, intermittent, and ephemeral streams as they have been classified within the watershed. Underlying stream mapping presented in Map 16 is the USGS's National Hydrologic Dataset which delineates surface waters for the country. Also, subbasin boundaries are delineated based upon the USGS's Hydrologic Unit Code (HUC) mapping which is described in Chapter 5 Stream Hydrology.

4.2.4.2 WATER QUALITY

Stream Classifications

The Water Quality Division of the Wyoming Department of Environmental Quality (WDEQ) has classified water bodies in the state that are identified on the USGS 1:500,000 scale hydrologic maps or are contained in the Wyoming Game and Fish Department (WGFD) database of state streams and lakes. The Wyoming Water Quality Rules and Regulations – Surface Water Standards explain the surface water body classification process. The designated uses that are protected for Wyoming waters include the following per WDEQ Water Quality Rules and Regulations Chapter 1 Wyoming Surface Water Standards Section 3.0 (WDEQ 2018):

- **Agriculture:** for purposes of water pollution control, agricultural uses include irrigation or stock watering.
- **Fisheries**: use includes water quality, habitat conditions, spawning and nursery areas, and food sources necessary to sustain populations of game and nongame fish.

- **Industry:** use protection involves maintaining a level of water quality useful for industrial purposes.
- **Drinking water**: use involves maintaining a level of water quality that is suitable for potable water or intended to be suitable after receiving conventional drinking water treatment.
- **Recreation:** use protection involves maintaining a level of water quality which is safe for human contact.
- **Scenic value:** use involves the aesthetics of the aquatic systems themselves (odor, color, taste, 'settleable' solids, floating solids, suspended solids, and solid waste) and is not necessarily related to general landscape appearance.
- **Aquatic life other than fish**: u se includes water quality and habitat necessary to sustain populations of organisms other than fish in proportions which make up diverse aquatic communities common to the waters of the state.
- **Wildlife:** use includes protection of water quality to a level which is safe for the contact and consumption by avian and terrestrial wildlife species.
- **Fish Consumption:** use involves maintaining a level of water quality that will prevent any unpalatable flavor and/or accumulation of harmful substances in fish tissue.

Designated uses that are protected within each state water classification (identified by a unique numeric and alphabetic code) are described as follows for those stream types encountered within the Study Area (WDEQ 2018):

Class 1: Outstanding 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 DEQ 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.

Class 2AB: waters known to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where a game fishery and drinking water use in 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 "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.

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.

Class 2C: waters 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.

Class 3B: waters or 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.

Class 4A: waters are artificial canals and ditches that are not known to support fish populations.

Figure 4-5 summarizes the classification of streams within the Study Area and Appendix 1A: Map 17 shows their locations.

Sedimentation Issues

Sediment has emerged as a prominent concern regarding water quality within the Project Study Area. There are several ongoing studies, each with the aim of mitigating the contribution of sediment to the region's surface waters.

In 2016, awareness of these issues was significantly heightened. During routine maintenance activities at Willwood Dam, situated on the Shoshone River in the lower portion of the Study Area, a substantial volume of sediment was unintentionally released. This event resulted in fish kills, the loss of aquatic habitat and invertebrates, and the deposition of considerable sediment downstream. The incident received extensive media coverage, leading to heightened citizen concern and awareness about the issue.

In response to the event, WDEQ formed three working groups with the goals to:

- Restore aquatic life and habitat damaged due to the release of accumulated sediment.
- Reduce and/or eliminate the future need to release accumulated sediment from the dam in amounts and of duration that are harmful to aquatic life and the aquatic and riparian habitats downstream of the dam.

The working groups and their objectives are as follows:

- Working Group 1: Clean up the sediment, trash and debris that were released from the dam (completed in 2017)
- Working Group 2: Find a way to operate the dam that would allow the sediment to be released while still protecting all downstream aquatic life.
- Working Group 3: Identify where the sediment behind the dam is coming from within the watershed and determine if there are ways to reduce the sediment accumulation.

FIGURE 4-5. WDEQ SURFACE WATER CLASSES AND STREAM CLASSIFICATIONS

Designated Use	1	2AB	2A	2B	2C	2D	3A	3B	3C	3D	4A	4B
	Surface Water Classification											
Drinking Water	yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Cold Water Game Fish	yes	Yes	No	Yes	No	When Present	No	No	No	No	No	No
Warm Water Game Fish	yes	Yes	No	Yes	No	When Present	No	No	No	No	No	No
Nongame Fish	yes	Yes	No	Yes	Yes	When Present	No	No	No	No	No	No
Fish Consumption	yes	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No
Aquatic Life other than Fish	yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Recreation	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
Agriculture	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
Scenic Value	yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

2AB:

Shoshone River
- Bitter Cr.
- Deer Cr.
- Eagle Nest Cr.
- Buck Cr.
- Iron Cr.
- Sage Cr.

Buffalo Bill Res
- Rattlesnake Cr
- Carter Cr.

South Fork Shoshone
- Marquette Cr.
- Rock Cr.
- Hardpan Cr.
- Bobcat Cr.
- Ishawooa Cr.
- Boulder Cr.
- Cabin Cr.

NF Shoshone
- Trout Cr.
- Big Cr.
- Whit Cr.
- Elk Fork Cr.
- Sweetwater Cr.
- Fishawk Cr.
- Eagle Nest Cr.
- Gimnell Cr.
- Middle Cr.

Clarks Fork
- Cottonwood Cr.
- Line Cr.
- Pat O'Hara Cr.
- Paint Cr.
- Dead Indian Cr.
- Sunlight Cr.
- Tail Cr.
- Gravelbar Cr.
- Sawtooth Lk.
- Crandall Cr.
- Pilot Cr.
- Rock Cr.
- Beartooth Cr.
- Crazy Cr.
- Lark Cr.

2C:
- Idaho Cr
- Sulphur Cr

3B:

Shoshone River:
- Hoodoo Cr.
- Ashworth Cr.
- Cottonwood Cr.
- Dry Cr.
- Loch Katrine Cr.
- Mower Cr.
- Bull Cr.
- Aldrich Cr.

Clarks Fk:
- Hunter Creek
- Big Sand Coulee
- Silvertip Cr

Legend:
Shoshone River Watershed
Clarks Fork Watershed

According the WDEQ's Willwood Project website (www.wyowillwood.org), recent projects and successes include:

1. Improvements to the Shoshone River fishery downstream of Willwood Dam.
2. Modifications to the operations of Willwood Dam.

3. Efforts to better understand sediment dynamics at the dam.

4. Studies evaluating the impacts of sediment on the fishery.

5. Efforts to evaluate options for improvements and modifications to Willwood Dam.

6. Efforts to address sources of sediment to the Shoshone River.

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 this report was prepared, there were a total of 59 active (WYPDES) permitted discharges present within the Study Area. Table 4-8 summarizes pertinent information regarding the permits. The locations of these discharges are shown on Appendix 1A: Map 17.

FIGURE 4-8. ACTIVE WYPDES DISCHARGE PERMITS

WYPDES Permit Number	Receiving Water	Permittee	Permit Type	Facility Name
WY0000353	Sulphur Creek (2C) via unnamed draw (3B), Big Horn River Basin	Vaquero Big Horn, LLC	Oil Treaters	Half Moon Tank Battery, Halfmoon Field
WY0000451 (Outfall 1)	Shoshone River (2AB), Big Horn River Basin	Flying J, Inc.	Industrial	Cody Refinery
WY0000451 (Outfall 2)	Shoshone River (2AB)	Flying J, Inc.	Industrial	Cody Refinery
WY0000451 (Outfall 3)	Shoshone River (2AB)	Flying J, Inc.	Industrial	Cody Refinery
WY0000451 (Outfall 4)	Shoshone River (2AB)	Flying J, Inc.	Industrial	Cody Refinery
WY0001520	Sage Creek (2AB) via an unnamed drainage (3B), Big Horn River Basin	PRINCIPLE PETROLEUM LLC	Oil Treaters	Hunt Field
WY0001988	Clarks Fork Yellowstone River (2AB), Yellowstone River Basin	Wyoming Game and Fish Department	Fish Hatchery	Clarks Fork Fish Hatchery
WY0020451 (Outfall 1)	Shoshone River (2AB), Big Horn River basin.	Cody, City of	Sanitary Wastewater	Cody Wastewater Lagoon
WY0020451 (Outfall 2)	Shoshone River (2AB), Big Horn River basin.	Cody, City of	Sanitary Wastewater	Cody Wastewater Lagoon
WY0020451 (Outfall 3)	Shoshone River (2AB), Big Horn River basin	Cody, City of	Sanitary Wastewater	Cody Wastewater Lagoon
WY0020648 (Outfall 1)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0020648 (Outfall 2)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0020648 (Outfall 3)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon

WYPDES Permit Number	Receiving Water	Permittee	Permit Type	Facility Name
WY0020648 (Outfall 4)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0020648 (Outfall 5)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0020648 (Outfall 6)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0020648 (Outfall 7)	Bitter Creek (2AB), Big Horn River Basin	Powell, City of	Sanitary Wastewater	Powell Wastewater Lagoon
WY0022829	unnamed drainage (3B) tributary to Silvertip Creek (3B), Yellowstone River Basin	Contango Resources, INC	Oil Treaters	Elk Basin Waterflood Station 7
WY0022837	unnamed drainage (3B) tributary to Silver Tip Creek (3B), Yellowstone River Basin	Contango Resources, INC	Oil Treaters	Elk Basin Water Flood Station 8
WY0024414	Hunter Creek via an unnamed drainage (3B), Yellowstone River Basin	Contango Resources, INC	Industrial	Elk Basin Gas Plant
WY0026808	Cottonwood Creek (3B) via an unnamed drainage (3B), Yellowstone River Basin	Grizzly Operating, LLC	Oil Treaters	South Elk Basin Battery #1
WY0032051	unnamed drainage (3B), tributary to Sulphur Creek (2C), Big Horn River Basin	Vaquero Big Horn, LLC	Oil Treaters	Half Moon Battery
WY0032999	Mower Creek via an unnamed drainage (all 3B), Big Horn River Basin	Cumberland Operating, LLC	Oil Treaters	Duncan 62-22 & 62-23, T.E. Ranch Field
WY0035629 (Outfall 1)	Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 2)	Boot and Bottle Creek (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 3)	Sulfur Creek (class 2C),Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 4)	Cody Canal (class 4A), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 5)	Beck Lake (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 6)	Beck Lake (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline

WYPDES Permit Number	Receiving Water	Permittee	Permit Type	Facility Name
WY0035629 (Outfall 7)	Beck Lake (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 8)	Unnamed Drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 9)	Irrigation to Sage Creek (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 10)	Sage Creek (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 11)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 12)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 13)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 14)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 15)	Buck Creek (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 16)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 17)	Swamp (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 18)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 19)	Alkali (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 20)	Irrigation (class 4A), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 21)	Irrigation (class 4A), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 22)	Drain (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline

WYPDES Permit Number	Receiving Water	Permittee	Permit Type	Facility Name
WY0035629 (Outfall 23)	Bitter Creek (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 24)	Drain (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 25)	Irrigation Drain (class 4A), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 26)	Drain (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 36)	Drainage to Bitter Creek (class 2AB), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 37)	Unnamed drainage (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 47)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 48)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 53)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 54)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 55)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline
WY0035629 (Outfall 56)	Unnamed ephemeral tributary (class 3B), Shoshone River drainage (class 2AB)	Shoshone Municipal Pipeline	Water Treatment Plant	Water Pipeline

WYPDES Permit Number	Receiving Water	Permittee	Permit Type	Facility Name
WY0095346	unnamed ephemeral tributary (3B), tributary to Sage Creek (2AB), Big Horn River Basin	Principle Petroleum LLC	Oil Treaters	Hunt Field Principle Production Facility
WY0095931	unnamed ephemeral tributary (3B) trib. South Fork Sage Creek (3B) trib. Sage Creek (2AB) via , Bighorn River Basin	Principle Petroleum LLC	Oil Treaters	Hoodoo Battery

Total Maximum Daily Load Affected Streams

Section 303(d) of the Clean Water Act (CWA) and the EPA Water Quality Planning and Management Regulations (40 CFR 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies not meeting applicable water-quality standards or guidelines for the protection of designated uses under technology-based controls. TMDLs specify the maximum pollutant load that a waterbody can receive and still meet water-quality standards. Based on a calculation of the total allowable load, TMDLs allocate pollutant loads to sources and incorporate a margin of safety (MOS). TMDL pollutant load reduction goals for significant sources provide a scientific basis for restoring surface water quality by linking the development and implementation of control actions to attaining and maintaining water-quality standards and designated uses (RESPEC 2013)

According to the WDEQ, there are eight impaired reaches in the Shoshone River watershed downstream of Buffalo Bill Reservoir; two of which are in the Study Area: Bitter Creek and Dry Gulch. Both streams have been identified as impaired by WDEQ for elevated e. coli levels. Bitter Creek flows primarily in response to irrigation and has its confluence with the Shoshone River near Garland, WY. Dry Gulch is a small intermittent stream draining range lands and irrigated lands. It joins the Shoshone River downstream of Cody. Additionally, a TMDL has been completed for the Clarks Fork for metals concentrations, specifically cadmium, copper and silver. The TMDL reach begins at the Montana/Wyoming state line and extends 6.8 miles downstream.

4.2.5 GEOMORPHOLOGY

Alluvial geomorphology is a field of study that examines how landforms are shaped by the processes associated with the water flow. The interplay between erosion, deposition, and sediment transport is pivotal in determining the characteristics and condition of a stream. The primary objective of the geomorphic evaluation in the Study Area is to discern the nature of this interplay and identify instances where this balance has been disrupted.

The condition of a stream can be evaluated in terms of its fundamental characteristics, such as width, depth, and slope, as well as its state of equilibrium or geomorphic stability, as described by Thorne et al. (1996) and Johnson et al. (1999). Stable channels are typically defined as those in which there is a harmonious equilibrium between the energy of the flowing water and the sediment being transported, resulting in sediment being carried away at the same rate at which it is supplied. In such geomorphically stable conditions, minor changes in either sediment supply or energy lead to gradual adjustments in the channel's shape and pattern to accommodate these changes (Lane 1955). Channels become destabilized when significant alterations occur in these factors, resulting in rapid and substantial changes in channel form or pattern. Common indicators of channel instability include active downcutting, accelerated bank erosion, notable shifts in channel width-to-depth ratios, and increased flooding due to sediment accumulation. Dynamically stable channels, conversely, are adaptable and flexible, allowing for lateral migration and associated dynamics like bank erosion and sediment deposition.

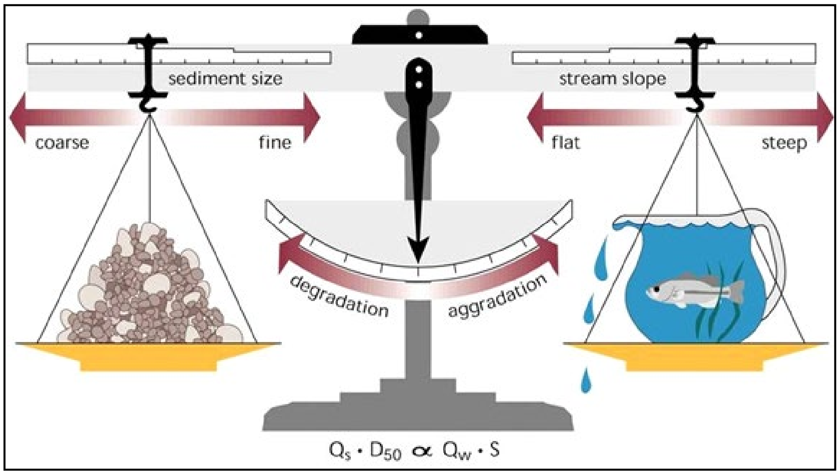
A stream in dynamic equilibrium has adjusted its width, depth, and slope in such a way that the channel neither aggrades (accumulates sediment) nor degrades (erodes excessively). However, changes may still occur on the stream banks, leading to erosion and necessitating bank stabilization measures, even in streams that are in dynamic equilibrium. The equilibrium concept can be expressed through various qualitative relationships, and one widely used relationship, proposed by Lane in 1955, states:

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

Where Q_w is the water discharge, S is the slope, Q_s is the bed material load, and D_{50} is the median size of the bed material. This relationship, commonly referred to as Lane's Balance, is illustrated in Figure 4-6.

This understanding of fluvial geomorphology is essential for assessing and managing the health and stability of streams and rivers within the Study Area.

FIGURE 4-6. LANE'S BALANCE



This graphic illustrates that any alteration in the four variables will trigger corresponding changes in the others, ultimately restoring equilibrium. Lane's Balance principle asserts that the sediment load and size are directly proportional to the channel flow and slope when the channel is in a state of equilibrium. When a channel is in equilibrium, it has adjusted these four variables in such a way that sediment entering the reach is transported out without significant deposition (aggradation) or excessive bed scour (degradation). Notably, under this stability definition, a channel has the freedom to laterally migrate by eroding one of its banks and building up the opposite bank at a similar rate.

In summary, a stable river, from a geomorphic perspective, is one that has adjusted its width, depth, and slope in a manner that avoids significant aggradation or degradation of the stream bed and substantial changes in planform (e.g., meandering to braided). By this definition, a stable river is not in a static condition but is instead in a state of dynamic equilibrium, capable of lateral adjustments through bank erosion and bar formation (Watson et al. 1999).

Geomorphic function is realized when a channel is in equilibrium while undergoing processes such as lateral migration, sediment reworking, and occasional overbank flooding, which effectively create and sustain valuable aquatic and terrestrial habitat features such as bars, pool/riffles, step/pools, and healthy riparian corridors undergoing regeneration. Impairments to geomorphic function represent a significant loss in the channel segment's functional potential. These impairments are generally described in qualitative terms, and any rehabilitation efforts for impaired channel segments necessitate a thorough, site-specific assessment of impacts, impairments, and feasible remedies.

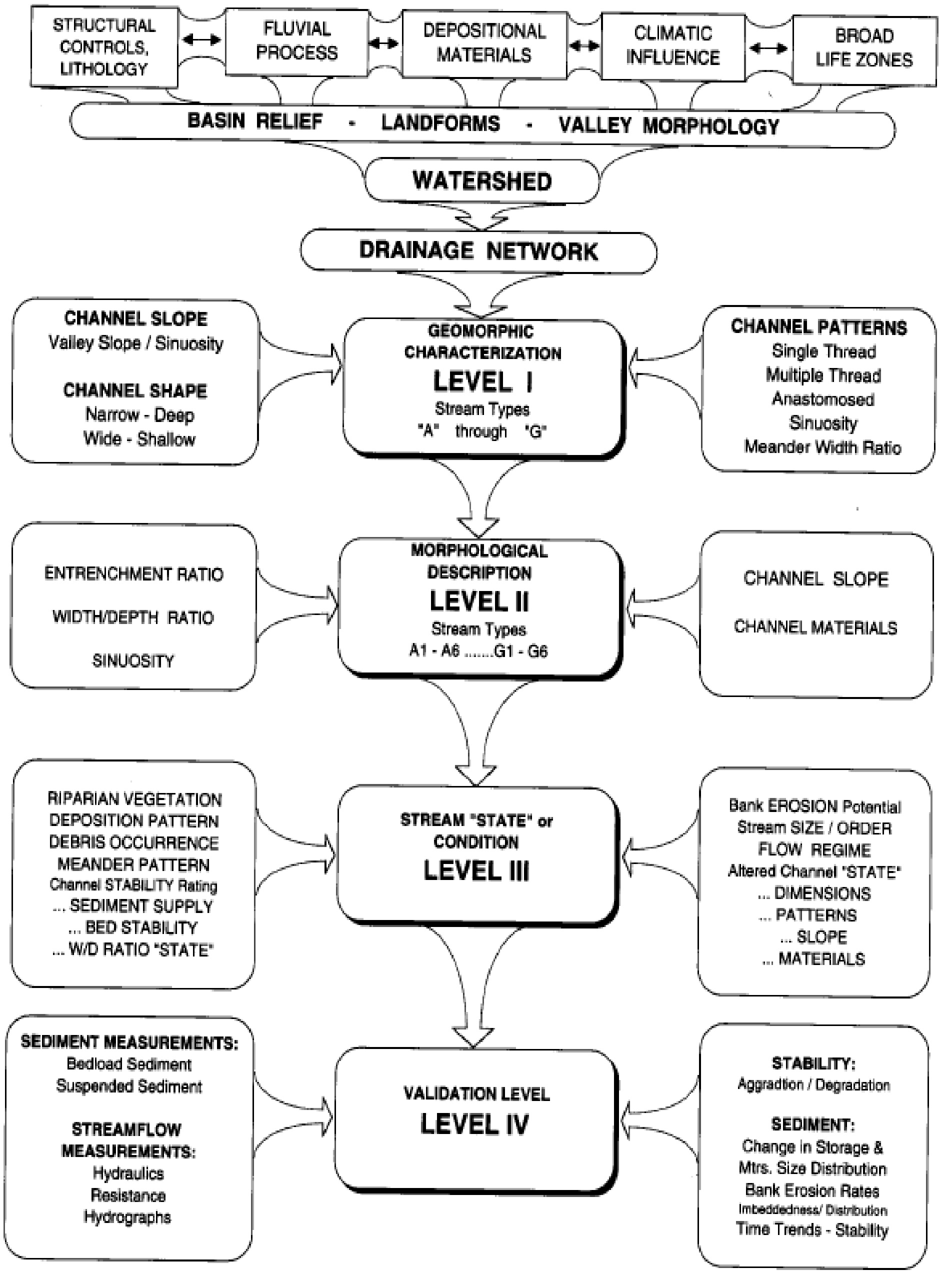
4.2.5.1 THE ROSGEN CLASSIFICATION SYSTEM

The literature presents various systems for classifying and evaluating stream systems, and one of the most widely used today is the Rosgen classification system (Rosgen 1996). This system, primarily based on the existing steam channel morphology, was employed in this Study. Parameters such as sinuosity, slope, width-to-depth ratio, and the size of channel materials are assessed to classify the stream into one of the various "types" within the Rosgen system.

The Rosgen classification system comprises four levels of classification, each offering more detailed information than the previous level. Figure 4-7 illustrates the hierarchy of assessment levels and the general level of effort associated with each. Much of the Level I geomorphic characterization is qualitative and relies on aerial photography and topographic maps. Streams are categorized into eight broad types based on their channel and floodplain geometry. These stream types can be seen as representing their relative locations within the watershed, ranging from headwaters to lowlands. For example, "A" type streams are typically found in headwaters, while "C" and "E" stream types are more common in lowland areas, and so on. The Level II effort delves into a more detailed stream description by taking measurements at selected locations. Stream types are further subdivided into 94 subtypes, depending on factors like the degree of entrenchment, width-to-depth ratio, water surface slope, streambed materials, and sinuosity (Figure 4-8). Consequently, the Level II characterization is more quantitative than the Level I assessment. Levels III and IV require even more extensive data collection and a deeper quantification of stream characteristics.

This Study includes a Level I evaluation of the mainstem channels and their primary tributaries, providing a broad but qualitative understanding of these streams and their geomorphic characteristics.

FIGURE 4-7. HIERARCHY OF THE ROSGEN STREAM CLASSIFICATION SYSTEM



4.2.5.1.1 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 general location and of stream types within the basin. The results of the Level I classification provide 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 product of the Level I classification is the determination of the major stream types, A through G which are described below.

FIGURE 4-8. ROSGEN CLASSIFICATION SYSTEM, STREAM TYPES (ROSGEN 1996)

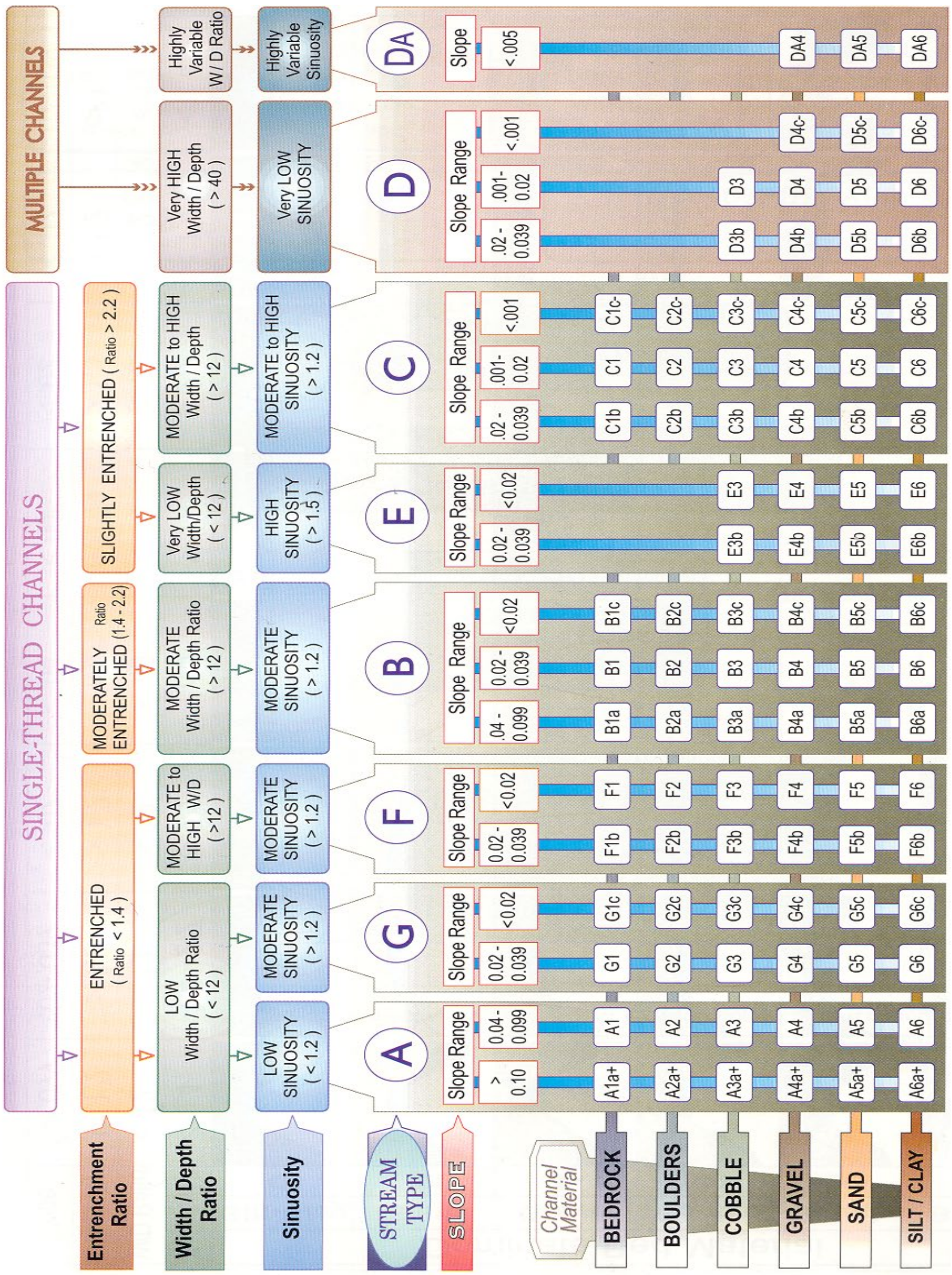
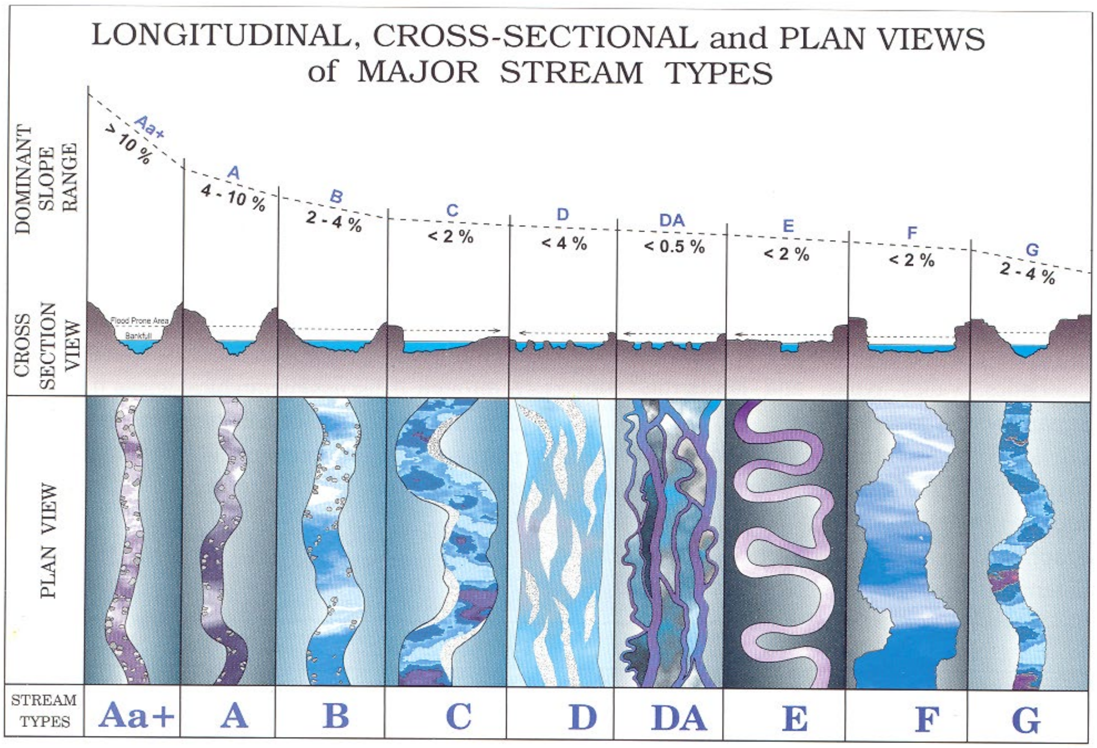


Figure 4-9 shows the major stream types within the Rosgen Classification System along with their relative locations within a typical watershed. Brief descriptions of the various stream types encountered in the watershed are presented in the following paragraphs.

FIGURE 4-9. MAJOR STREAM TYPES WITHIN THE ROSGEN CLASSIFICATION SYSTEM (ROSGEN 1996)



A-Type Channels are relatively steep channels (4-10%) 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.

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 4-10). 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 4-10. DEAD INDIAN CREEK B-TYPE CHANNEL

FIGURE 4-11. CLARKS FORK NEAR MONTANA STATE LINE C-TYPE CHANNEL

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 4-11). 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-type 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.

D-Type Channels are typically multiple channel systems with a braided/bar-braided pattern (Figure 4-12). The channels tend to have very high width/depth ratios, and the attendant valley slope typically dictates channel slope. D-Type channels are very often found amongst landforms consisting of steep depositional fans, broad alluvial mountain valley, glacial activities, and delta environments. Bank erosion rates are generally high and meander rates are generally very low, with sediment supply typically unlimited. Aggradation and lateral channel extension are common channel adjustment processes and can occur in a wide variety of landscapes from deserts to glacial outwash plains.

FIGURE 4-12. SUNLIGHT CREEK REACH D-TYPE CHANNEL

E-Type Channels typically exhibit very low slopes and represent the evolutionary "endpoint" of channel stability. The channels often develop inside wide, entrenched and meandering channels of F-Type Channels, and are typically found in alluvial valleys of low elevational relief. E-channels showcase very high sinuosity with very low width/depth ratios and result in the highest meander width ratios of any channel type. E-channels will generate the highest number of pools per unit distance of channel of any other riffle/pool channel type (C and F). Though considered a highly stable channel type, E-Type channels tend to be very sensitive to outside disturbance and possess the ability to be rapidly converted to other stream types in short periods of time.

F-Type Channels typically have relatively low slopes (<2%), like C and E channel types. The primary difference between C/E channels and F channels is with respect to entrenchment. F channels are entrenched, which means that the floodplain is quite narrow relative to the channel width. The entrenchment of alluvial F-type channels typically is an indicator of a historic downcutting event. F-type channels may form in resistant boundary materials (e.g., U-shaped bedrock canyons) and relatively erodible alluvial materials (e.g., arroyos). When the boundary materials are erodible, the steep valley walls are prone to instability, and channel widening commonly occurs within the entrenched channel cross section (Figure 4-13).

FIGURE 4-13. DEER CREEK F-TYPE CHANNEL

G-Type Channels are narrow, steeply entrenched gullies and are typically found in alluvial fans, debris cones, and meadows. Except for areas containing bedrock materials, G-Type channels have very high bank erosion rates. Along with low channel width/depth ratios and high sediment supplies, G-channels tend to generate suspended sediment transport rates and characteristically high bedload. Channel degradation and side slope rejuvenation processes are typical.

The Level I classification effort was conducted primarily using existing information incorporated into the Project GIS. Several analytical tools were developed and integrated into the GIS which allowed the evaluation of various geomorphic parameters (sinuosity, slope, and stream station determination). The data collated and incorporated in the Project GIS include digital aerial photography, USGS topographic maps, Landsat color infrared imagery, a digital elevation model (DEM), and digitized hydrography information. The most current data available were used in the geomorphic evaluation. Because the DEM was limited to a 10-meter grid, elevations and subsequent slope calculations are approximate. Stream alignments were digitized using 2022 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 considering the characteristics required at the Level I classification. These parameters, as indicated in Figure 4-9, 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.

4.2.5.1.2 RESULTS OF THE LEVEL I CLASSIFICATION

Results of the Level I classification effort are presented in Map 18. This figure displays a map of the Study Area depicting the various stream types as well as the reach designations used in the classification effort.

The headwater reaches of most tributaries within the basin are situated in moderately steep, arid terrain, composed of colluvial deposits, bedrock, residuum, and sparsely vegetated landscapes. The primary stream types in these areas are typically of the A and B varieties. These headwater streams are often characterized by lateral and vertical instability due to highly erodible soil and bedrock conditions, along with a lack of vegetation.

As these headwater streams flow into the lower valley reaches, a shift in character becomes evident, particularly in regions dominated by agriculture. The headwater reaches are generally steep and confined. In contrast, the lower valley reaches feature relatively lower slopes and a higher density and diversity of riparian vegetation. Entrenchment is a common feature throughout the lower watershed, owing to the highly erodible soils and bedrock resulting in an abundance of F-type channels. The stable channel types typically found in these lower valley settings include B, C, and E-type channels.

The Level I assessment can help determine the typical response of a given stream type to changes in its hydrologic regime. When a system loses equilibrium due to changes in hydrologic, sediment, and/or boundary conditions, it follows an evolutionary trajectory in an attempt to restore equilibrium. Understanding these processes can help watershed planning efforts by guiding prescriptive channel restoration strategies.

For example, after a disturbance in the system, such as channelization or changes in land use, degradation typically occurs due to an excess of stream power in the affected section. This degradation eventually leads to the oversteepening of the banks, and when critical bank heights are exceeded, bank failures and mass wasting (the episodic downslope movement of soil and rock) result in channel widening. As the channel widens and mass wasting progresses upstream, an aggradation phase follows in which a new low-flow channel begins to form within the sediment deposits. During this time, upper banks may still remain unstable. The final stage of evolution involves the development of a channel within the deposited alluvium, with dimensions and capacity similar to those of the pre-disturbance channel.

The new channel typically lies at a lower elevation than the pre-disturbance channel, and the former floodplain now primarily functions as a terrace. When streambanks become elevated, either due to downcutting or sediment deposition on the floodplain, they start to fail due to a combination of erosion at the base of the banks and mass wasting. The channel continues to widen until flow depths no longer reach the required depths for moving the sloughed bank materials. These materials at the base of the banks may begin to be colonized by vegetation, which increases roughness and promotes deposition at the base of the banks. This, in turn, leads to the formation of a new, smaller-capacity channel between the stabilized sediment deposits. The final stage of channel evolution results in a new bank-full channel and an active floodplain at a new, lower elevation. The original floodplain has been abandoned due to channel incision or excessive sediment deposition and is now referred to as a terrace.

Tributaries in the lower watershed reaches appear to be currently experiencing this pattern. Sage Creek and Sulfur Creek, both classified as F-type channels through at least portions of their length, have become entrenched and are contributing substantial amounts of sediment to the Shoshone River. At some point, these systems may stabilize as described above resulting in a stable C-type channel within the confines of an entrenched floodplain. The time for this to occur, however, greatly exceeds the needs of watershed planning efforts.

Furthermore, note that a June 13, 2022, flood event resulted in extensive reaches of bank erosion and channel destabilization, particularly in the upper Clarks Fork portion of the Study Area. Flooding of this magnitude caused extensive destabilization of stream banks throughout the subbasin causing significant amounts of sediment to be contributed to the system. Delineation of the extent of flood related impacts was beyond the scope of this Project. However, observations of extensive erosion, sediment deposition in the form of large gravel bars, and mid-channel deposition of large woody debris, indicates portions of the watershed may experience unstable conditions for years to come.

Figure 4-14 displays a photo of the upper portions of the Clarks Fork where within the Study Area flooding has resulted in deposition of extensive quantities of gravel which may ultimately lead to further widening of the channel.
Figure 4-15 displays the deposition of large quantities of large woody debris within the Hoodoo Creek subbasin.
Finally, Figure 4-16 displays erosion of streambanks on the Clarks Fork. Note that the vertical bank is approximately 6-ft high.

FIGURE 4-14. SEDIMENT DEPOSITION FROM JUNE 2022 FLOOD EVENT WITHIN THE CLARKS FORK WATERSHED

FIGURE 4-15. DEPOSITION OF LARGE WOODY DEBRIS FROM JUNE 2022 FLOOD EVENT WITHIN THE HOODOO CREEK SUBBASIN

FIGURE 4-16. EROSION OF CLARKS FORK STREAMBANK FOLLOWING THE JUNE 2022 FLOOD EVENT

4.2.5.2 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. Best management practices for these channels could include stabilizing culverts, irrigation diversions, etc.

Type C channels are non-entrenched and have "access" to their floodplains. These channels migrate, have oxbow features, and bank erosion is a natural feature (within limits), etc. Best management practices 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 adds to the understanding of the watershed's health and function. With an abundance of F-type channels (entrenched), there is a high potential for geomorphic instability. 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. In particular, the abundance of F-type channels in the lower portions of the

Study Area will have direct effects on sediment issues within the Shoshone River. Efforts of the WDEQ working groups are currently focusing on selected streams in this area: ex. Sage Creek and Sulfur Creek. Stabilization strategies applicable to F-type channels include grade control construction, stream bank stabilization measures, sediment check dams, and to a limited extent, beaver dam analogs (BDA's).

Unmapped 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

The following section describes the biological systems: land cover and fish and wildlife of the watershed. The inventory and descriptions of biological systems provides a snapshot of existing conditions within the Study Area.

4.3.1 LAND COVER

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):

The NLCD is distributed by the Multi-Resolution Land Characteristics (MRLC) Consortium 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 variability, and develop land management policy. NLCD products are created by the MRLC Consortium, a partnership of Federal agencies led by the U.S. Geological Survey (Homer et al. 2012). The NLCD data were published in 2021 and depict 2019 ground conditions.

The Landscape Fire and Resource Management Planning Tools Project, or LANDFIRE:
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.

This raster-based database was created at a 30-meter resolution. It was used to quantify and map riparian areas because of its high resolution. This database is useful for evaluation defined areas and quantification of areas of various vegetation classes, but it does not lend itself to map presentation at a watershed scale. The LANDFIRE database provides more detailed classifications with 844 categories. The LANDFIRE data were published in 2019 and depict 2016 ground conditions.

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 data validation. 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 et al. 2003). While the geographic resolution (30-meter) of the LANDFIRE data is the same as the NLCD data discussed previously, LANDFIRE land classifications are more detailed 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

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. The USGS produced data for the State and provided updated data in 2019.

National Wetlands Inventory (NWI): The NWI data, created by the US Fish and Wildlife Service (USFWS), was used to quantify and map wetland communities. The NWI data is a commonly used database, however, ground verification of results is recommended. Data is continually revised by the USFWS and updated biannually. The data used for this report was downloaded May25, 2022.

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.

4.3.1.1 VEGETATION AND PLANT COMMUNITIES

The NLCD data was used 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. Table 4-9 presents the results of NLCD analysis for the Study Area.

TABLE 4-9. CLARKS FORK/UPPER SHOSHONE WATERSHED: NATIONAL LAND COVER DATABASE (NLCD)

Classification	Description	Acres	Percent of Watershed
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.	1,217,998	56.31%
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.	572,189	26.45%
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.	141,441	6.54%
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.	81,650	3.77%
Barren Land	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.	64,394	2.98%
Hay/Pasture	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.	22,913	1.06%
Open Water	Areas of open water, generally with less than 25% cover of vegetation or soil	14,864	0.69%

Classification	Description	Acres	Percent of Watershed
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.	11,443	0.53%
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.	10,765	0.50%
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.	8,153	0.38%
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.	7,977	0.37%
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.	3,796	0.18%
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.	3,208	0.15%
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.	953	0.04%
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.	876	0.04%
Perennial Snow/Ice	Areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover	554	0.03%
Total		2,163,175	100.00%

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).

The LANDFIRE existing vegetation data indicate a diverse collection of vegetation types totaling 85 different vegetation classes within the Study Area. The five most common vegetation types are summarized separately for the Clarks Fork and Upper Shoshone portions of the Study Area in Table 4-10.

TABLE 4-10. LANDFIRE DATA ANALYSIS

Predominant LANDFIRE Existing Vegetation Type: Shoshone Watershed			
Existing Vegetation Type Name	**Existing Vegetation Type Physiognomy**	**Acres**	**Percent Watershed**
Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	260,574	19%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	113,791	8%
Rocky Mountain Cliff Canyon and Massive Bedrock	Sparsely Vegetated	105,363	8%
Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	103,626	8%
Inter-Mountain Basins Big Sagebrush Steppe	Shrubland	88,883	7%
Totals		672,237	50%

Predominant LANDFIRE Existing Vegetation Type: Clarks Fork Watershed			
Existing Vegetation Type Name	**Existing Vegetation Type Physiognomy**	**Acres**	**Percent Watershed**
Inter-Mountain Basins Big Sagebrush Shrubland	Shrubland	147,916	18%
Inter-Mountain Basins Montane Sagebrush Steppe	Shrubland	119,710	15%
Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	Conifer	72,067	9%
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	Conifer	59,692	7%
Rocky Mountain Cliff Canyon and Massive Bedrock	Sparsely Vegetated	54,921	7%
Totals		454,305	56%

Shrubland dominates the watershed, and the most common existing vegetation type is Inter-Mountain Basins Montane Sagebrush Steppe. Inter-Mountain Basins Big Sagebrush Shrubland is the second most common vegetation type, followed by Middle Rocky Mountain Montane Douglas-fir Forest and Woodland, Rocky Mountain Cliff Canyon and Massive Bedrock, and Inter-Mountain basins Big Sagebrush Steppe.

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 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" (USGS 2019)

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 Study Area. Appendix 1A: Map 19 displays the Wyoming GAP Analysis results for the Study Area. Note that the classifications in the map are listed in their order of abundance within the watershed. Table 4-11 summarizes the results of the analysis.

Distinct plant communities within the Study Area are influenced by the following characteristics:

- Geology: soil depth, soil texture, and salinity
- Climate variables: temperature, total and seasonal distribution of precipitation, and wind
- Topography: elevation, aspect, and slope
- Biotic factors: wildlife foraging, rodent burrowing, and ant hills

Plants themselves also influence soil chemistry and soil resistance to wind and water erosion.

TABLE 4-11. TABULATION OF GAP ANALYSIS

Shoshone River Watershed: USGS GAP Analysis		
Vegetation Classification	**Acres**	**Percent of Watershed**
Wyoming big sagebrush	286,264	21%
Douglas fir	195,460	14%
Spruce-fir	157,586	12%
Alpine exposed rock/soil	143,700	11%
Irrigated crops	142,671	11%
Lodgepole pine	139,326	10%
Meadow tundra	56,045	4%
Mountain big sagebrush	54,760	4%
Subalpine meadow	37,342	3%

Clarks Fork River Watershed: USGS GAP Analysis		
Vegetation Classification	**Acres**	**Percent of Watershed**
Wyoming big sagebrush	177,244	22%
Lodgepole pine	114,877	14%
Subalpine meadow	95,443	12%
Douglas fir	94,197	12%
Alpine exposed rock/soil	70,826	9%
Mountain big sagebrush	65,245	8%
Saltbush fans and flats	43,517	5%
Meadow tundra	32,680	4%
Spruce-fir	30,296	4%

Shoshone River Watershed: USGS GAP Analysis		
Vegetation Classification	Acres	Percent of Watershed
Limber pine and woodland	29,171	2%
Saltbush fans and flats	26,352	2%
Whitebark pine	21,491	2%
Desert shrub	14,271	1%
Shrub-dominated riparian	13,247	1%
Forest-dominated riparian	10,087	1%
Open water	7,018	1%
Juniper woodland	4,927	0.36%
Great Basin foothills grassland	4,236	0.31%
Aspen forest	3,656	0.27%
Human settlements	3,077	0.23%
Mesic upland shrub	2,339	0.17%
Greasewood fans and flats	2,262	0.17%
Mixed grass prairie	747	0.06%
Dry-land crops	305	0.02%
Burned conifer	261	0.02%

Clarks Fork River Watershed: USGS GAP Analysis		
Vegetation Classification	Acres	Percent of Watershed
Desert shrub	19,525	2%
Shrub-dominated riparian	14,941	2%
Irrigated crops	10,060	1%
Whitebark pine	9,879	1%
Great Basin foothills grassland	9,471	1%
Mesic upland shrub	6,640	1%
Mixed grass prairie	3,221	0.40%
Forest-dominated riparian	3,112	0.39%
Basin exposed rock/soil	2,832	0.35%
Limber pine and woodland	2,469	0.31%
Burned conifer	14	0.00%

4.3.1.2 RIPARIAN AREAS

The LANDFIRE data includes a limited determination of riparian areas. The LANDFIRE data does not graphically represent well at the watershed scale, therefore the riparian vegetation communities in the dataset are presented only in Table 4-12 and not graphically. There are a total of 42,545 acres designated as Riparian areas in the LANDFIRE dataset.

TABLE 4-12. LANDFIRE DATA ANALYSIS: RIPARIAN AREAS

LANDFIRE Riparian/Wetlands Classifications: Shoshone Watershed				
Existing Vegetation Type Name	**Physiognomy (form/morphological structure of vegetation)**	**Acres**	**Percent Watershed**	**Cumulative Percent**
Rocky Mountain Lower Montane-Foothill Riparian Shrubland	Riparian	5,865	0.43%	0.43%
Rocky Mountain Lower Montane-Foothill Riparian Woodland	Riparian	5,074	0.37%	0.81%
Rocky Mountain Alpine-Montane Wet Meadow	Riparian	3,007	0.22%	1.03%
North American Arid West Emergent Marsh	Riparian	2,628	0.19%	1.22%
Rocky Mountain Subalpine-Montane Riparian Woodland	Riparian	2,399	0.18%	1.40%
Interior West Ruderal Riparian Scrub	Riparian	1,557	0.11%	1.51%
Interior West Ruderal Riparian Forest	Riparian	1,354	0.10%	1.61%
Rocky Mountain Subalpine-Montane Riparian Shrubland	Riparian	1,230	0.09%	1.70%
Western North American Ruderal Wet Meadow & Marsh	Riparian	571	0.04%	1.746%
Western North American Ruderal Wet Shrubland	Riparian	22	0.002%	1.747%
Inter-Mountain Basins Alkaline Closed Depression	Riparian	2	0.0001%	1.748%

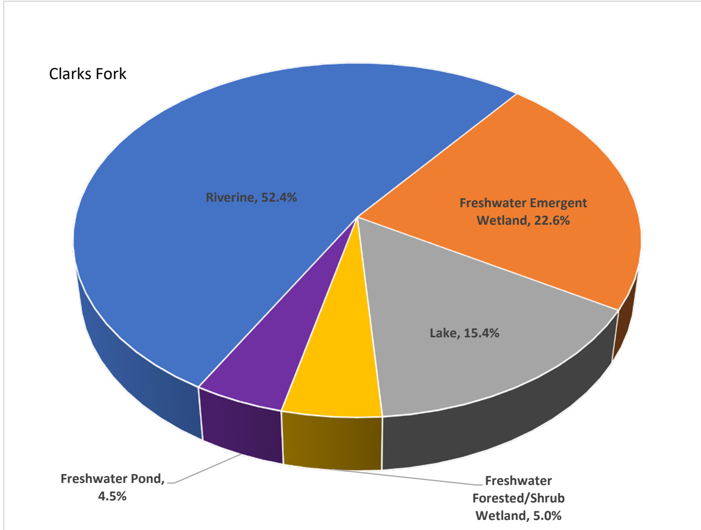
LANDFIRE Riparian/Wetlands Classifications: Clarks Fork Watershed				
Existing Vegetation Type Name	**Physiognomy (form/morphological structure of vegetation)**	**Acres**	**Percent Watershed**	**Cumulative Percent**
Rocky Mountain Alpine-Montane Wet Meadow	Riparian	5,318	0.66%	0.66%
Rocky Mountain Subalpine-Montane Riparian Woodland	Riparian	3,496	0.43%	1.09%
Rocky Mountain Lower Montane-Foothill Riparian Woodland	Riparian	2,869	0.36%	1.45%
Rocky Mountain Lower Montane-Foothill Riparian Shrubland	Riparian	2,189	0.27%	1.72%
Rocky Mountain Subalpine-Montane Riparian Shrubland	Riparian	1,712	0.21%	1.93%
Interior West Ruderal Riparian Scrub	Riparian	1,125	0.14%	2.07%
Western North American Ruderal Wet Meadow & Marsh	Riparian	986	0.12%	2.19%
Interior West Ruderal Riparian Forest	Riparian	648	0.08%	2.27%
North American Arid West Emergent Marsh	Riparian	466	0.06%	2.332%
Western North American Ruderal Wet Shrubland	Riparian	28	0.004%	2.335%

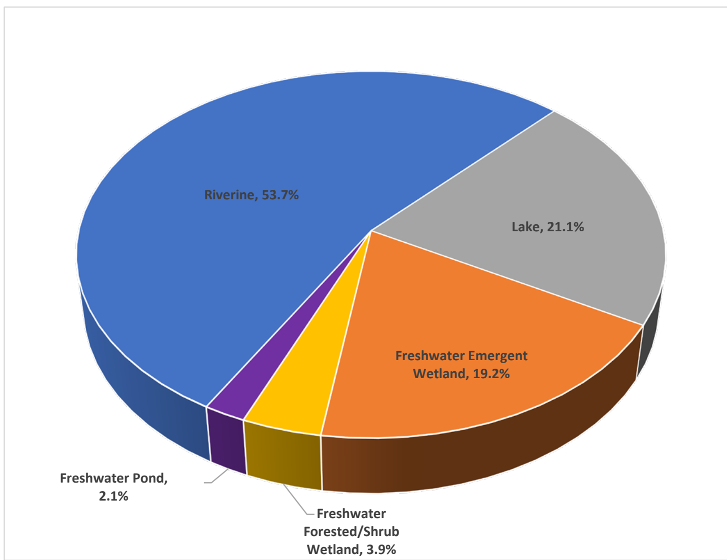
4.3.1.3 WETLANDS

Existing mapping of wetlands within the Study Area consisted of the NWI created by the 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 54,730 acres of wetlands exist within the watershed, which is only about 2.53% of the total Study Area.

Figure 4-17 illustrates the relative distribution of the general wetland types for the Shoshone River and Clarks Fork subbasins. The major contiguous wetlands in the watershed are Buffalo Bill Reservoir and other reservoirs associated with irrigation. Riverine wetlands are the most common type of wetland in the watershed, making up over half of the total wetlands within each subbasin. Freshwater Emergent Wetlands and Lakes are also found throughout the Study Area, each making up around one-fifth of the total wetlands. The remaining wetlands in the watershed are classified as Freshwater Forested/Shrub Wetlands (4.3%) and Freshwater Ponds (2.9%).

FIGURE 4-17. RELATIVE PROPORTIONS OF WETLAND TYPES





Each wetland type is defined as follows:

- **Riverine** –Riverine wetlands are *"wetlands and deepwater habitats contained within a channel, with two exceptions: (1) wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and (2) habitats with water containing ocean-derived salts of 0.5 ppt or greater."* (FGDC et al 2013)
- **Freshwater Emergent** – 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."* (FGDC et al. 2013)

- **Lakes** – *"a standing body of freshwater greater than 1 hectare (about 2.5 acres) that has at least 1000 square meters (about 0.25 acre) of open water and is at least 1 meter (about 3 feet) deep at its deepest point."* (USEPA 2023)
- **Freshwater Forested/Shrub** – A couple definitions exist for swamps. *"A forested wetland (swamp) is a forest where soils are saturated or flooded for at least a portion of the growing season, and vegetation, dominated by trees, is adapted to tolerate flooded conditions."* (Duberstein and Krauss 2015) Meanwhile the USEPA provides the following definitions: *"A swamp is any wetland dominated by woody plants."* Forested wetland vegetation varies greatly by region. By comparison, a shrub wetland/swamp is *"similar to a freshwater forested wetland, except that shrubby vegetation… predominates."* (USEPA 2023)

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 Bighorn River Wetland Complex is the largest in the watershed, occupying 313,504 acres on the eastern side of the watershed. The Beartooth Plateau Wetland Complex occupies 163,374 acres in the northwestern portion of the watershed, and the Skull Creek/Pat Ohara Creek Wetland Complex occupies 51,361 acres in the central portion of the watershed. Five unnamed complexes also exist within the Study Area, occupying 104,424 acres (Appendix 1A: Map 20).

Much of the wetland complexes in the Study Area coincide with agricultural fields. These areas satisfy criteria established by the Nature Conservancy though will not necessarily provide the same benefits for water quality improvement or riparian habitat as natural wetland areas.

4.3.1.4 GRAZING ALLOTMENTS ADMINISTRATION

Federal land grazing is managed under the Federal Land Policy and Management Act of 1976 and the Taylor Grazing Act of 1934. Grazing on USFS and BLM lands is administered through permit systems administered through the respective agency. To a lesser degree, the State administers grazing leases on State lands. Permit systems allow ranchers to graze livestock on specific properties defined as grazing allotments. Permits include provisions for monitoring and maintenance, prescription of numbers of animal units, and other management requirements.

Livestock and wildlife typically concentrate near water sources: riparian areas, streams, ponds and manmade sources such as stock tanks. Without adequate management, waterbodies and their surroundings can be greatly disturbed, vegetation overgrazed, and soils compacted. Overgrazing can lead to loss of productivity and vigor. However, with proper grazing management, livestock can be dispersed from concentrating about water sources, grazing allotments can be better utilized, and vegetation enhanced by employing prescribed grazing strategies encompassing proper timing of grazing and herding techniques.

Permittees are required to pay annual grazing fees and manage their livestock in a manner consistent with the guidelines described in the allotment management plan and federal regulations. Failure to pay fees or meet prescribed standards can result in the loss of grazing privileges. Generally, ranchers are required to maintain all grazing infrastructure on public lands, including fencing and water systems, as well as follow grazing schedules set each year in collaboration with agency personnel. They may also be required to meet other management requirements, such as special management for wildlife and endangered species. Finally, grazing is only one of many uses of public lands. The management of livestock may be altered or reduced to ensure other uses such as recreation, hunting, and wilderness are maintained (The Rangelands Partnership 2023)

BLM and USFS allotments are shown in Appendix 1A: Map 21. There are 152 BLM allotments and 37 Forest Service allotments.

Bureau Of Land Management Administration

Grazing activities on BLM lands are required to meet *Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands* as established in 1997. These Standards and Guidelines target several initiatives, such as the following:

- 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 that maintain or enhance downstream riparian function.
- Adopt management practices and implement range improvements that protect vegetative cover and thereby maintain, restore, or enhance water quality.

Since the passage of the Federal Land Policy and Management Act (FLPMA) in 1976, numerous laws, regulations, and policies have directed the BLM to manage its riparian and wetland areas. The purpose of these standards and guidelines is to uphold rangeland health as outlined in the grazing regulations. Holistic rangeland health consists of four fundamental requirements, which are:

1. Watersheds are functioning properly.
2. Water, nutrients, and energy are cycling properly.
3. Water quality meets State standards.
4. Habitat for special status species is protected.

To address the health, productivity, and sustainability of BLM-administered lands in Wyoming, the BLM established six Standards for Healthy Rangelands. The standards are outlined below (BLM 2001).

> *Standard #1 – Within the potential ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.*
>
> *Standard #2 – Riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge.*
>
> *Standard #3 – Upland vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance.*
>
> *Standard #4 – Rangelands can sustain viable populations and a diversity of native plant and animal species appropriate to the habitat. Habitats that support or could support threatened species, endangered species, species of special concern, or sensitive species will be maintained or enhanced.*
>
> *Standard #5 – Water quality meets State standards.*
>
> *Standard #6 – Air quality meets State standards.*

In addition to these standards, the BLM has developed general guidelines for livestock grazing management. The BLM develops, implements, and enforces appropriate corrective action where grazing activities are shown to harm rangeland health or otherwise violate these standards.

United States Forest Service Administration

In addition to the BLM allotments within the watershed, the USFS administers 37 grazing allotments. The Shoshone National Forest is an administrative unit of the US Forest Service. Each forest and grassland are guided by a unique Land and Resource Management Plan (USDA 2015).

This guidance information outlines the 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 pertinent 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.

According to the Shoshone National Forest Management Plan Revision (USDA 2015), grazing activities on forest lands, and the neighboring areas, are described as follows:

> *"Since a high point in the early 1900s, commercial sheep grazing has been in a steady decline on the Shoshone. The initial decline in sheep numbers was primarily due to adjustments to stocking rates that reflected a more sustained use of the range resource. The decline in sheep animal unit months continued through the 1970s and continued to decline in subsequent decades, though at a slower rate, reflecting declining demand and increased importation of wool and mutton from overseas. The last 10 years have seen the removal of all but one commercial sheep-grazing permit due to an increase in predator/livestock conflicts and concern over the potential for disease transmission from domestic sheep to bighorn sheep.*
>
> *"In contrast to commercial sheep use, the levels of permitted cattle grazing and demand for allotments have changed little for many decades. Improved livestock management, consolidation of*

vacant sheep allotments with cattle allotments, where appropriate, and construction of fences and off-site water sources have led to improved livestock management and distribution."

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.

4.3.1.5 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) (Wyoming Weed and Pest Council 2018).

- Field bindweed (Convolvulus arvensis L.)
- Canada thistle (Cirsium arvense L.)
- Leafy spurge (Euphorbia esula L.)
- Perennial sowthistle (Sonchus arvensis L.)
- Quackgrass (Agropyron repens (L.) Beauv.)
- Hoary cress (whitetop) (Cardaria draba and Cardaria pubescens (L.) Desv.)
- Perennial pepperweed (giant whitetop) (Lepidium latifolium L.)
- Ox-eye daisy (Chrysanthemum leucanthemum L.)
- Skeletonleaf bursage (Franseria discolor Nutt.)
- Russian knapweed (Centaurea repens L.)
- Yellow toadflax (Linaria vulgaris L.)
- 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.)
- Dyers woad (Isatis tinctoria L.)
- Houndstongue (Cynoglossum officinale L.)
- Spotted knapweed (Centaurea maculosa Lam.)
- Diffuse knapweed (Centaurea diffusa Lam.)
- Purple loosestrife (Lythrum salicaria L.)
- Saltcedar (Tamarix spp.)
- Common St. Johnswort (Hypericum perforatum)
- Common Tansy (Tanacetum vulgare)
- Russian olive (Elaeagnus angustifolia)
- Black Henbane (Hyoscyamus Niger L.)
- Common Mullein (Verbascum thapsus L.)
- Yellow starthistle (Centaurea solstitialis L.)
- Ventenata (Ventenata dubia (Leers) Coss.)
- Medusahead rye (Taeniatherum caput-medusae (L.) Nevski)
- Palmer amaranth (Amaranthus palmeri)

Designated noxious weeds are defined as follows:

> *"[W]eeds, 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:

> *“[A]ny 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.” (Univ. of Wyoming, 2023)*

4.3.1.6 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 78 plants as SOC or SOPC within the Clarks Fork subbasin and 61 within the Shoshone River subbasin. The results are presented in Appendix 4B.

4.3.2 FISH AND WILDLIFE

The following section provides a summary of the existing conditions of fisheries, aquatic species of greatest conservation need, big game, Wyoming Game and Fish priority areas, sage grouse habitat, and sensitive wildlife species within the watersheds.

4.3.2.1 FISHERIES

The general character of fisheries within the Study Area were well described in the Lower Shoshone River Level 1 Watershed Study (Biota 2021). The following excerpt was extracted from that report and included herein:

> *“The construction of the Buffalo Bill Dam and four diversion dams (Corbett, Willwood, Mormon, and Penrose) have fragmented the fish populations by blocking access to spawning tributaries. Additionally, dam construction has limited gravel recruitment in the Lower Shoshone River and resulted in an armored channel of course substrates that no longer provide adequate salmonid spawning habitat to maintain a self-sustaining Shoshone River fishery (BMP). Sedimentation and associated turbidity are a major factor limiting fish production and recruitment in the basin. Sedimentation is a result of several sources. Precipitation falling on naturally erosive soils can contribute sediment to the Lower Shoshone River. Poor grazing practices, tillage and cropping practices, road development, resource extraction, and urban and suburban development have removed terrestrial vegetation and increased upland and stream bank erosion. The water delivery system associated with agricultural irrigation in the basin utilizes some natural stream channels as*

wastewater conduit. The addition of water to these small stream networks leads to imbalanced sediment budgets, channel incision and widening, and deposition of these sediments into the downstream Shoshone River. Sediment flushing from behind Willwood Dam has resulted in large scale fish kills in the Lower Shoshone River.

Yellowstone Cutthroat Trout are considered a species of concern within the watershed. As a trout fishery the Shoshone River drainage was historically and exclusively native Yellowstone Cutthroat trout range. Introductions of Brown, Lake, Rainbow, and Brook trout have been stocked and become naturalized in the Shoshone River and reservoirs upstream of the Study Area. The earliest recorded stocking of exotic salmonids (Rainbows) occurred in 1915 (Shoshone River Watershed Plans Issues and Concerns). The Lower Shoshone River corridor is identified as an Aquatic Conservation Area in the 2010 State Wildlife Action Plan."

The WGFD uses a stream classification system to identify and rank the most important cold water recreational fisheries, and to assess the relative potential impacts of proposed development projects to streams. Categories are based on pounds of trout per mile using WGFD 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

Appendix 1A: Map 22 shows the stream classifications within the Study Area. Trout are present throughout most of the Study Area. There are five streams in the watershed classified as Blue Ribbon (>600 pounds of trout per mile):

- Shoshone River east of Cody
- North Fork Shoshone River west of Cody
- Trout Creek west of Buffalo Bill Reservoir
- Clarks Fork Yellowstone River from the Montana state line downstream to Shoshone National Forest Road 174
- Little Bear Creek (flows into Beartooth Lake)

There are six Red Ribbon streams in the Study Area (300 to 600 pounds of trout per mile):

- South Fork Shoshone River from Fall Creek confluence to Buffalo Bill Reservoir
- Alkali Creek near Powell, tributary to Shoshone River
- Sunlight Creek, upstream of Little Sunlight Creek confluence
- Jones Creek, tributary of North Fork Shoshone River
- Rock Creek, tributary of Clarks Fork Yellowstone River
- Crazy Creek, tributary of Clarks Fork Yellowstone River

The eastern (downstream) reaches of the Clarks Fork, as well as many of its tributaries (such as Crandall Creek, North Fork Crandall Creek, the lower portion of Sunlight Creek, and Dead Indian Creek) are classified as Yellow Ribbon streams (50-300 pounds per mile). Other Yellow Ribbon streams include Bitter Creek near Powell, Goff Creek, Fishhawk Creek, and Elk Fork. Many of the tributaries of these streams are classified as Green Ribbon streams (<50 pounds per mile).

4.3.2.2 AQUATIC SPECIES OF GREATEST CONSERVATION NEED (SGCN)

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). SGCN designation is reserved for species whose conservation status warrants heightened management attention and funding, and necessitates consideration in conservation efforts, land use planning, and development planning within Wyoming.

Within the Study Area, there are three fish species classified as SGCN, which are described below. Appendix 1A: Map 23 illustrates the distribution of these species:

- Yellowstone Cutthroat Trout: Found predominantly in the western or upstream portion of the Study Area.
- Flathead Chub: Inhabiting the eastern or downstream sections of the Study Area.
- Plains Minnow: Also located in the eastern or downstream sections of the Study Area.

These designations are in accordance with the SWAP reports, and the following paragraphs were directly extracted from these reports (WGFD 2017).

“**Flathead Chub (*Platygobio gracilis*):** While Flathead Chub distribution in Wyoming has seen a heavy decline due to reductions in turbidity and flow in some areas, populations have remained stable and common throughout the Bighorn Basin (Bear 2009). Water development and dam construction have also caused the species’ abundance to dwindle over time. To mitigate these losses, Wyoming Game and Fish plans to continue efforts to reduce land and water uses that lead to stream channel drying.”

“**Plains Minnow (*Hybognathus placitus*):** Plains Minnow distribution has seen a stark decline in Wyoming due to impoundments in major river drainages, the presence and expansion of nonnative species in waters occupied by Plains Minnows, a reduction in competitive advantages caused by turbidity reduction, and altered temperature and flow regimes. It is believed that this species may no longer exist in the Bighorn Basin, as detailed fish and habitat surveys at multiple sites throughout the basin in 2006 and 2007 yielded zero specimens. To combat the loss of the Plains Minnow, Wyoming Game and Fish plans to continue educating landowners and the public on the importance of native fish and the habitats they occupy.”

“**Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*):** Yellowstone Cutthroat Trout numbers in Wyoming have declined due to several factors, including increases in genetic impurity caused by hybridization with nonnative salmonid species, increased competition, habitat loss, and predation brought on by increased numbers of nonnative salmonids, and lack of connectivity within stream systems caused by low flows and physical barriers (both anthropogenic and natural). Land management activities such as grazing, irrigation and municipal water diversions, infrastructure expansion, and energy development have also been contributing factors to the population decline of Yellowstone Cutthroat Trout. To conserve and grow the current population, Wyoming Game and Fish intends to increase public outreach and stress the importance of conservation, construct in-channel barriers to prevent the further spread of nonnative salmonid species into waters populated by Yellowstone Cutthroat Trout, continue efforts to physically remove all nonnative salmonids from these waters, and prevent the stocking of public and private waters with nonnative salmonid species. Other important conservation measures proposed by Wyoming Game and Fish include using riparian fencing and invasive species control measures to promote native vegetation growth in riparian areas that support Yellowstone Cutthroat Trout populations, as well as developing refugia for pure populations of Yellowstone Cutthroats in surrounding lakes and streams to serve as backup for hatchery brood sources.”

4.3.2.3 BIG GAME

The Wyoming Game and Fish Department (WGFD) conducts mapping of seasonal ranges by herd unit for each big game species, with special emphasis on identifying areas designated as Crucial Habitat and Parturition areas (birthing areas). Crucial Habitat is defined by the WGFD as seasonal ranges or habitats, primarily winter ranges, which have been documented as critical factors in a population's ability to sustain itself over an extended period. Within the Study Area, the primary big game species include antelope, bighorn sheep, elk, moose, mule deer, Rocky Mountain goats, and white-tailed deer. Approximately 670,713 acres (approximately 45-46 percent of the Study Area) have been identified as crucial habitat for one or more of these species, specifically antelope, bighorn sheep, elk, or mule deer.

Among the big game species mapped by the WGFD, only bighorn sheep, elk, and Rocky Mountain goats have parturition areas within the watershed, totaling approximately 15,873 acres (about 301.1% of the Study Area). The combined areas designated as crucial and parturition habitats for all big game species are depicted in Appendix 1A: Map 24. According to the WGFD data provided, white-tailed deer may use the Study Area but primarily as seasonal range.

Appendix 1A: Maps 25 through 32 illustrate the WGFD's delineation of seasonal range, crucial range, parturition areas, and/or migration routes for antelope, bighorn sheep, elk, grizzly bear, moose, mule deer, Rocky Mountain goats, and white-tailed deer, respectively, within the Study Area and adjacent regions of Wyoming. An examination of these figures reveals that while the entire watershed is classified as seasonal range for these big game species, only antelope, mule deer, and white-tailed deer are found throughout the entire watershed. Parturition areas typically overlap extensively with crucial areas for the same species. Crucial habitat areas between different species generally do not overlap significantly but tend to be concentrated in rugged terrain and higher elevations on the western side of the Study Area.

As previously mentioned, crucial ranges are typically associated with winter range areas where foraging is more accessible due to lower snow depths, and the landscape offers some form of thermal cover (BLM, 2008). In the Study Area, the parturition areas for bighorn sheep are primarily situated in the south-central portions of the watershed along the North and South Fork Shoshone River and Ishawooa Creek. Conversely, the parturition areas for elk encompass a much larger area, extending from the North and South Fork Shoshone River to the Sunlight and Pat O'Hara Creek areas located north of Buffalo Bill Reservoir. The Rocky Mountain goat parturition areas cover a considerably smaller area compared to those of bighorn sheep and elk and are concentrated in the mountainous regions to the north of the Clarks Fork along the Montana-Wyoming border. No parturition areas for antelope, moose, mule deer, or white-tailed deer are situated within the Study Area.

4.3.2.4 WGFD PRIORITY AREAS

As part of the WGFD Statewide Habitat Plan (previously known as the Strategic Habitat Plan) issued in 2020, previously existing priority habitat areas within the state were refined into Goal 1 Crucial Habitat Priority Areas, Goal 2 Restoration Habitat Priority Areas, and Goal 3 Connectivity Habitat Priority Areas for both aquatic and terrestrial terrain (Appendix 1A: Map 33), "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 Habitat 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, quality of watershed hydrologic function, etc. The Department will concentrate habitat protection and management activities in these areas."*
>
> *Goal 2 Restoration 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. Restoration areas are based on habitat issues. Like crucial areas where values are key, issues were identified by regional personnel and used to select restoration habitat areas. Examples of issues include loss of aspen communities, habitat fragmentation, development, water quality effects, water quantity limitations, beetle killed conifer, loss of fish to diversions, degraded habitat, etc."*
>
> *Goal 3 Connectivity Habitat Priority Areas were developed to reflect the high importance that issues related to connectivity among fish and wildlife populations have gained in recent years. These areas are meant to promote protecting connectivity where it currently occurs and focus attention on enhancing fish passage and wildlife migrations to improve connectivity. Officially designated wildlife migration corridors as well as informally identified migration routes are included under this goal. Likewise, fish passage areas are included. A sampling of issues addressed under this goal include road crossings that impede fish or wildlife, diversion dams that block fish, the location and accessibility of ungulate stopover areas, diversions that entrain high numbers of fish, and fences that block or impede migrations."*

4.3.2.5 SAGE GROUSE

Appendix 1A: Map 34 delineates the most recently identified Core Sage Grouse Population Areas within the Study Area. According to the WGFD, the overarching goal of these Core Area delineations is to protect as many sage grouse as possible while minimizing the acreage encompassed by these areas. This may result in occupied leks, which are communal breeding grounds for sage grouse, falling outside of the identified Core Areas.

As depicted in Appendix 1A: Map 34, Sage Grouse Core Areas have an impact on small eastern and northeastern portions, as well as a significant central portion, of the Study Area. Collectively, there are 215,984 acres of Sage Grouse Core Area within the Study Area, constituting 9.9% of the total watershed area. According to the 2021 lek data provided by WGFD, the Study Area includes a total of 31 occupied leks, 6 unoccupied leks, and 14 leks of undetermined status (WGFD 2021). The regulations pertaining to these leks are detailed in Attachment B of Executive Order 2019-3.

4.3.2.6 SENSITIVE WILDLIFE SPECIES

Construction activities within the Study Area should consider other sensitive species beyond trout, big game, and grouse. Under the National Environmental Policy Act, surveys for sensitive species are required in project areas before project construction is carried out by federal agencies or on federal land. If sensitive species are identified in the Project area, mitigation measures must be implemented. Prior sections of this report have identified many of the species and key areas to be aware of, and more information on sensitive species of Wyoming is provided by the Wyoming Natural Diversity Database (WYNDD) on their website. A table of known sensitive wildlife species in Park County is provided as Appendix 4B (WYNDD 2023).

Fifty-five species within the Clarks Fork subbasin were classified as Species of Concern. Of these, three have been listed as threatened by the USFWS under the Endangered Species Act of 1973: Forest gadfly (Zapada glacier), Canada lynx (Lynx canadensis), and the Grizzly bear (Ursus arctos). In the Shoshone River subbasin, there are 110 species of concern. Two of these are listed as threatened by the USFWS: Canada lynx (Lynx canadensis), and the Grizzly bear (Ursus arctos).

4.4 ANTHROPOGENIC SYSTEMS

The following section describes the anthropogenic systems including land features, agricultural water use, domestic, municipal, and industrial water use, and water storage. The inventory and descriptions of human derived systems provides a summary of existing conditions within the Study Area.

4.4.1 LAND

Watershed topics within the Land category include inventory and descriptions of land ownership, land use summaries and specific land use related to mining, transportation, energy, communications, infrastructure, and oil and gas, land management, and cultural resources.

4.4.1.1 LAND OWNERSHIP

Land ownership information was acquired from the Bureau of Land Management (BLM) and served as a crucial resource for this evaluation. This data source includes general land ownership categories, encompassing various federal land management agencies (such as BLM, USFS, etc.), the State of Wyoming, and privately owned lands. Note that this data source does not provide details about the ownership of individual private parcels.

Detailed mapping of private lands within the Study Area was sourced from the Park County Assessor's offices. This specific information proved invaluable for several purposes, including the development of contact lists and the verification of ownership status during the formulation of conceptual designs for components within the Watershed Management Plan (Chapter 6).

Appendix 1A: Map 35 visually represents the general land use categories as indicated by the BLM data layer. The total land area encompassed by the Study Area is estimated at approximately 2.2 million acres, equivalent to 3,400 square miles. As highlighted in this map, Park County constitutes approximately 99.9 percent of the Study Area, covering 3,378 square miles, while Bighorn County accounts for the remaining 0.1 percent, or approximately 1.7 square miles.

Land ownership distribution within the Study Area is summarized as follows:

- Federal Lands: 2,496 square miles (73.9%)
- United States Forest Service: 1,971 square miles (58.3%)
- Bureau of Land Management: 492 square miles (14.6%)
- National Park Service: 33 square miles (1.0%)
- Private Lands: 772 square miles (22.8%)
- State of Wyoming: 94 square miles (2.8%)
- Local Government: 7 square miles (0.2%)
- Water bodies: 17 square miles (0.5%)

Management Implications

> *Land ownership has direct implications to the watershed study and implementation of proposed watershed improvements. Like much of the State, the project Study Area is dominated by federally owned lands. Project implementation will require coordination with the USFS, BLM, USBR, and NPS 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. Privately owned properties (around 23 percent of the Study Area) will allow for greatly simplified permitting efforts when compared to the rest of the Study Area. Chapter 9: Permitting provides descriptions of potential permitting requirements, application information, and agency contact tabulations.*

4.4.1.2 LAND USE

Land uses reviewed included mining, transportation, communication, energy, mining, oil and gas, cultural resources, and agriculture.

4.4.1.2.1 LAND DEVELOPMENT

Park County has become a popular destination for tourists and individuals seeking a rural lifestyle and is, consequently, currently experiencing notable development. The development has been influenced by various factors, including its proximity to Yellowstone National Park, the allure of small-town living, and the increasing popularity of second homes and retirement communities. Wyoming's State projection for Park County anticipates a population increase at an annual rate of 0.37 percent per year between 2020 and 2040, translating to the addition of around 2,300 new residents. This projected growth rate represents a decrease compared to the growth observed in the preceding two decades. Nevertheless, contemporary growth indicators, including the surge in building permits and new address requests, indicate that the rate of expansion in the County is on the rise (Park County, 2023)

As the county's growth persists, the subdivision of currently irrigated lands becomes a recurring issue, frequently giving rise to conflicts and challenges concerning water rights management. Traditionally, irrigated lands in the county receive their irrigation water from various irrigation districts. However, the division of larger parcels into smaller ones complicates the administration of water rights, primarily due to the escalating number of individual parcels and landowners involved. Additionally, new landowners are often unfamiliar with the intricate protocols and policies governing water administration, further exacerbating the situation. These dynamics underscore the need for enhanced education and communication regarding water rights among the growing population of landowners in the County.

4.4.1.2.2 MINE PERMITS

The WDEQ Land Quality Division records show there are seventeen active mines within the Study Area (Table 4-13). Appendix 1A: Map 36 displays their location. Fourteen of the mines are sand and gravel mines, one is a granite mine, one is a bentonite mine and one is a gypsum mine.

TABLE 4-13. WDEQ ACTIVE MINE PERMITS

Permit Number	Company Name	Mine Name	Mineral	Permit Type	Acres	Status
ET1545	Luckinbill construction Inc	Luckinbill	Granite	Limited Mine Operations (ET)	3	Active
ET1072	Thiel Construction	Clark Pit 1	Sand & Gravel	Limited Mine Operations (ET)	4.5	Active
ET1451	Denney, Jerry	Denney Ranch	Sand & Gravel	Limited Mine Operations (ET)	10	Active
SP0325	Park, County of	Elk Basin	Sand & Gravel	Small Mine (SP)	N/A	Active
ET1263	Spomer Construction Co Inc	N/A	Sand & Gravel	Limited Mine Operations (ET)	15	Active
SP0325	Park, County of	Davis	Sand & Gravel	Small Mine (SP)	N/A	Active
ET1373	Fry Gravel and Excavation Inc	Ralston	Sand & Gravel	Limited Mine Operations (ET)	6	Active
PT0803	Big Horn Redi Mix Inc	Willy Gravel Pit	Gravel	Permit	146.78	Active
SP0325	Park, County of	Roth	Sand & Gravel	Small Mine (SP)	N/A	Active
ET1613	Harris Trucking & Const co	N/A	Sand & Gravel	Limited Mine Operations (ET)	15.05	Active
SP0325	Park, County of	Cody North	Sand & Gravel	Small Mine (SP)		Active
PT0818	Canyon concrete Sand & Gravel LTD LLC	Cody Lumber Pit	Sand & Gravel	Permit	96.59	Active
ET1537	Fry Gravel & Excavation Inc	Gibbons	Gravel	Limited Mine Operations (ET)	5	Active
SP0325	Park, County of	Sheep Mountain	Sand & Gravel	Small Mine (SP)	N/A	Active
SP0325	Park, County of	Andy Martin	Sand & Gravel	Small Mine (SP)	N/A	Active
PT0322	American Colloid Co	Lovell Mine	Bentonite	Permit	23,688.5	Active
PT0358	Certain Teed Gypsum & Ceiling Manuf Inc	Certain Teed	Gypsum	Permit	1203.3	Active

4.4.1.2.3 TRANSPORTATION, ENERGY, AND COMMUNICATIONS

The location of state transportation routes within the Study Area are shown on Appendix 1A: Map 37, and includes US14, US14A, US16, WY294, WY296, and WY120. These routes are primarily located in the eastern and northern portion of the Study Area, providing access to the cities of Cody and Powell, access north to Montana and west toward Yellowstone, there are no interstate routes within the area.

There are four hydroelectric powerplant facilities located within the Project Study Area all of which are operated off the Shoshone River. The Buffalo Bill Powerplant (18,000 kW), Shoshone Powerplant (3,000 kW), Spirit Mountain Powerplant (4,500 kW) and the Heart Mountain Powerplant (5,000 kW). The Buffalo Bill, Shoshone, and Spirit Mountain Powerplants are all located between Buffalo Bill Reservoir and Cody. The Heart Mountain Powerplant is located northeast of Cody.

The electric power transmission line corridors are located on the eastern side of the Study Area extending between Cody and Powell. The Elk Basin natural gas processing plant is located 15 miles north of Powell.

Communication towers are predominantly located along the transportation routes in the eastern section of the Study Area between Cody and Powell.

4.4.1.2.4 OIL AND GAS PRODUCTION AND RESOURCES

The eastern side of the Study Area sits along the western boundary of the Bighorn Basin in north-central Wyoming. The Bighorn Basin is primarily an oil-producing basin and has produced oil from more than 125 fields and more than 30 reservoirs (WSGS 2022). Appendix 1A: Map 38 shows the location of oil/gas fields and pipelines. As shown on Map 38 the active gas and oil wells are primarily located along the eastern boundary of the Study Area. Historically oil and gas extraction has been a major contributor to Park County's economy however extraction activity peaked between 2010 and 2012 and has declined over 50 percent since (Park County Land Use Plan, 2023). Table 4-14 lists the oil and gas fields located within the Study Area, number of wells in the field and if abandoned.

TABLE 4-14. OIL AND GAS FIELDS IN THE STUDY AREA

Field Name	Total Wells	Abandoned
Line Creek	1	Y
Northline	1	Y
Terry	5	N
Doctor Ditch	2	Y
Badger Basin	23	N

Field Name	Total Wells	Abandoned
Silver Tip	112	N
Elk Basin	599	N
Silver Tip South	12	N
Elk Basin South	42	N
Ralston	5	Y
Bearcat	11	N
Coulee	2	N
Heart Mountain	17	N
McCulloch Peak	4	Y
Shoshone North	10	N
Shoshone	35	N
Cody	37	N
City	1	Y
Penney Gulch	1	Y
Half Moon	58	N
Hunt	29	N
Ferguson Ranch	24	N
T.E. Ranch	6	N
Shoshone South	1	Y

4.4.1.3 LAND MANAGEMENT

Out of the approximately 2.2 million acres encompassed by this Study Area, approximately 0.5 million acres are privately owned. The discussion regarding private land management within this watershed primarily focuses on the potential for forage plant production within specific "ecological sites." The condition of an ecological site, including the existing diversity of plants and the overall plant community, often serves as a reflection of past and present land management practices. Therefore, the ecological site description associated with a particular location within the watershed can serve as a valuable reference point against which current grazing management practices can be compared, assessed, and adjusted as needed. This approach allows for a more informed and sustainable approach to managing private lands within the Study Area.

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

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

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

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

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

- Site characteristics—physiographic, climate, soil, and water features
- Site interpretations—management alternatives for the site and its related resources
- Supporting information—relevant literature, information, and data sources.

In practical application, ESDs can be used to compare what is growing on the rangeland with what each site is capable of growing with respect to rangeland vegetation and density. 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.

Within the Study Area, the three most prevalent ESDs are:

- Saline Upland (SU) 5-9" Big Horn Basin Precipitation Zone

- Sandy (Sy) 5-9” Big Horn Basin Precipitation Zone.
- Shale (Sh) 5-9” Big Horn Basin Precipitation Zone

4.4.1.4 CULTURAL RESOURCES

The Wyoming State Historic Preservation Office (SHPO) maintains an ongoing database of inventoried historic sites within the state. This database includes assessments of each site's eligibility for inclusion in the National Register of Historic Places (Register). Additionally, SHPO has created a spatial data file that applies a form of "location fuzzing" to the historically significant data. This process is designed to protect these sites from unauthorized disturbance. The recorded attributes for each section of the Public Land Survey System encompass site count, inventory acres, report numbers, and eligible site numbers.

Appendix 1A: Map 39 provides a visual representation of the results obtained from the database retrieval. Each square mile section within the Study Area is color-coded based on the number of sites within it that have been determined to be eligible for inclusion on the National Register.

The National Register of Historic Places (National Register) serves as the official list of cultural resources considered deserving of preservation at the national level. This list is administered at the federal level by the National Park Service and managed at the local level by SHPO. The National Register plays a crucial role in coordinating and supporting both public and private initiatives aimed at identifying, assessing, and safeguarding historic and archaeological resources. It serves as a recognition of the contributions made by individuals and communities to the history and heritage of the United States, as well as at the state and local levels.

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 (https://www.nps.gov/subjects/nationalregister/index.htm https://www.nps.gov/nr/national_register_fundamentals.htm).

4.4.2 AGRICULTURAL WATER USE

Agriculture is the single largest water user within the Big Horn Basin. Statewide, 80% to 85% of the water used in Wyoming is for irrigation (“Wyoming’s Water Resources”, Jacobs and Brosz at http://library.wrds.uwyo.edu/wrp/93-12/93-12.html). With agriculture being a prominent component of the local economies within the Upper Shoshone and the Clarks Fork watersheds, the statewide agricultural water use statistic likely holds true within the Study Area as well. The average length of the growing season in Park County is 147 days which permits a wide variety of irrigated crops to be grown within the Study Area. As per the USDA's 2017 Census of Agriculture, Park County, Wyoming, the market value of the agricultural products sold in 2017 amounted to $85,174,000 (USDA 2018). That converts to $104,932,000 in 2023 dollars using an inflation factor of 1.23197 (https://www.bls.gov/data/inflation_calculator.htm). Clearly, the economic impact of the agricultural water use within the Study Area is significant. Irrigated crops grown within the Shoshone Irrigation District include malt barley, sugar beets, beans (dry & edible), irrigated pasture, alfalfa hay, alfalfa seed, other hay, corn, wheat, corn silage, feed barley, grass, oats and garden vegetables. These irrigated crops are also grown throughout much of the Study Area, with irrigated hay and irrigated pasture being the primary crops grown along the North and South Forks of the Shoshone River and along the Clarks Fork.

4.4.2.1 IRRIGATED LANDS

The gradual slopes of the upland benches toward the Shoshone River and the Clarks Fork are ideal for irrigation. Based on the Statewide Basin Plan – 2007 GIS Irrigated Lands Dataset developed by Greenwood Mapping in 2007 for the Wyoming Water Development Commission Framework Water Plan, approximately 131,778 acres within the Study Area are irrigated lands (Appendix 1A: Map 40). These irrigated acres include not only lands that are serviced by the large irrigation districts along the Upper Shoshone River system, but also include lands serviced by numerous, smaller irrigation diversions for ditches and pipelines owned by individual landowners, loosely formed partnerships and associations, and registered, private ditch companies located throughout the Study Area – including the Wyoming portion of the Clarks Fork. Comparing aerial imagery from the 2007 irrigation season to the 2022 irrigation season, the primary method of irrigation delivery throughout the Study Area is still open-channel conveyance with field ditches and gated pipe used for on-farm distribution to the intended lands. However, during the past couple decades, the irrigation method for a growing share of these irrigated lands has changed from flood irrigation to sprinkler irrigation. A review of the 2022 aerial photographic images for the Study Area identified over 290 center pivot irrigation systems already in use. This trend is continuing due to the efficiency, effectiveness, and labor savings realized from sprinkler irrigation. Further, center pivots have been proven to reduce the distribution of salts. Center pivot irrigation also helps to reduce the conveyance loss that is common with open channel irrigation.

The aerial imagery also shows changes can occur in the footprints of some irrigated lands where center pivot irrigation has replaced flood irrigation. Due to their coverage geometry, center pivots and other sprinkler systems sometimes take in and irrigate new lands. With the use of pumps, side-roll sprinklers and center pivots, landowners can apply irrigation water to lands where flood irrigation was not an option. Irrigation methods are not the only evident change in irrigation footprints. The loss of prime irrigated farm ground to residential and commercial subdivisions is a local concern.

Table 4-15 outlines the usage and storage of the irrigation districts identified in the Wyoming Water Development Commission (WWDC) State of Wyoming 2021 Irrigation System Survey Report.

TABLE 4-15. WWDC 2021 WYOMING IRRIGATION SYSTEMS REPORT #3: USAGE AND STORAGE (1)

Year	Entity	Irrigated Acres	Number of individual Water Users	Name of Reservoir with Account	Amount of Storage (AF)
2021	Cody Canal Irrigation District	13,200	2,185	Beck Lake	712 (1)
2017	Heart Mountain Irrigation District	33,739	690	Buffalo Bill Reservoir	330,710 (2)
2015	Lakeview Irrigation District	9,779	494	N/A	N/A
2021	Shoshone Irrigation District	36,009	1269	Buffalo Bill Reservoir	330,710 (2)
2019	Willwood Irrigation District	11,595	193	Buffalo Bill Reservoir	330,710 (2)

[1] in Beck Reservoir

[2] in Buffalo Bill Reservoir under the Shoshone Project Account, which is shared between the Shoshone I.D., the Heart Mountain I.D., the Willwood I.D. and the Deaver I.D. which is not within the Study Area

AF - acre-feet I.D. - Irrigation District

The amount of water used for irrigation can vary depending on an assortment of things like the type of application, the annual climate, type of crop and the condition of the means of conveyance. One of the concerns evaluated in each of the irrigation districts master plans is irrigation efficiency. The definition of irrigation efficiency is the ratio between irrigation water actually utilized by growing crops and water diverted from a source. There can be several situations between the irrigation water's source to the crops and back to the source that may prevent optimal irrigation efficiency.

Some recognized causes of major losses associated with surface water distribution systems include but are not limited to:

- Surface runoff
- Over-watering

- Seepage
- Evaporation

4.4.2.2 IRRIGATION SYSTEMS

The Study Area has five large irrigation district-owned canal systems and some smaller ditch company-owned canals and ditches, as well as myriad small irrigation systems owned by individual water users (Appendix 1A: Map 41).

There are five large irrigation diversions on the Shoshone River within the Study Area:

1. Cody Canal Diversion operated by the Cody Canal Irrigation District
2. Heart Mountain Canal Diversion operated by the Heart Mountain Irrigation District
3. Lakeview Canal Diversion operated by the Lakeview Irrigation District
4. Corbett Diversion Dam & Tunnel and Garland Canal operated by the Shoshone Irrigation District
5. Willwood Diversion Dam & Canal operated by the Willwood Irrigation District

All these Districts hold direct (natural) flow appropriations of water from Shoshone River. The Lakeview Irrigation District, with its canal diverting from the South Fork Shoshone River at a point upstream of Buffalo Bill Reservoir, is the only irrigation district of the districts that does not hold storage rights. As such, it only operates on the natural flow of the South Fork. The Heart Mountain, Shoshone and Willwood Irrigation Districts each also hold storage rights in Buffalo Bill Reservoir. The Cody Canal Irrigation District, with its canal diversion on the South Fork Shoshone River (upstream of Buffalo Bill Reservoir), holds storage rights in Beck Lake which is located just southwest of the City of Cody.

Table 4-16 outlines these major irrigation diversions of the Shoshone River which were identified in the WWDC State of Wyoming 2021 Irrigation System Survey Report. For this effort, the diversion capacities for the Cody Canal and the Heart Mountain Canal as shown on Table 4-15 were estimated from the diversion data contained within the Hydrographer's Annual Reports, Districts 9 & 10, Water Division III, Water Years 2018 – 2022, published by the WSEO.

TABLE 4-16. IRRIGATION DISTRICT-OWNED DIVERSIONS ON THE UPPER SHOSHONE RIVER

Entity	Surface Source	Diversion Capacity (cfs)	No. of users	Storage
				(AF)
Cody Canal Irrigation District	South Fork Shoshone River	241 (est.)	2,185	712 (1)
Heart Mountain Irrigation District	Shoshone River and Buffalo Bill Reservoir	882 (est.)	690	330,710 (2)
Lakeview Irrigation District Diversion/Canal	South Fork Shoshone River	270	494	N/A
Shoshone Irrigation District	Shoshone River and Buffalo Bill Reservoir	900	1,269	330,710 (2)
Willwood Irrigation District	Shoshone River and Buffalo Bill Reservoir	400	193	330,710 (2)

[1] in Beck Reservoir

[2] in Buffalo Bill Reservoir under the Shoshone Project Account, which is shared between the Shoshone I.D., the Heart Mountain I.D., the Willwood I.D. and the Deaver I.D. which is not within the Study Area

AF - acre-feet   cfs - cubic feet per second

Additional details of the infrastructure of the above irrigation systems are described in the following WWDC studies:

- Cody Master Plan Level I Study (Engineering Associates 2009)
- Cody Canal Irrigation District Rehabilitation and GIS Level II Study (Engineering Associates 2009)
- Heart Mountain Irrigation District Master Plan Level II Study (Sage Civil Engineering 2015)
- Lakeview Irrigation Master Plan Level II Study (Sage Civil Engineering 2013)
- Shoshone Irrigation District Rehabilitation and GIS Level II Study (Sage Civil Engineering 2008)
- Willwood Irrigation District Master Plan Update Level I Study (Sage Civil Engineering 2015)
- Willwood Rehabilitation and GIS Level II Study (Engineering Associates 2009)

The largest irrigation diversion on the Clarks Fork within the Study Area is the Sirrine Canal / Ditch with its combined direct water flow appropriation amounting to over 41 cubic feet per second (cfs). This private irrigation system is owned and operated by the Sirrine Irrigation Company. The actual diversion capacity is not known by the author, it is likely substantially more. Recognizing the ability of irrigators under Wyoming water law to divert and use more water during times when a stream or river's higher flows permit, most privately held diversions and the receiving irrigation ditches are maintained with a capacity greater than their combined one-cfs-per-70-acre appropriation(s). The diversion and use of extra water during such times can vastly improve the overall effectiveness and timeliness of flood irrigation.

As throughout most of the State, surface water supplies within the Study Area are largely dependent on snowpack accumulated during prior winter months. While spring and summer rains certainly can contribute, snowmelt runoff provides most of the irrigation water supplies in the Shoshone River and in the Clarks Fork. Excess flow of the North Fork and the South Fork Shoshone River is captured within the Bureau of Reclamation's Buffalo Bill Reservoir. The Reservoir has a storage capacity of 646,565 acre-feet (within the Conservation pool). This storage is allocated for a variety of multiple uses, including irrigation. The reservoir is an important late-season source of irrigation water for much of the irrigable lands within the Shoshone Project which is comprised of four divisions, the Garland, Willwood, Heart Mountain and Frannie Divisions. The first three Divisions are operated by the Shoshone Irrigation District, the Willwood Irrigation District and the Heart Mountain Irrigation District (respectively). The Frannie Division, operated by the Deaver Irrigation District and involving 15,119 irrigated acres, is located outside the Study Area (Shoshone Irrigation District 2023).

Table 4-17 lists the storage accounts (reported for Water Year 2022) in Buffalo Bill Reservoir (WSEO 2023). The reported accounting underscores both the need for and importance of storage for irrigation, and for other uses, of water within the Study Area. Irrigation use of storage water varies from year-to-year dependent upon the availability of direct-flow water supplies, rainfall and crop type/acreage. However, during drought periods, an irrigator's sufficient storage water supply can save his or her annual livelihood.

TABLE 4-17. STORAGE ACCOUNTS FOR BUFFALO BILL RESERVOIR, END OF WATER YEAR 2022

Name	Storage Capacity (acre-feet)
Shoshone Project Account	170948
Polecat Account	67932
Private Account	14162
State Account	177145
Total	**430187**

The primary data source for irrigation systems spatial data was the statewide datasets developed by WWDC. These spatial datasets include groundwater, reservoir, and surface water Points of Diversion (POD), Places of use (POU), conveyance systems (i.e., canals, pipelines, ditches, pipes, and open laterals) and reservoirs (Biota 2022).

Table 4-18 outlines the Diversion/Conveyance of the five irrigation districts identified in the WWDC State of Wyoming 2021 Irrigation System Survey Report. A variety of structural/water management improvements within each District are employed to deliver water to members' turnouts. They include concrete lining, check structures, divider structures, steel gates, piping, etc.

TABLE 4-18. WWDC 2021 WYOMING IRRIGATION SYSTEMS REPORT #2: DIVERSIONS/CONVEYANCE

Year	Entity	Surface Source	Type of Diversion	Capacity of Diversion (cfs)	Type of Conveyance	Capacity of Conveyance (cfs)	Miles	Conveyance Losses
2021	Cody Canal Irrigation District	South Fork Shoshone River	Dam	0	Ditch	300	78.07	20%
2017	Heart Mountain Irrigation District	Shoshone River and Buffalo Bill Reservoir	Dam	--	Ditch, lined ditch	830	28	13%
2015	Lakeview Irrigation District	South Fork Shoshone River	Dam headgate	270	Ditch	500	28	70%
2021	Shoshone Irrigation District	Shoshone River and Buffalo Bill Reservoir	Dam	900	Ditch	900	132.1	18%
2019	Willwood Irrigation District	Shoshone River and Buffalo Bill Reservoir	Dam	400	Ditch	400	82	0.20%

--Not reported
MODIFIED FROM WWDC 2005; WWDC 2014; WWDC 2017; WWDC 2019

Table 4-19 shows the main water rights/appropriations for each of the five major canals (South Fork and Shoshone River diversions) within the Study Area. Note that each Canal listed in Table 4-19 may contain additional small water rights/appropriations. In some cases, there may be a multitude of such small water rights/appropriations (with varying dates of priority ranging from senior to junior) in addition to that of the main water right(s)/appropriation(s) listed. Further, some Districts hold supplemental supply water rights (not shown) for diversion and use of waters from surface water sources other than their primary water source. A complete inventory of all water rights in each Canal was beyond the scope of this Study.

TABLE 4-19. WATER RIGHT (MAIN) INFORMATION FOR STUDY AREA IRRIGATION DIVERSIONS (MODIFIED FROM BRS ENGINEERING 2003)

Diversion Name	Priority Date	Permit Number	Permit Use*	Adjudicated Acres	Flow (cfs)	Cumulative Flow (cfs)
Cody Canal	08/07/1895	1042	Dom, Irr, DSP, S&D, Mun, Oth, Res	22,110.69	315.867	315.867
Heart Mountain Canal	05/22/1899	2111	Irr, S&D	9,732.10	139.03	454.897
	3/29/1904	1189ENL	Irr, Mis	13,083.70	186.91	641.807
	12/21/1920	6099ENL	Irr, S&D	5,320.00	76	717.807
Hammit (Lakeview) Canal	12/31/1900	3000	Dom, Irr, S&D	13,579.16	193.988	911.795
Garland Canal	05/22/1899	2111	Irr, S&D	35,807.80	511.54	1423.335
Willwood Canal	05/22/1899	2111	Irr, S&D	5,198.90	74.27	1497.605
	4/12/1904	1191ENL	Irr, S&D	6,123.60	87.48	1585.085

*Permitted Use(s): Dom = Domestic, Irr = Irrigation, DSP = Domestic Supply; S&D = Stock & Domestic; Mun = Municipal; Oth = Other; Res = Reservoir Supply; Mis = Miscellaneous

4.4.3 DOMESTIC, MUNICIPAL, AND INDUSTRIAL WATER USE

The Shoshone Municipal Pipeline (SMP) supplies treated water from Buffalo Bill Reservoir to the municipalities of Cody and Powell and the Northwest Rural Water District (NRWD) within the Study Area. The SMP treatment plant has a capacity of 16.5 million gallons per day (MGD) and potential to expand to 22 MGD. Table 4-20 summarizes the allocation and usage of SMP water within the Study Area. The remaining 2.88 MGD is allocated to Lovell, Byron, Deaver, and Frannie, which are outside the watershed Study Area.

TABLE 4-20. SHOSHONE MUNICIPAL PIPELINE WATER ALLOWANCE AND USAGE, 2022

Community	Allowance (MGD)	Highest Daily Usage (July, 2022) MGD	Peak Average Daily Usage (July, 2022) MGD
Cody	11.36	3.24	2.8
Powell	4.95	1.50	1.11
NRWD	2.16	1.14	0.97

Sources: WWDC, 2018 Wyoming Public Water systems Report
Powell Master Plan, Level 1 Study, 2000
Cody Master Plan, Level 1 Study, 2021
Northwest Rural Master Plan, Level 1 Study, 2017
Park County Land Use Plan, 2023

SMP's main transmission line is designed to accommodate 18 taps for large service areas, which are currently only used by Cody, Powell and NRWD. Table 4.4.3-2 summarizes the demand for domestic water per each community along the SMP, with a total demand of 890.6 million gallons (MG) per year and roughly 23,000 people serviced (WWDC 2019). Water towers and water tanks are used to store potable water in Cody, Powell, and the NRWD as tabulated in Table 4.4.3-3. These have a combined water storage capacity of 6.8 MG (Table 4.4.3-3).

The NRWD services ten rural areas, eight of which are in the CF-USW. Park County estimates that 88.4% of households in the county are served by the SMP. Properties located outside of NRWD service areas have private groundwater wells. The NRWD has a storage capacity of 1.1 MG and a peak average daily usage of 0.97 MGD representing 44.9% of the SMP allowance.

The City of Cody provides treated water and raw water service (for irrigation) within its municipal boundaries. The system has a storage capacity of 3.8 MG (Table 4.4.3-3) and a peak average daily usage of 2.8 MG representing 24.6% of the SMP allowance. The Park County Land Use Plan (2023) estimates that Cody's maximum allocation of 11.36 MGD is adequate to provide treated water to four times the current number of dwellings and to three times the projected 2042 population (Park County Board of County Commissioners 2023).

The City of Powell provides treated water within its municipal boundaries. The system has a storage capacity of 1.9 MG and a peak average daily usage of 1.11 MGD representing 22.4% of the SMP allowance.

TABLE 4-21. DOMESTIC WATER USE

Community	Water Source	Annual Water Usage (MG)	Population
Cody	SMP	465.8	9,740
Powell	SMP	220.8	6,314
Northwest Rural Water District	SMP	204.0	7,000
Total		890.6	23,054

WWDC, 2018 Wyoming Public Water systems Report (WWDC 2019)
Powell Master Plan, Level 1 Study, 2000 (Engineering Associates and Wester-Wetstein & Associates 2000)
Cody Master Plan, Level 1 Study, 2021 (Engineering Associates 2021a, 2021b, 2021c)
Northwest Rural Master Plan, Level 1 Study, 2017 (Rosenlund 2017)
Park County Land Use Plan, 2023 (Park County Board of County Commissioners 2023)

4.4.4 WATER STORAGE

A reservoir database was constructed by downloading reservoir storage rights from the WSEO ePermit system. The database was then incorporated into the Project GIS for evaluation. Appendix 1A: Map 42 displays the results of the effort. Included in this Map are all permitted reservoirs except stock reservoirs which are evaluated in Section 4.4.4.1 of this report.

4.4.4.1 RESERVOIRS

There are 13 permitted water storage reservoirs located within the watershed. Table 4-22 summarizes information tabulated by the WSEO pertaining to the permitted reservoirs within the watershed that exceed 500 acre-feet capacity. Note that there are five major reservoirs within the watershed (defined as having a storage capacity greater than 1,000 acre-feet), with Buffalo Bill Reservoir (Shoshone Reservoir in Table 4-22) being the largest at 869,230 acre-feet capacity. Appendix 1A: Map 43 displays their locations.

TABLE 4-22. PERMITTED RESERVOIRS LARGER THAN 500 ACRE-FEET

PERMIT	PRIORITY	NAME	SOURCE	CAPACITY (ACRE-FEET)
P1112.0R	9/16/1907	ENL Perkins and Kinney Reservoir	South Sage Creek	746
P121.0R	2/7/1898	Newton Reservoir	Trail Creek	4,525
P1338.0R	7/24/1908	Beck Lake Reservoir	South Fork Shoshone River	623
P492.0R	3/5/1904	Shoshone Reservoir	Shoshone River	869,230
P9554.0R	5/1/1989	Diamond Creek Dike	Diamond Creek	18,378
CR CC24/103	2/7/1898	Newton Reservoir	Trail Creek	4,525
CR CCR15/245	9/8/1947	Cody Municipal Reservoir	South Fork Shoshone River	508
P731.0R	8/7/1905	Luce Reservoir	Paint Creek	1,073
CR CR43/160	10/16/1902	Paint Creek Reservoir	Paint Creek	650
CR CR16/232	2/4/1982	Powell Sewage Lagoon System Secondary	Bitter Creek	536

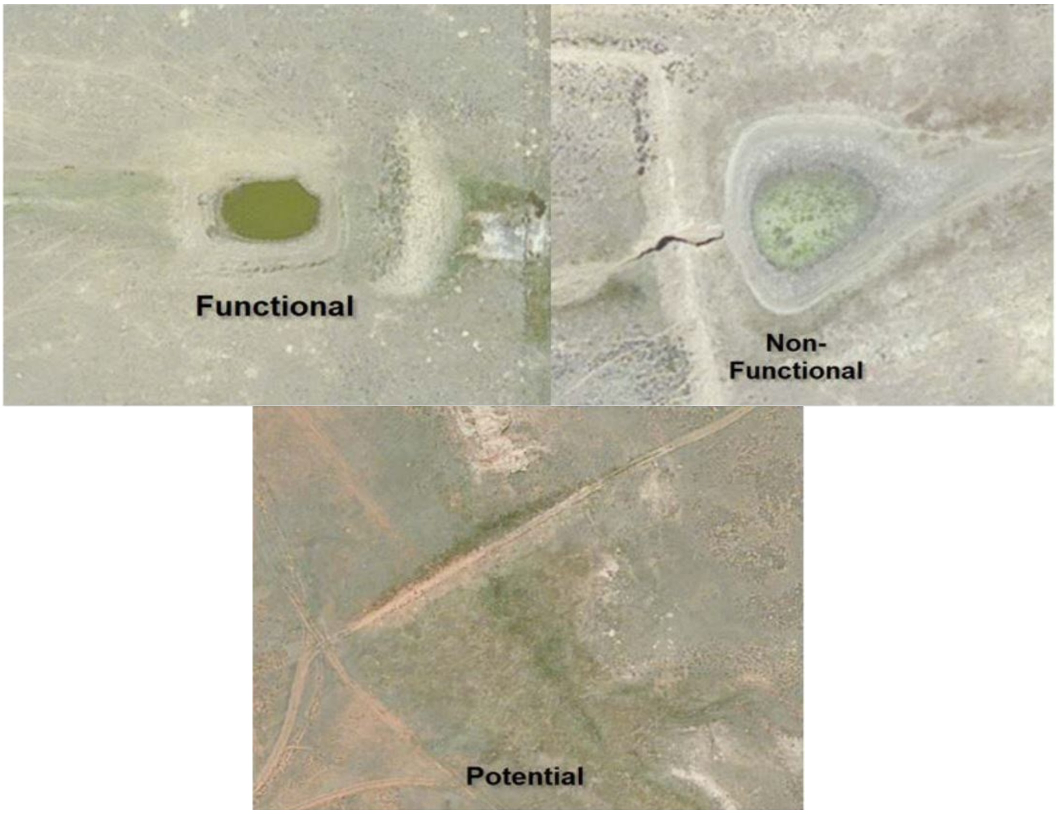
4.4.4.2 UPLAND WATER STORAGE

An inventory of existing livestock/wildlife reservoirs was conducted to compile a database of upland water storage resources. The upland water storage inventory entailed the following:

1. Mapping of existing livestock/wildlife reservoirs was obtained from the Cody Field Office of the BLM and the NRCS.
2. Mapping of reservoirs permitted with the WSEO 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 and the Project GIS, each mapped reservoir was evaluated to determine its functionality.
    a. Reservoirs with visible physical breaches or choked with sediment were classified as "Non-functional".
    b. Reservoirs visibly containing water were classified as "Functional".
    c. Reservoirs not holding water and with no visible breach were classified as "Potential" since a definitive declaration of functionality could not be made.

Figure 4-18 illustrates the process of determining reservoir functionality from aerial photography.

FIGURE 4-18. EVALUATION OF STOCK RESERVOIRS WITHIN GIS



The upland reservoir inventory results indicate:

- There is an estimated total of 312 stock reservoirs/ponds in the watershed.
- A minimum of 217 reservoirs appears to be “Functional” water sources,
- There are 83 “Potential” water sources (functionality could not be determined), and
- A minimum of 12 reservoirs appears to be “Non-functional” water sources. These reservoirs displayed physical breaches or other failures.

Appendix 1A: Map 44 displays the locations of “Functional” livestock/wildlife reservoirs, “Potential” and “Non-functional” reservoirs identified during the inventory.

5.0 SURFACE HYDROLOGY

This Project Study covers over 2.3 million acres or about 3,500 square miles. About 37.3%, or 1,305 square miles, comprise the Clarks Fork watershed, and the remaining 62.7% (2,195 square miles) make up the Upper Shoshone River watershed. As indicated on Map 1 (Appendix 1A), the Study Area includes the headwaters region upstream of Buffalo Bill Reservoir and extends easterly to Bitter Creek / Shoshone River confluence within Park County.

Surface hydrology was evaluated using methods consistent with the Scope of Work as well as the WWDC-funded project "Lower Shoshone River Watershed Study", completed in 2022 by Biota, inc. By using identical methods, assumptions, and protocols, the partnering conservation districts and other entities will have comparable data for planning purposes.

5.1 HYDROLOGIC UNIT

The USGS employs a hierarchical system for classifying watersheds known as Hydrologic Unit Codes (HUCs). This system divides the United States into progressively smaller hydrologic units based on four levels of classification: regions, sub-regions, accounting units, and cataloging units. Each of these hydrologic units is identified by a unique HUC consisting of two to eight digits, with the number of digits indicating the level of classification within the hierarchy.

The four levels of classification in the hydrologic unit system are described as follows:

Regions: The first level divides the nation into 21 major geographic areas or regions. These regions are typically delineated based on the drainage area of major rivers, such as the Missouri region. Eighteen of these regions cover the land area of the contiguous lower 48 states.

Sub-regions: Within each region, sub-regions are defined, forming a more detailed classification level.

Accounting Units: Sub-regions are further subdivided into accounting units. These units help track and manage water resources within specific areas.

Cataloging Units: The smallest and most detailed subdivisions are cataloging units. They are identified with 12-digit HUCs, reflecting the deepest level of classification in the system.

The following information is provided as a HUC system example as it refers to one of the Clarks Fork of the Yellowstone: Little Sunlight Creek.

Region: 10 Missouri (Second order HUC)

Subregion: 10 Nor 07 Upper Yellowstone River (Fourth Order HUC)

Accounting Unit: 100700 Upper Yellowstone (Sixth Order HUC)

Cataloging Unit: 10070006 Clarks Fork Yellowstone (Eighth Order HUC)

Sub-basin: 1007000603 Sunlight Creek (Tenth Order HUC)

Sub-basin: 100700060302 Little Sunlight Creek (Twelfth Order HUC)

The Clarks Fork / Upper Shoshone River watershed Study Area was defined by:

1. The eighth order HUC, 10070006: Clarks Fork Yellowstone within the State of Wyoming
2. The eighth order HUCs:
   a. 10080012: North Fork Shoshone River
   b. 10080013: South Fork Shoshone River
   c. 10080014: Shoshone River upstream of the Park County / Bighorn County line

Table 5-1 displays the HUC system in the Study Area.

TABLE 5-1. SUBWATERSHEDS WITHIN THE STUDY AREA

HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10 Number	HUC 10 Name	HUC 12 Number	HUC 12 Name
Region 10: Missouri	Subregion 1007: Upper Yellowstone	Accounting Unit 100700: Upper Yellowstone	Cataloging Unit 10070006: Clarks Fork Yellowstone	1007000 601	Crandall Creek	10070006 0101	Hoodoo Creek
						10070006 0102	Upper Crandall Creek
						10070006 0103	North Fork Crandall Creek
						10070006 0104	Lower Crandall Creek
				1007000 602	Pilot Creek-Clarks Fork Yellowstone River	10070006 0201	Pilot Creek
						10070006 0202	Broadwater Creek-Clarks Fork Yellowstone River
						10070006 0203	Crazy Creek
						10070006 0204	Lake Creek
						10070006 0205	Gilbert Creek-Clarks Fork Yellowstone River
						10070006 0206	Beartooth Creek
						10070006 0207	Squaw Creek-Clarks Fork Yellowstone River
				1007000 603	Sunlight Creek	10070006 0301	Upper Sunlight Creek
						10070006 0302	Little Sunlight Creek
						10070006 0303	Middle Sunlight Creek
						10070006 0304	Lower Sunlight Creek
				1007000 604	Dead Indian Creek-Clarks Fork Yellowstone River	10070006 0401	Canyon Creek
						10070006 0402	Table Creek-Clarks Fork Yellowstone River
						10070006 0403	Dead Indian Creek
						10070006 0404	Russell Creek-Clarks Fork Yellowstone River
						10070006 0405	Cyclone Bar Creek-Clarks Fork Yellowstone River
				1007000 605	Bennett Creek-Clarks Fork Yellowstone River	10070006 0501	Paint Creek
						10070006 0502	Newmeyer Creek-Clarks Fork Yellowstone River
						10070006 0503	Skull Creek
						10070006 0504	Upper Pat O'Hara Creek
						10070006 0505	Lower Pat O'Hara Creek
						10070006 0506	Littlerock Creek

HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10		HUC 12	
				Number	Name	Number	Name
						100700060507	Bennett Creek
						100700060508	Little Sand Coulee
						100700060509	Bennett Creek Ditch-Clarks Fork Yellowstone River
						100700060510	Line Creek
						100700060511	Badura Number 1 Reservoir-Clarks Fork Yellowstone River
				1007000606	Bear Creek-Clarks Fork Yellowstone River	100700060601	Polecat Bench
						100700060602	Upper Big Sand Coulee
						100700060603	Middle Big Sand Coulee
						100700060604	Lower Big Sand Coulee
						100700060605	Dilworth Creek-Clarks Fork Yellowstone River
						100700060608	Upper Silver Tip Creek
						100700060610	Wolf Creek-Clarks Fork Yellowstone River
				1007000607	Cottonwood Creek-Clarks Fork Yellowstone River	100700060702	Upper Cottonwood Creek
						100700060703	Middle Cottonwood Creek
				1007000609	Rock Creek	100700060902	Wyoming Creek-Rock Creek
	Subregion 1008: Big Horn	Accounting Unit 100800: Big Horn	Cataloging Unit 10080012: North Fork Shoshone	1008001201	Upper North Fork Shoshone River	100800120101	Jones Creek
						100800120102	Crow Creek
						100800120103	Middle Creek
						100800120104	Grinnell Creek
						100800120105	Bear Creek-North Fork Shoshone River
				1008001202	Middle North Fork Shoshone River	100800120201	Eagle Creek
						100800120202	Fishhawk Creek
						100800120203	Gunbarrel Creek
						100800120204	Libby Creek-North Fork Shoshone River
						100800120205	Clearwater Creek
						100800120206	Upper Elk Fork

HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10		HUC 12	
				Number	Name	Number	Name
						100800120207	Lower Elk Fork
						100800120208	Sweetwater Creek
						100800120209	Sheep Creek-North Fork Shoshone River
				1008001203	Lower North Fork Shoshone River	100800120301	Big Creek
						100800120302	Grizzly Creek-North Fork Shoshone River
						100800120303	Trout Creek
						100800120304	Whit Creek-North Fork Shoshone River
						100800120305	Rattlesnake Creek
						100800120306	Buffalo Bill Reservoir-North Fork Shoshone River
			Cataloging Unit 10080013: South Fork Shoshone	1008001301	Upper South Fork Shoshone River	100800130101	Clark Creek-South Fork Shoshone River
						100800130102	East Fork Creek
						100800130103	Younts Creek-South Fork Shoshone River
						100800130104	Needle Creek
						100800130105	Cabin Creek
						100800130106	Saddle Creek-South Fork Shoshone River
				1008001302	Middle South Fork Shoshone River	100800130201	Deer Creek
						100800130202	Boulder Creek
						100800130203	Legg Creek-South Fork Shoshone River
						100800130204	Ishawooa Creek
						100800130205	Aldrich Creek-South Fork Shoshone River
						100800130206	Hardpan Creek
						100800130207	Rock Creek
						100800130208	Houlihan Creek-South Fork Shoshone River
				1008001303	Lower South Fork Shoshone River	100800130301	Belknap Creek-South Fork Shoshone River
						100800130302	Bear Creek-South Fork Shoshone River
						100800130303	Carter Creek-South Fork Shoshone River

HUC 2 Number / Name	HUC 4 Number / Name	HUC 6 Number / Name	HUC 8 Number / Name	HUC 10		HUC 12	
				Number	Name	Number	Name
			Cataloging Unit 10080014: Shoshone	1008001401	Trail Creek-Shoshone River	100800140101	Trail Creek
						100800140102	Sulphur Creek
						100800140103	Cottonwood Creek
						100800140104	Upper Sage Creek
						100800140105	Lower Sage Creek
						100800140106	Dry Creek-Shoshone River
						100800140107	Idaho Creek-Shoshone River
						100800140108	Iron Creek-Shoshone River
				1008001402	Bitter Creek-Shoshone River	100800140201	Alkali Creek Patch
						100800140202	Eaglenest Creek-Shoshone River
						100800140203	Deer Creek
						100800140204	Roan Wash
						100800140205	Bitter Creek
						100800140206	Peerless Coulee-Shoshone River

5.2 STREAM GAGE ANALYSIS

Historical and currently active stream gaging stations within the Study Area managed by the USGS are presented in Appendix 1A: Map 45. Gage station details are presented in Table 5-2. The USGS currently operates three stream flow gage stations in and one downstream of the Study Area. There are 24 historical, nonactive USGS gages in the Study Area. Active and historical USGS gage data for Wyoming can be found online (https://waterdata.usgs.gov/wy/nwis/r). Additionally, the WSEO maintains basin data on ditch and canal systems flow gage stations. The real-time data can be found online (https://seoflow.wyo.gov/). This Study and Table 5-2 do not include the canal and ditch data. Appendix 1A: Map 45 also illustrates Hydrologic Unit Code 12 (HUC12) watersheds represented for this Study. HUC12 watersheds that overlapped the Montana-Wyoming border were clipped using HUC12 to only represent the areas inside Wyoming. Data were downloaded from the USGS web portal for recently active, long-term sites (USGS 2023). Recently active, long-term sites are defined as sites with more than 20 years of data with the latest measurements collected during the past 30 years (1992 or later).

Mean daily discharges were obtained from six USGS stream gaging stations which provided the longest and/or most recent record periods, including one on the Clarks Fork Yellowstone River, one on the North Fork Shoshone, two on the South Fork Shoshone, and two on the mainstem Shoshone. The gaging station selected along the North Fork of the Shoshone River has data compiled from two record periods. Figures 5-1 through 5-6 depict mean daily discharge data recorded at these locations. The hydrographs depict the typical timing and magnitude of flows within the Study Area and its tributary system. Elevated flows typically occur for approximately 3 months between May and August during spring snowmelt. Dam-release and irrigation activities within the Shoshone River heavily influence late summer and winter flows.

Figures 5-7 through 5-12 depict duration curves based upon mean daily discharge values (cfs) developed from recorded flow data at six gaging stations. Flow duration curves from the Shoshone River gages have similar slopes, reflective of the basin's dam-release, irrigation-driven hydrologic regime.

TABLE 5-2. STREAMFLOW GAGING STATIONS INSIDE THE STUDY AREA

Agency	Site ID	Site Name	Drainage Area (square miles)	Beginning	End	Period of Record (years)	County
USGS	06205500	CLARKS FK YELLOWSTONE R AB SQUAW C NR PAINTER, WY	194	10/1/1945	9/29/1951	6.0	Park County, WY
USGS	06205950	LODGEPOLE CREEK AT MOUTH, NEAR PAINTER, WY	9	4/1/1989	9/29/1989	0.5	Park County, WY
USGS	06206000	CLARKS FK YELLOWSTONE R BL CRANDAL C NR PAINTER	446	10/1/1929	9/29/1957	28.0 (2)	Park County, WY
USGS	06206500	SUNLIGHT CREEK NEAR PAINTER, WY	135	8/1/1929	9/29/1971	42.2 (2)	Park County, WY
USGS	06207000	CLARKS FORK YELLOWSTONE RIVER NEAR CLARK WYO	912	10/1/1918	12/31/1924	6.3	Park County, WY
USGS	**06207500**	**CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT**	**1152**	**8/1/1921**	**3/6/2023**	**101.7**	**Carbon County, MT**
USGS	06207507	BIG SAND CL AB ST DITCH NR BADGER BASIN, WY	98	5/1/1973	9/29/1977	4.4	Park County, WY
USGS	06209010	ROCK CR BL GLACIER LAKE NR RED LODGE, MT	4	10/1/1960	9/29/1964	4.0	Carbon County, MT
USGS	06279790	JONES CREEK AT MOUTH, NEAR PAHASKA, WY	25	3/9/1989	9/29/1993	4.6	Park County, WY
USGS	06279795	CROW CREEK AT MOUTH, AT PAHASKA, WY	19	3/9/1989	9/29/2005	16.6	Park County, WY
USGS	06279800	NORTH FORK SHOSHONE RIVER AT PAHASKA, WY	108	4/1/1989	9/29/1990	1.5	Park County, WY
USGS	06279850	MIDDLE CR AT E ENTRANCE YNP WY	33	10/1/1981	9/29/1984	3.0	Park County, WY
USGS	**06279940**	**NORTH FORK SHOSHONE RIVER AT WAPITI, WY**	**699**	**10/1/1989**	**3/6/2023**	**33.4 (3)**	**Park County, WY**
USGS	**06280000**	**NORTH FORK SHOSHONE RIVER NEAR WAPITI, WY**	**775**	**1/1/1921**	**9/29/1989**	**68.8 (3)**	**Park County, WY**
USGS	**06280300**	**SOUTH FORK SHOSHONE RIVER NEAR VALLEY, WY**	**297**	**10/1/1956**	**3/6/2023**	**66.5**	**Park County, WY**
USGS	06280500	SOUTH FORK SHOSHONE RIVER NR ISHAWOOA WYO	541	6/1/1915	10/31/1923	8.4	Park County, WY
USGS	**06281000**	**SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES, WY**	**585**	**5/1/1903**	**3/6/2023**	**119.9**	**Park County, WY**

Agency	Site ID	Site Name	Drainage Area (square miles)	Beginning	End	Period of Record (years)	County
USGS	06281400	DIAMOND CREEK NR MOUTH, NR CODY, WY	7	12/1/1980	9/30/1992	11.8	Park County, WY
USGS	06281500	BUFFALO BILL RES NR CODY WYO	1498	N/A	N/A	N/A	Park County, WY
USGS	**06282000**	**SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR, WY**	**1538**	**1/1/1921**	**2/23/2016**	**95.2**	**Park County, WY**
USGS	06282500	SHOSHONE RIVER AT CODY WYO	1603	5/1/1902	12/31/1909	7.7	Park County, WY
USGS	06283000	SHOSHONE RIVER AT CORBETT DAM, WY	1793	5/1/1908	9/29/1925	17.4	Park County, WY
USGS	06283800	SHOSHONE R AB WILLWOOD DAM, NR WILLWOOD, WY	1820	11/1/1979	10/5/1982	2.9	Park County, WY
USGS	06284000	SHOSHONE RIVER AT WILLWOOD DAM, WY	1850	8/1/1925	9/29/1926	1.2	Park County, WY
USGS	06284200	SHOSHONE RIVER AT WILLWOOD, WY	1980	4/1/1974	9/29/1979	5.5	Park County, WY
USGS	06284400	SHOSHONE RIVER NEAR GARLAND, WY	2036	5/1/1958	9/29/1979	21.4 (2)	Park County, WY
USGS	06284500	BITTER CREEK NEAR GARLAND, WY	81	3/1/1950	9/29/1987	37.6 (2)	Big Horn County, WY
USGS	**06285100**	**SHOSHONE RIVER NEAR LOVELL, WY**	**2350**	**10/1/1996**	**3/5/2023**	**26.4**	**Big Horn County, WY**

Notes:

1 - Sites in bold are used for stream flow analysis.

2 - Periods of record that are longer than 20 years and that ended over 30 years ago.

3 - For project purposes, time series for stations 06279940 and 06280000 are combined for analysis.

FIGURE 5-1. MEAN DAILY DISCHARGE WITH 80 PERCENT AND 20 PERCENT VALUES: CLARKS FORK YELLOWSTONE RIVER NEAR BELFRY, MONTANA (USGS 06207500)

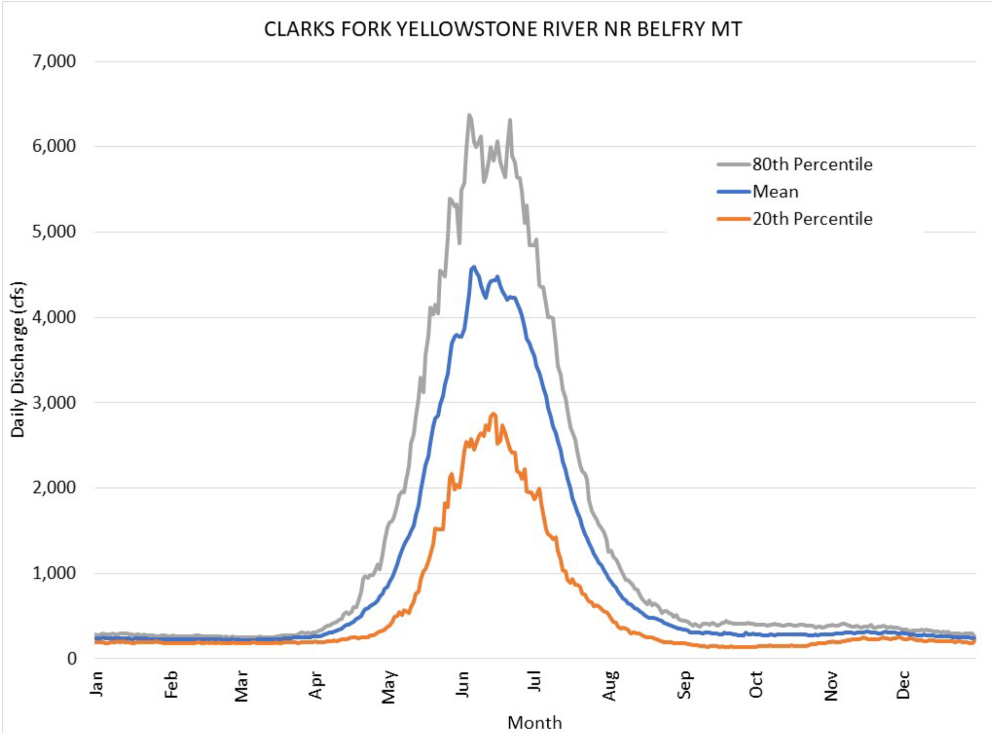


FIGURE 5-2. MEAN DAILY DISCHARGE 80 PERCENT AND 20 PERCENT VALUES: NORTH FORK SHOSHONE RIVER AT WAPITI, WYOMING (USGS 06279940 AND USGS 06280000)

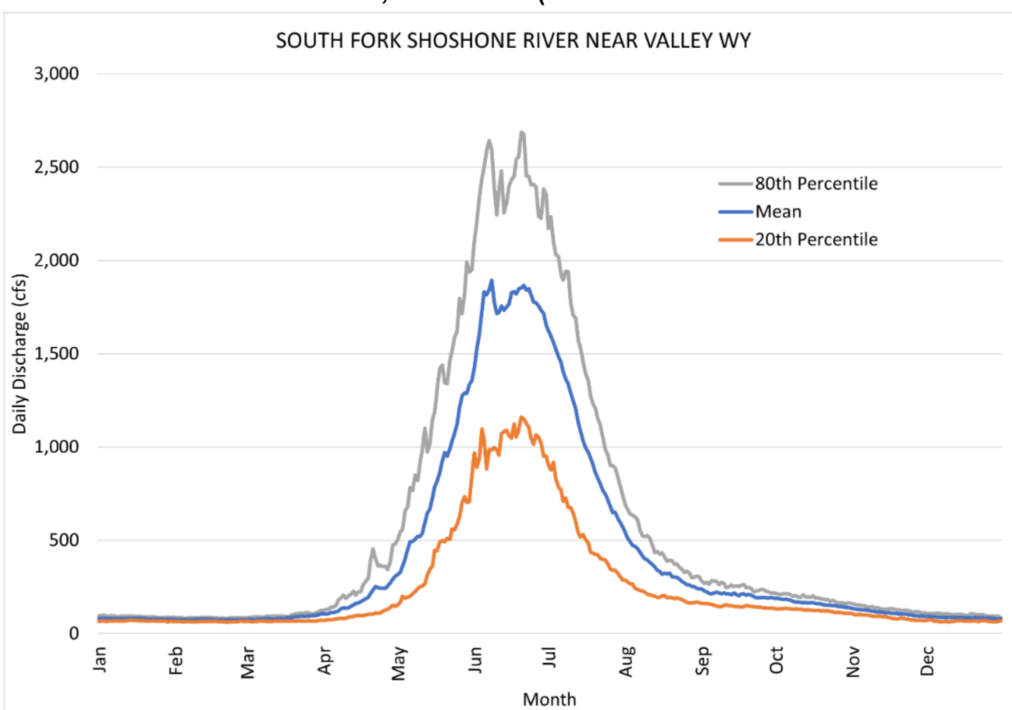


FIGURE 5-3. MEAN DAILY DISCHARGE 80 PERCENT AND 20 PERCENT VALUES: SOUTH FORK SHOSHONE RIVER NEAR VALLEY, WYOMING (USGS 06280300)

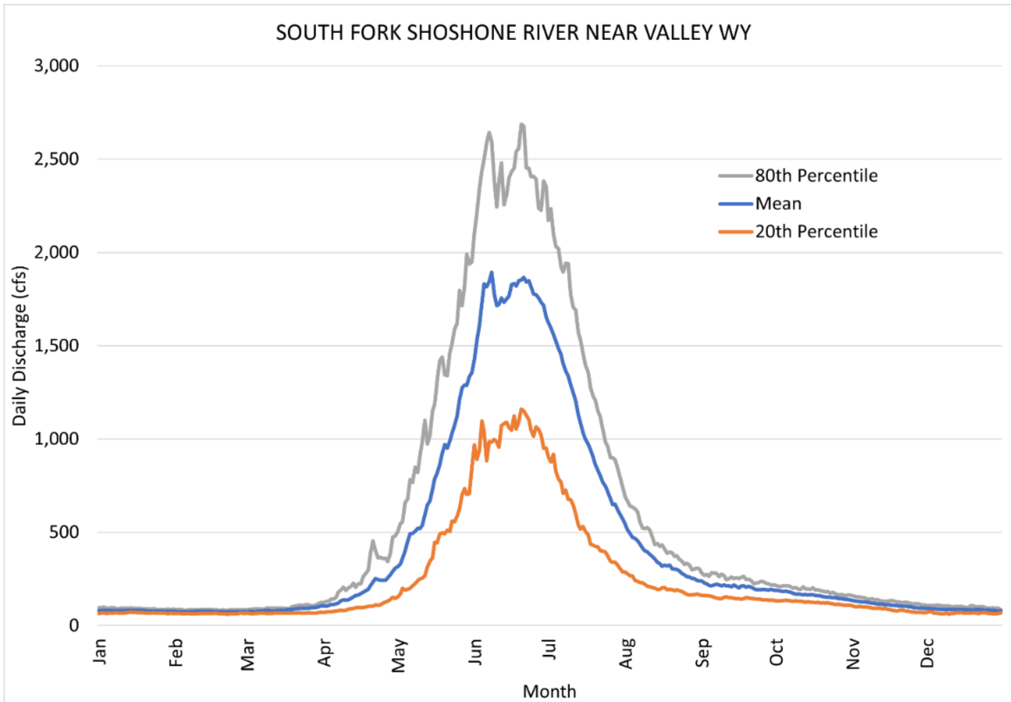


FIGURE 5-4. MEAN DAILY DISCHARGE 80 PERCENT AND 20 PERCENT VALUES: SOUTH FORK SHOSHONE RIVER ABOVE BUFFALO BILL RESERVOIR, WYOMING (USGS 06281000)

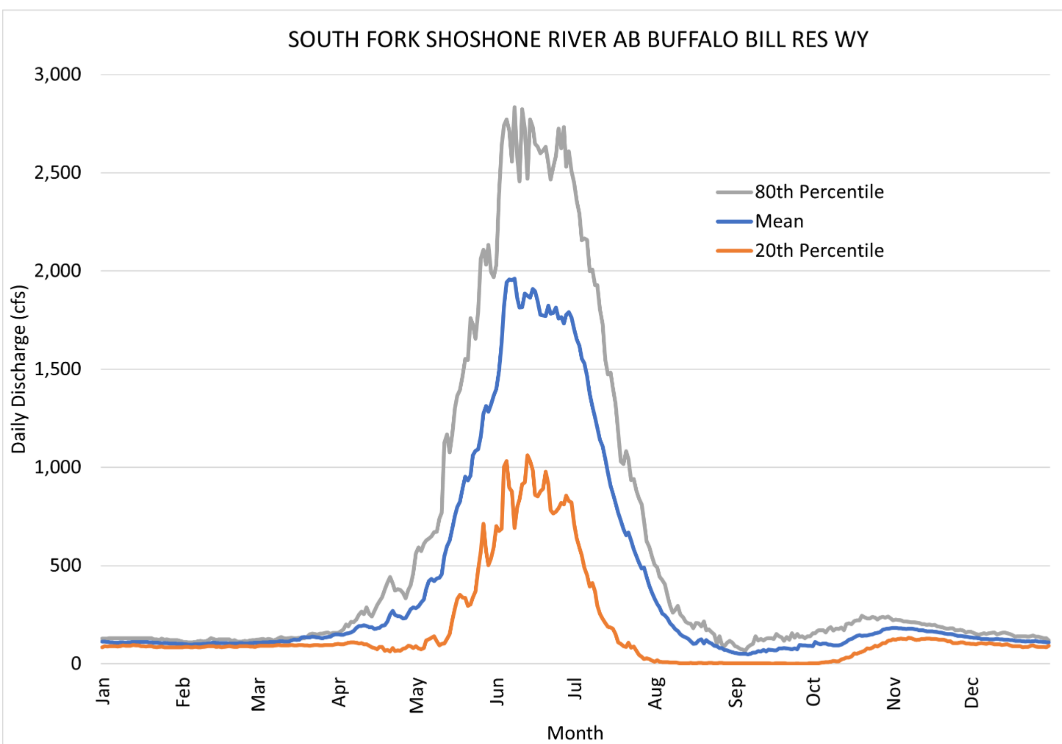


FIGURE 5-5. MEAN DAILY DISCHARGE 80 PERCENT AND 20 PERCENT VALUES: SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR, WYOMING (USGS 06282000)

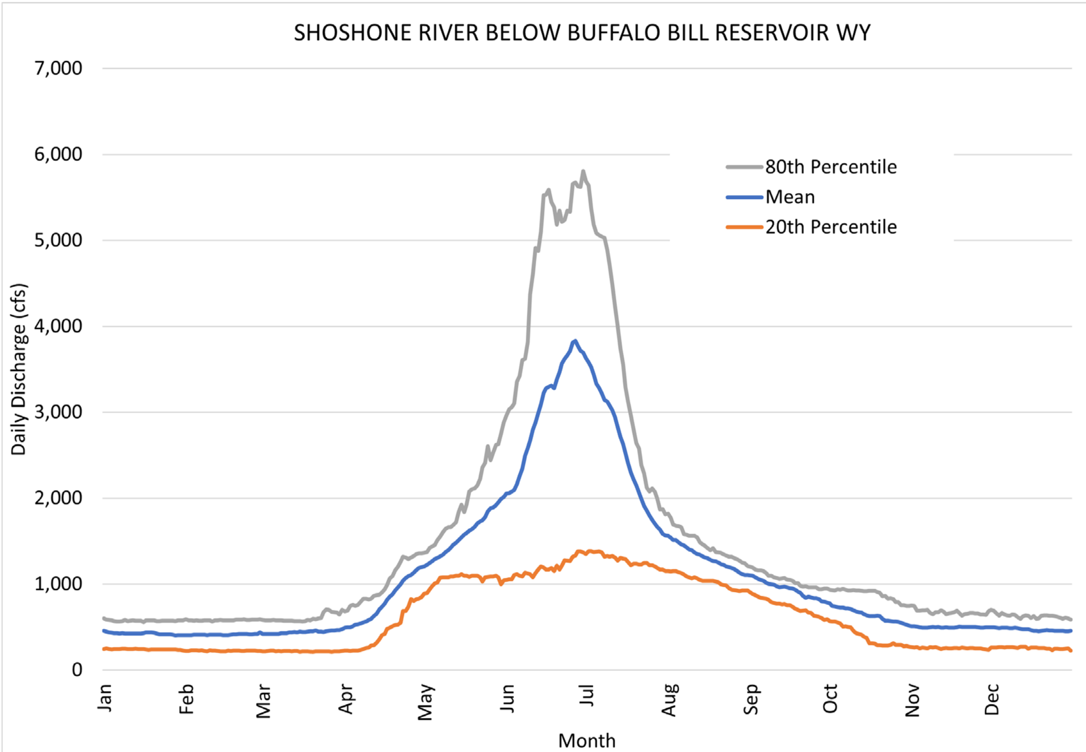


FIGURE 5-6. MEAN DAILY DISCHARGE 80 PERCENT AND 20 PERCENT VALUES: SHOSHONE RIVER NEAR LOVELL, WYOMING (USGS 06285100)

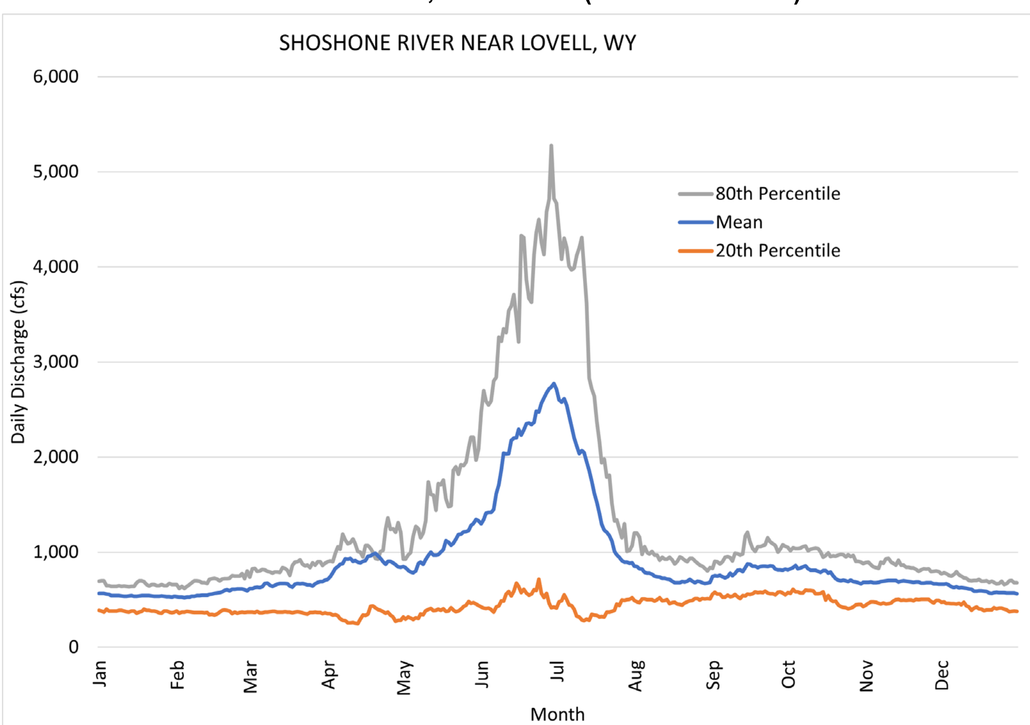


FIGURE 5-7. MEAN DAILY DISCHARGE FLOW DURATION CURVES: CLARKS FORK YELLOWSTONE RIVER NEAR BELFRY, MONTANA (USGS 06207500)

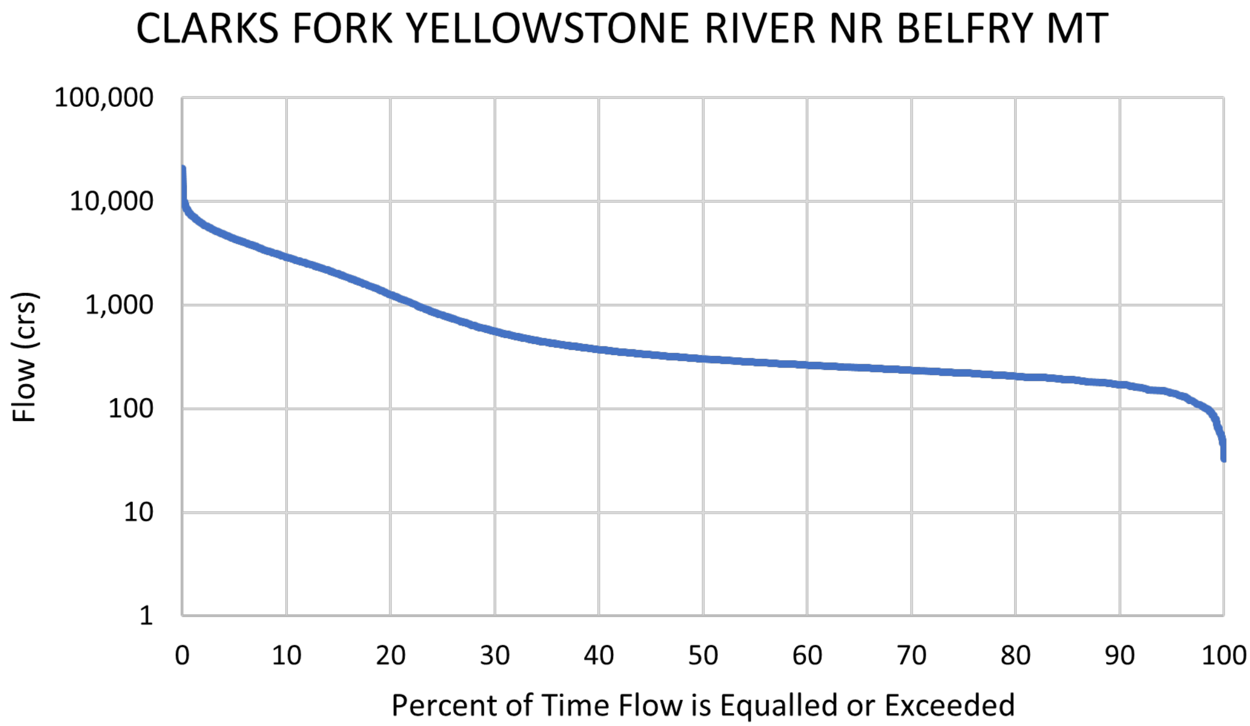


FIGURE 5-8. MEAN DAILY DISCHARGE FLOW DURATION CURVES: NORTH FORK SHOSHONE RIVER AT WAPITI, WYOMING (USGS 06279940 AND USGS 06280000)

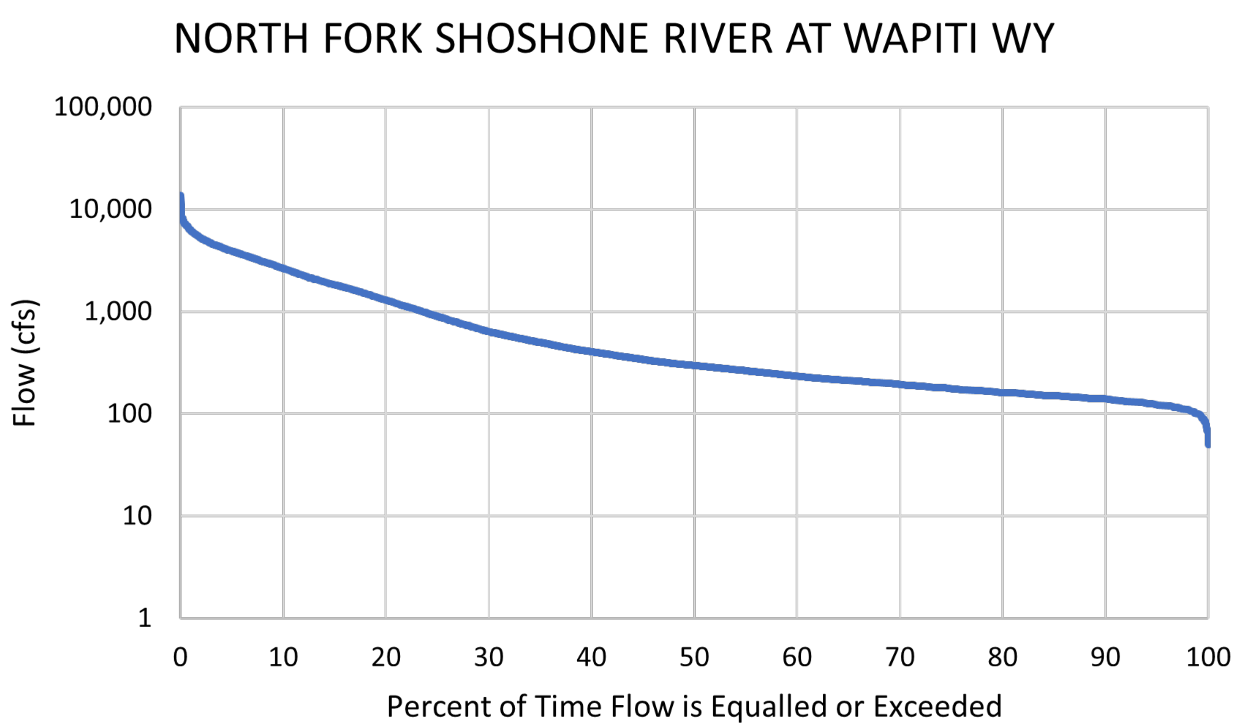


FIGURE 5-9. MEAN DAILY DISCHARGE FLOW DURATION CURVES: SOUTH FORK SHOSHONE RIVER NEAR VALLEY, WYOMING (USGS 06280300)

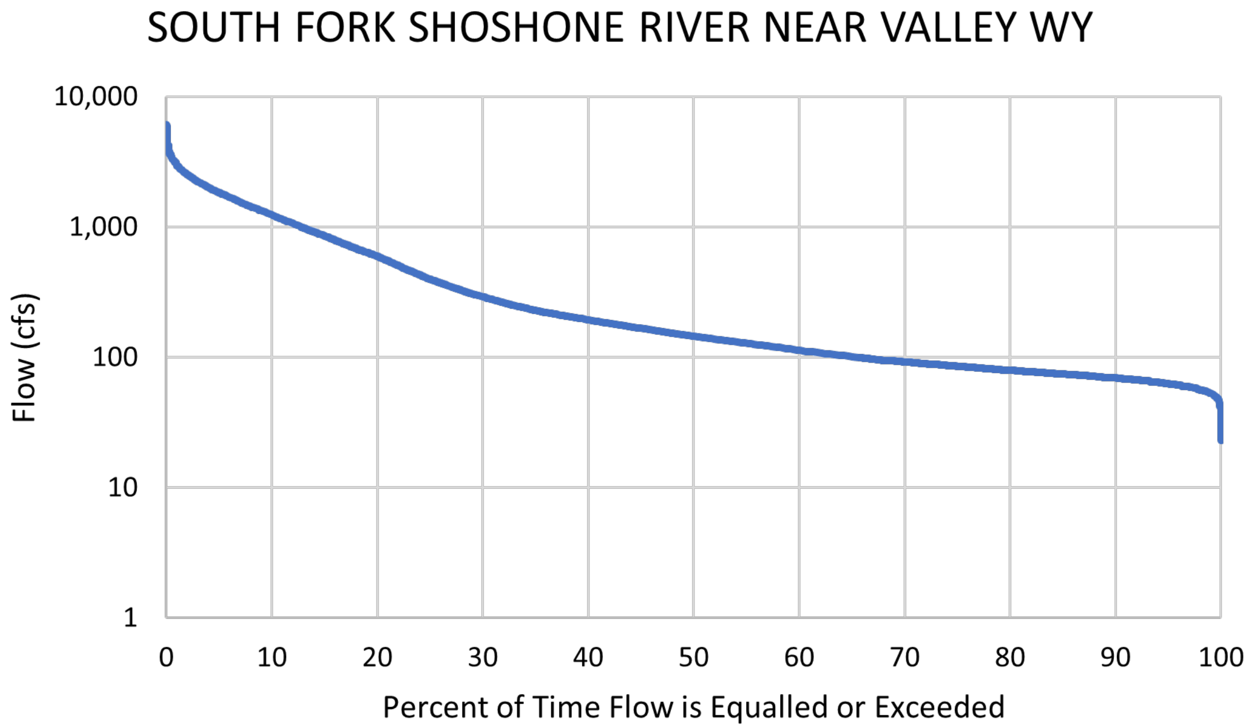


FIGURE 5-10. MEAN DAILY DISCHARGE FLOW DURATION CURVES: SOUTH FORK SHOSHONE RIVER ABOVE BUFFALO BILL RESERVOIR, WYOMING (USGS 06281000)

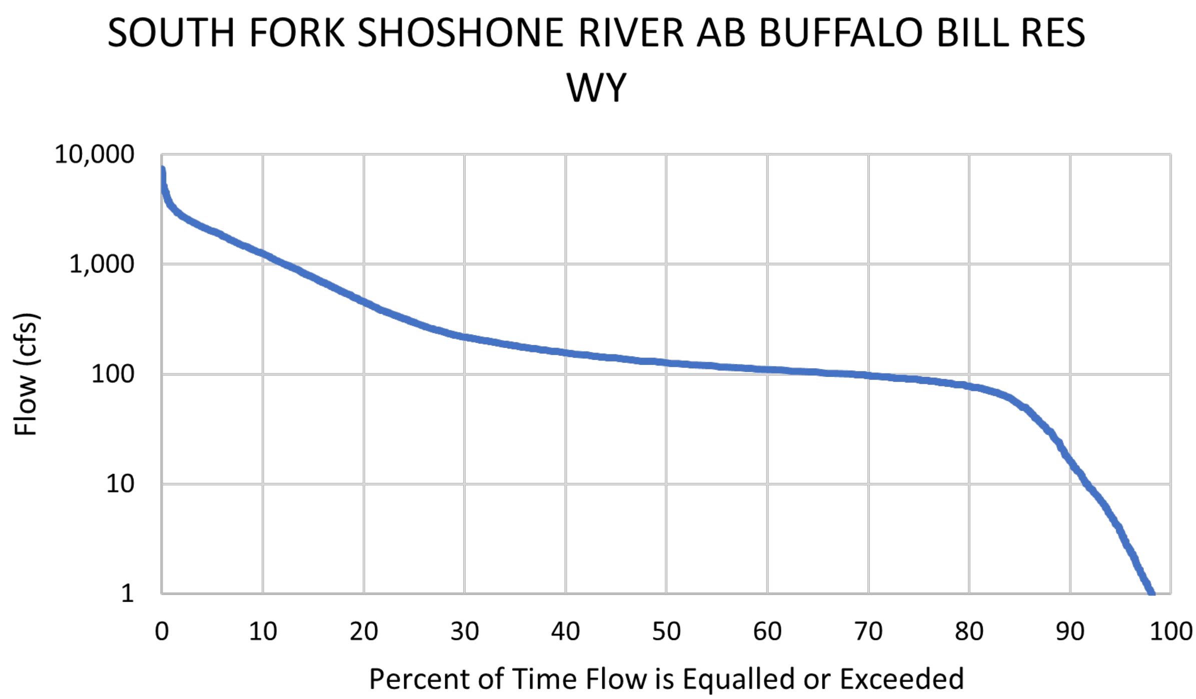


FIGURE 5-11. MEAN DAILY DISCHARGE FLOW DURATION CURVES: SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR, WYOMING (USGS 06282000)

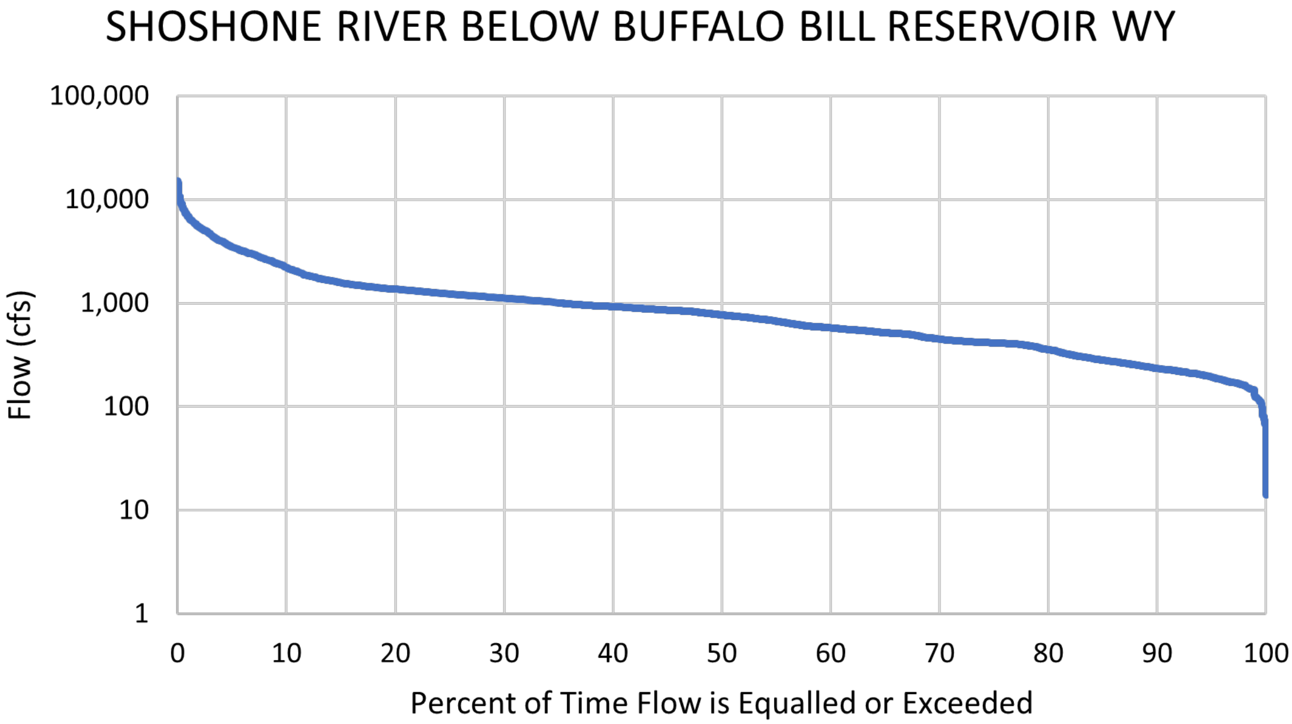
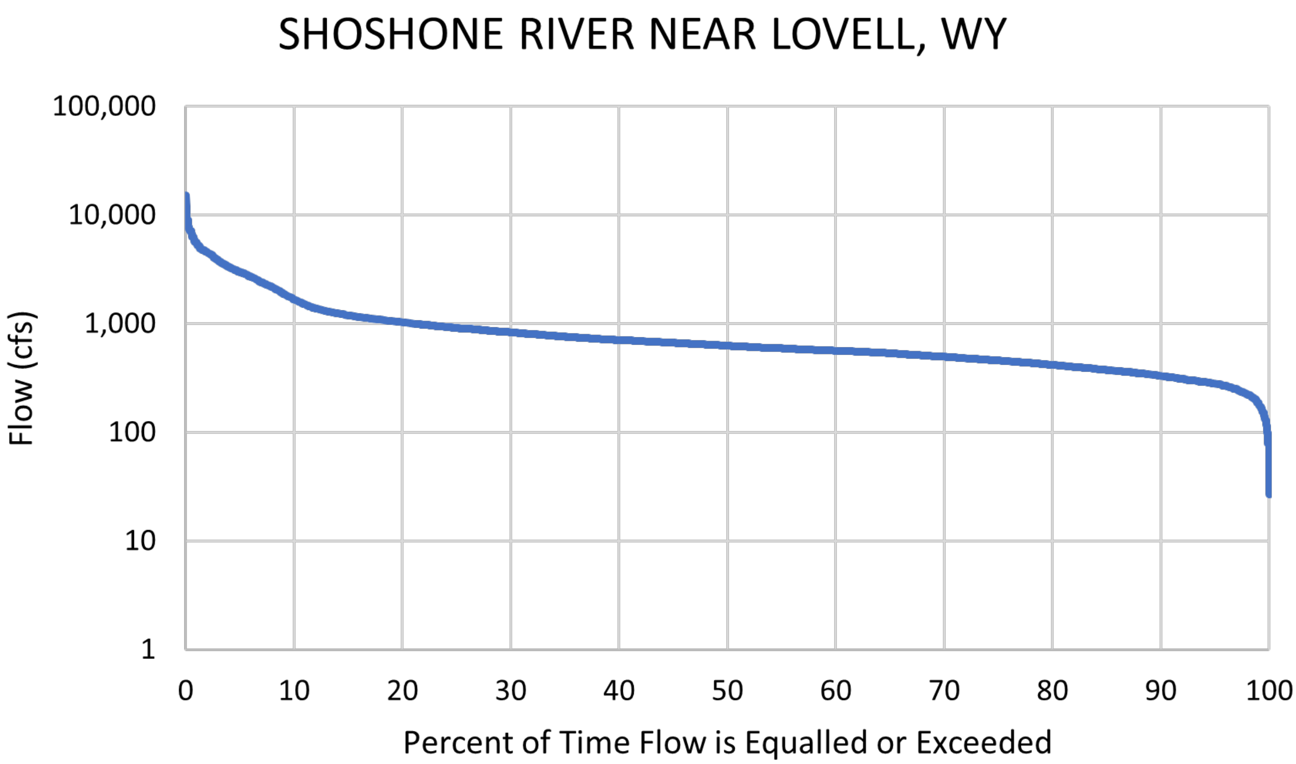


FIGURE 5-12. MEAN DAILY DISCHARGE FLOW DURATION CURVES: SHOSHONE RIVER NEAR LOVELL, WYOMING (USGS 06285100)



5.3 HUC10 WATERSHED MEAN ANNUAL RUNOFF

Mean annual discharge and total annual yield for each of the HUC10 watersheds were calculated using Equation 1-1 from Lowham (1988). The methodologies described by Lowham estimate mean annual discharge for ungaged streams in Wyoming's mountainous regions based on drainage area and mean annual precipitation (Table 5-3). This methodology has a high standard error of 0.92 that should be considered when interpreting results. Further quantification of streamflow hydrology, including measured and estimated mean annual and mean monthly discharge, is presented in the following sections. The annual average precipitation Climate PRISM Raster (1981–2010) was used for this Study (Natural Resources Conservation Service 2023).

$$Q = 0.013 \times A^{0.93} \times P^{1.43} \tag{0-1}$$

where:

$Q =$ mean annual flow (cfs)

$A =$ contributing drainage area (square miles)

$P =$ average annual preciptiation (inches)

TABLE 5-3. MEAN ANNUAL DISCHARGE FROM HUC10 WATERSHEDS

HUC10	HUC10	Total Contributing Drainage Area	Mean Annual Discharge at Outlet	Total Yield at Outlet
No.	**Name**	**(square miles)**	**(cfs)**	**(acre-feet)**
1008001301	Upper South Fork Shoshone River	139,713	292	211,716
1008001302	Middle South Fork Shoshone River	184,670	511	370,262
1008001303	Lower South Fork Shoshone River	92,016	544	394,291
1008001201	Upper North Fork Shoshone River	113,689	251	181,920
1008001202	Middle North Fork Shoshone River	256,031	650	470,898
1008001203	Lower North Fork Shoshone River	176,710	785	568,626
1008001401	Trail Creek-Shoshone River	218,805	1,306	945,926
1008001402	Bitter Creek-Shoshone River	174,992	1,306	946,455
1007000601	Crandall Creek	109,966	205	148,574
1007000602	Pilot Creek-Clarks Fork Yellowstone River	166,141	411	297,445
1007000603	Sunlight Creek	103,344	182	132,159
1007000604	Dead Indian Creek-Clarks Fork Yellowstone River	110,579	868	629,194
1007000605	Bennett Creek-Clarks Fork Yellowstone River	227,764	987	714,830
1007000606	Bear Creek-Clarks Fork Yellowstone River	157,974	996	721,503

HUC10	HUC10	Total Contributing Drainage Area	Mean Annual Discharge at Outlet	Total Yield at Outlet
No.	**Name**	**(square miles)**	**(cfs)**	**(acre-feet)**
1007000607	Cottonwood Creek-Clarks Fork Yellowstone River	61,829	22	15,915
1007000609	Wyoming Creek-Rock Creek	32,085	75	54,258

5.4 WET/NORMAL/DRY FLOW AT GAGES

Streamflow can be characterized by classifying flows into dry, normal, and wet years based on cumulative streamflow at a gage site. For this analysis, the following definitions were used.

- **Dry Years:** 20 percent of analyzed years with the lowest cumulative annual streamflow.
- **Wet Years:** 20 percent of analyzed years with the greatest cumulative annual streamflow.
- **Normal Years**: the remaining 60 percent of years.

Table 5-4 shows all years with complete flow data and whether each year is dry, wet, or normal. Average monthly discharge at each gage is evaluated for dry years, wet years, and normal years. Dry years and wet years are analyzed separately because of meteorological variations and varied periods of record between gaging stations. Shoshone River near Lovell, Wyoming, which is downstream of the Project area, was included since it is the nearest gage to the Study Area outlet.

TABLE 5-4. ANNUAL STREAMFLOW AND MOISTURE CLASSIFICATIONS FOR SELECT GAGING STATIONS IN THE CLARKS FORK/UPPER SHOSHONE WATERSHED

	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
Year	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
1907	NA	NA	NA	NA	NA	NA	510,770	Wet	NA	NA	NA	NA
1921	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1922	579,306	Normal	512,733	Normal	NA	NA	NA	NA	913,382	Normal	NA	`
1923	623,383	Normal	580,512	Normal	NA	NA	332,132	Normal	817,158	Normal	NA	NA
1924	645,755	Normal	518,759	Normal	NA	NA	282,351	Normal	923,054	Normal	NA	NA
1925	996,500	Wet	889,277	Wet	NA	NA	395,373	Wet	1,267,579	Wet	NA	NA
1926	691,307	Normal	NA	Normal	NA	NA	NA	Normal	806,291	Normal	NA	NA
1927	983,903	Wet	NA	NA	NA	NA	NA	NA	1,197,459	Wet	NA	NA
1928	1,058,106	Wet	NA	NA	NA	NA	NA	NA	1,358,844	Wet	NA	NA
1929	633,243	Normal	NA	NA	NA	NA	NA	NA	800,503	Normal	NA	NA
1930	597,251	Normal	NA	NA	NA	NA	NA	NA	872,981	Normal	NA	NA
1931	469,154	Dry	NA	NA	NA	NA	NA	NA	657,717	Normal	NA	NA
1932	650,128	Normal	NA	NA	NA	NA	NA	NA	1,040,481	Wet	NA	NA
1933	521,841	Dry	NA	NA	NA	NA	NA	NA	852,290	Normal	NA	NA
1934	544,762	Dry	NA	NA	NA	NA	NA	NA	537,386	Dry	NA	NA
1935	629,187	Normal	NA	NA	NA	NA	NA	NA	916,512	Normal	NA	NA
1936	711,275	Normal	NA	NA	NA	NA	NA	NA	980,519	Wet	NA	NA

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
1937	549,735	Normal	NA	NA	NA	NA	NA	NA	828,662	Normal	NA	NA
1938	649,464	Normal	NA	NA	NA	NA	NA	NA	990,048	Wet	NA	NA
1939	558,365	Normal	NA	NA	NA	NA	NA	NA	943,646	Normal	NA	NA
1940	491,159	Dry	NA	NA	NA	NA	NA	NA	772,578	Normal	NA	NA
1941	530,450	Dry	NA	NA	NA	NA	NA	NA	680,297	Normal	NA	NA
1942	618,218	Normal	NA	NA	NA	NA	NA	NA	958,380	Normal	NA	NA
1943	1,016,102	Wet	NA	NA	NA	NA	NA	NA	1,277,280	Wet	NA	NA
1944	599,401	Normal	NA	NA	NA	NA	NA	NA	791,125	Normal	NA	NA
1945	714,230	Normal	NA	NA	NA	NA	NA	NA	797,649	Normal	NA	NA
1946	629,282	Normal	NA	NA	NA	NA	NA	NA	819,911	Normal	NA	NA
1947	613,672	Normal	NA	NA	NA	NA	NA	NA	951,989	Normal	NA	NA
1948	678,288	Normal	NA	NA	NA	NA	NA	NA	913,492	Normal	NA	NA
1949	647,066	Normal	NA	NA	NA	NA	NA	NA	738,744	Normal	NA	NA
1950	809,460	Normal	NA	NA	NA	NA	NA	NA	869,451	Normal	NA	NA
1951	898,782	Wet	NA	NA	NA	NA	NA	NA	1,167,701	Wet	NA	NA
1952	698,333	Normal	NA	NA	NA	NA	NA	NA	951,523	Normal	NA	NA
1953	598,744	Normal	NA	NA	NA	NA	NA	NA	658,731	Normal	NA	NA

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
1954	678,932	Normal	NA	NA	NA	NA	NA	NA	779,189	Normal	NA	NA
1955	492,002	Dry	NA	NA	NA	NA	NA	NA	571,797	Normal	NA	NA
1956	795,941	Normal	NA	NA	NA	NA	NA	NA	904,332	Normal	NA	NA
1957	808,078	Normal	NA	NA	362,807	Wet	NA	NA	1,045,597	Wet	NA	NA
1958	586,122	Normal	NA	NA	NA	Normal	NA	NA	986,739	Wet	NA	NA
1959	734,204	Normal	NA	NA	NA	NA	NA	NA	526,518	Dry	NA	NA
1960	489,455	Dry	NA	NA	209,179	Dry	NA	NA	606,716	Normal	NA	NA
1961	508,088	Dry	NA	NA	246,157	Normal	NA	NA	444,793	Dry	NA	NA
1962	736,441	Normal	NA	NA	324,785	Normal	NA	NA	892,149	Normal	NA	NA
1963	686,888	Normal	NA	NA	326,380	Normal	NA	NA	887,913	Normal	NA	NA
1964	685,008	Normal	NA	NA	313,303	Normal	NA	NA	796,576	Normal	NA	NA
1965	854,584	Wet	NA	NA	422,037	Wet	NA	NA	1,038,490	Wet	NA	NA
1966	539,960	Dry	NA	NA	256,623	Normal	NA	NA	652,762	Normal	NA	NA
1967	872,043	Wet	NA	NA	353,895	Normal	NA	NA	955,394	Normal	916,003	Wet
1968	684,309	Normal	NA	NA	299,062	Normal	NA	NA	660,990	Normal	578,993	Normal
1969	603,798	Normal	NA	NA	291,796	Normal	NA	NA	722,553	Normal	696,222	Normal
1970	745,113	Normal	NA	NA	311,381	Normal	NA	NA	834,395	Normal	775,087	Normal

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT Flow (ac-ft/yr)	Dry/Normal /Wet	NORTH FORK SHOSHONE RIVER AT WAPITI WY Flow (ac-ft/yr)	Dry/Normal /Wet	SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY Flow (ac-ft/yr)	Dry/Normal /Wet	SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY Flow (ac-ft/yr)	Dry/Normal /Wet	SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY Flow (ac-ft/yr)	Dry/Normal /Wet	SHOSHONE RIVER NEAR LOVELL, WY Flow (ac-ft/yr)	Dry/Normal /Wet
1971	939,554	Wet	NA	NA	377,675	Wet	NA	NA	1,015,898	Wet	907,398	Wet
1972	901,434	Wet	NA	NA	340,947	Normal	NA	NA	860,124	Normal	818,908	Normal
1973	577,402	Normal	NA	NA	241,398	Dry		NA	702,133	Normal	683,982	Normal
1974	897,039	Wet	NA	NA	400,104	Wet	381,542	Wet	969,786	Wet	884,144	Normal
1975	853,515	Wet	NA	NA	318,916	Normal	329,417	Normal	853,565	Normal	847,059	Normal
1976	922,467	Wet	NA	NA	369,765	Wet	355,640	Normal	1,007,163	Wet	953,425	Wet
1977	395,462	Dry	NA	NA	159,572	Dry	131,841	Dry	480,581	Dry	348,914	Dry
1978	770,987	Normal	NA	NA	352,838	Normal	335,468	Normal	794,811	Normal	795,126	Normal
1979	633,949	Normal	470,723	Dry	236,273	Dry	180,085	Normal	692,614	Normal	579,420	Normal
1980	685,563	Normal	595,630	Normal	298,237	Normal	241,900	Normal	606,228	Normal	536,940	Normal
1981	706,173	Normal	614,142	Normal	264,756	Normal	239,929	Normal	766,764	Normal	635,062	Normal
1982	760,433	Normal	844,312	Wet	377,040	Wet	393,918	Wet	828,149	Normal	821,076	Normal
1983	604,479	Normal	677,357	Normal	309,570	Normal	287,781	Normal	821,976	Normal	765,261	Normal
1984	682,899	Normal	653,794	Normal	323,411	Normal	295,555	Normal	770,299	Normal	640,913	Normal
1985	446,967	Dry	479,355	Dry	249,201	Normal	146,111	Dry	553,317	Dry	417,033	Normal
1986	714,821	Normal	788,769	Wet	386,160	Wet	339,129	Normal	946,810	Normal	850,508	Normal
1987	446,598	Dry	433,442	Dry	218,283	Dry	154,831	Dry	508,074	Dry	424,288	Normal

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
1988	403,811	Dry	358,677	Dry	196,219	Dry	131,128	Dry	403,184	Dry	260,876	Dry
1989	636,672	Normal	545,843	Normal	276,056	Normal	220,925	Normal	553,771	Dry	416,279	Normal
1990	605,972	Normal	536,571	Normal	259,029	Normal	203,164	Normal	657,663	Normal	549,183	Normal
1991	639,330	Normal	676,114	Normal	337,137	Normal	345,412	Normal	740,731	Normal	659,544	Normal
1992	658,040	Normal	506,001	Normal	206,698	Dry	157,177	Dry	475,716	Dry	408,188	Dry
1993	598,594	Normal	566,864	Normal	245,524	Normal	208,985	Normal	440,208	Dry	407,804	Dry
1994	469,478	Dry	398,924	Dry	185,274	Dry	132,498	Dry	566,124	Normal	443,740	Normal
1995	712,689	Normal	648,754	Normal	326,634	Normal	320,206	Normal	498,135	Dry	415,896	Dry
1996	975,421	Wet	897,675	Wet	378,736	Wet	375,453	Wet	1,163,907	Wet	1,179,055	Wet
1997	1,075,434	Wet	958,302	Wet	440,644	Wet	483,233	Wet	1,207,329	Wet	1,201,386	Wet
1998	660,169	Normal	593,030	Normal	301,121	Normal	254,492	Normal	718,808	Normal	684,137	Normal
1999	739,603	Normal	710,664	Normal	350,725	Normal	328,445	Normal	849,110	Normal	808,887	Normal
2000	573,775	Normal	484,713	Dry	246,182	Normal	187,381	Normal	569,133	Normal	493,496	Normal
2001	417,235	Dry	362,162	Dry	179,102	Dry	106,832	Dry	482,477	Dry	360,889	Dry
2002	667,381	Normal	505,299	Normal	223,259	Dry	156,669	Dry	408,904	Dry	257,770	Dry
2003	640,295	Normal	575,103	Normal	260,027	Normal	232,379	Normal	504,179	Dry	388,034	Dry
2004	498,818	Dry	427,805	Dry	188,138	Dry	123,783	Dry	408,091	Dry	285,102	Dry

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
2005	529,224	Dry	504,895	Dry	253,366	Normal	214,118	Normal	526,239	Dry	475,422	Normal
2006	550,500	Normal	548,924	Normal	255,129	Normal	181,701	Normal	509,500	Dry	392,442	Dry
2007	486,461	Dry	432,990	Dry	202,327	Dry	148,146	Dry	422,265	Dry	316,518	Dry
2008	842,546	Wet	810,577	Wet	359,784	Wet	306,513	Normal	925,242	Normal	855,531	Normal
2009	842,138	Normal	763,426	Normal	348,488	Normal	372,313	Wet	985,377	Wet	920,755	Wet
2010	544,508	Dry	567,380	Normal	284,162	Normal	260,920	Normal	655,073	Normal	562,028	Normal
2011	1,010,150	Wet	930,184	Wet	454,112	Wet	473,886	Wet	1,299,644	Wet	1,300,998	Wet
2012	722,378	Normal	573,884	Normal	264,725	Normal	191,771	Normal	581,712	Normal	472,284	Normal
2013	555,431	Normal	539,372	Normal	309,420	Normal	179,250	Dry	500,461	Dry	426,980	Normal
2014	1,057,892	Wet	863,191	Wet	436,649	Wet	408,702	Wet	1,095,243	Wet	1,112,386	Wet
2015	658,731	Normal	554,255	Normal	335,999	Normal	298,819	Normal	765,903	Normal	677,960	Normal
2016	480,734	Dry	552,367	Normal	264,661	Normal	312,423	Normal	NA	NA	437,568	Normal
2017	1,028,612	Wet	1,008,130	Wet	468,659	Wet	592,092	Wet	NA	NA	1,263,525	Wet
2018	1,296,139	Wet	1,086,388	Wet	351,536	Normal	424,641	Wet	NA	NA	1,385,080	Wet
2019	845,466	Wet	757,192	Normal	308,202	Normal	347,974	Normal	NA	NA	1,013,500	Wet
2020	754,971	Normal	757,323	Normal	308,091	Normal	352,706	Normal	NA	NA	776,362	Normal

Year	CLARKS FORK YELLOWSTONE RIVER NR BELFRY MT		NORTH FORK SHOSHONE RIVER AT WAPITI WY		SOUTH FORK SHOSHONE RIVER NEAR VALLEY WY		SOUTH FORK SHOSHONE RIVER AB BUFFALO BILL RES WY		SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR WY		SHOSHONE RIVER NEAR LOVELL, WY	
	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet	Flow (ac-ft/yr)	Dry/Normal /Wet
2021	558,623	Normal	524,122	Normal	240,708	Dry	197,922	Normal	NA	NA	446,945	Normal
2022	776,093	Normal	671,187	Normal	NA	Normal	285,932	Normal	NA	NA	571,287	Normal

At the Clarks Fork Yellowstone River near Belfry, MT gage, the observed average annual discharge during dry, normal, and wet years is 670, 918, and 1,335 cfs, respectively. Monthly streamflow peaks in June ranged from 2,940 cfs during a dry year to 5,746 cfs during a wet year (Figure 5-13). Monthly streamflow is lowest in February, ranging from 203 cfs during a dry year to 253 cfs during a wet year (Table 5-5).

FIGURE 5-13. AVERAGE MONTHLY DISCHARGE: CLARKS FORK YELLOWSTONE RIVER NEAR BELFRY (USGS 06207500) GAGE FOR DRY, NORMAL, AND WET YEARS

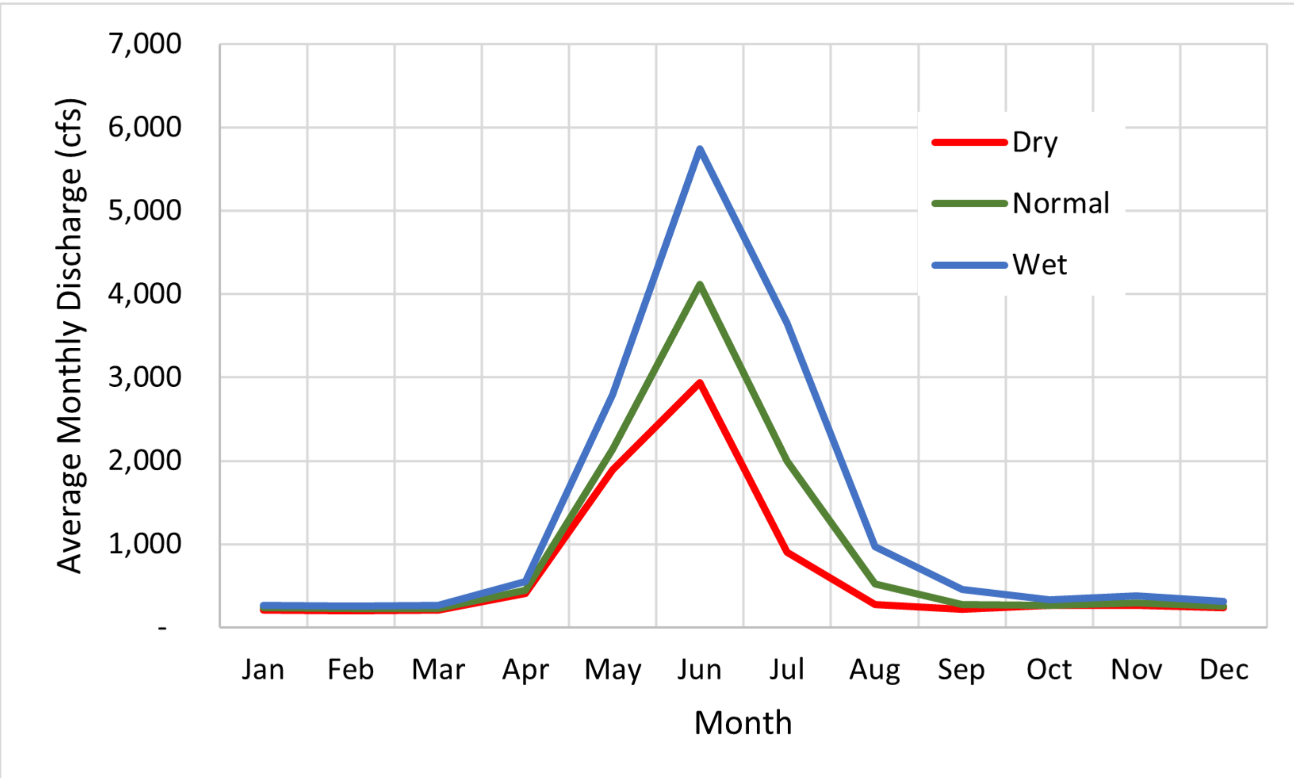


TABLE 5-5. AVERAGE MONTHLY DISCHARGE: CLARKS FORK YELLOWSTONE RIVER NEAR BELFRY (USGS 06207500) GAGE FOR DRY, NORMAL AND WET YEARS

Clarks Fork Yellowstone River Near Belfry (USGS 06207500)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	212	203	211	407	1,896	2,940	902	274	219	265	268	236
Normal Years (n = 61)	233	225	228	443	2,136	4,118	1,998	524	274	268	292	260
Wet Years (n = 20)	265	253	265	548	2,797	5,746	3,652	968	450	335	376	314

At the North Fork Shoshone River at Wapiti, WY gage, the observed average annual discharge during dry, normal, and wet years is 638, 828, and 1,253 cfs, respectively. Monthly streamflow peaks in June ranged from 2,211 cfs during a dry year to 5,287 cfs during a wet year (Figure 5-14). Monthly streamflow is lowest in January and February, ranging from 138 cfs in February during a dry year to 178 cfs in January during a wet year (Table 5-6).

FIGURE 5-14. AVERAGE MONTHLY DISCHARGE: NORTH FORK SHOSHONE RIVER AT WAPITI, WYOMING (USGS 06279940 AND USGS 06280000) GAGES FOR DRY, NORMAL, AND WET YEARS

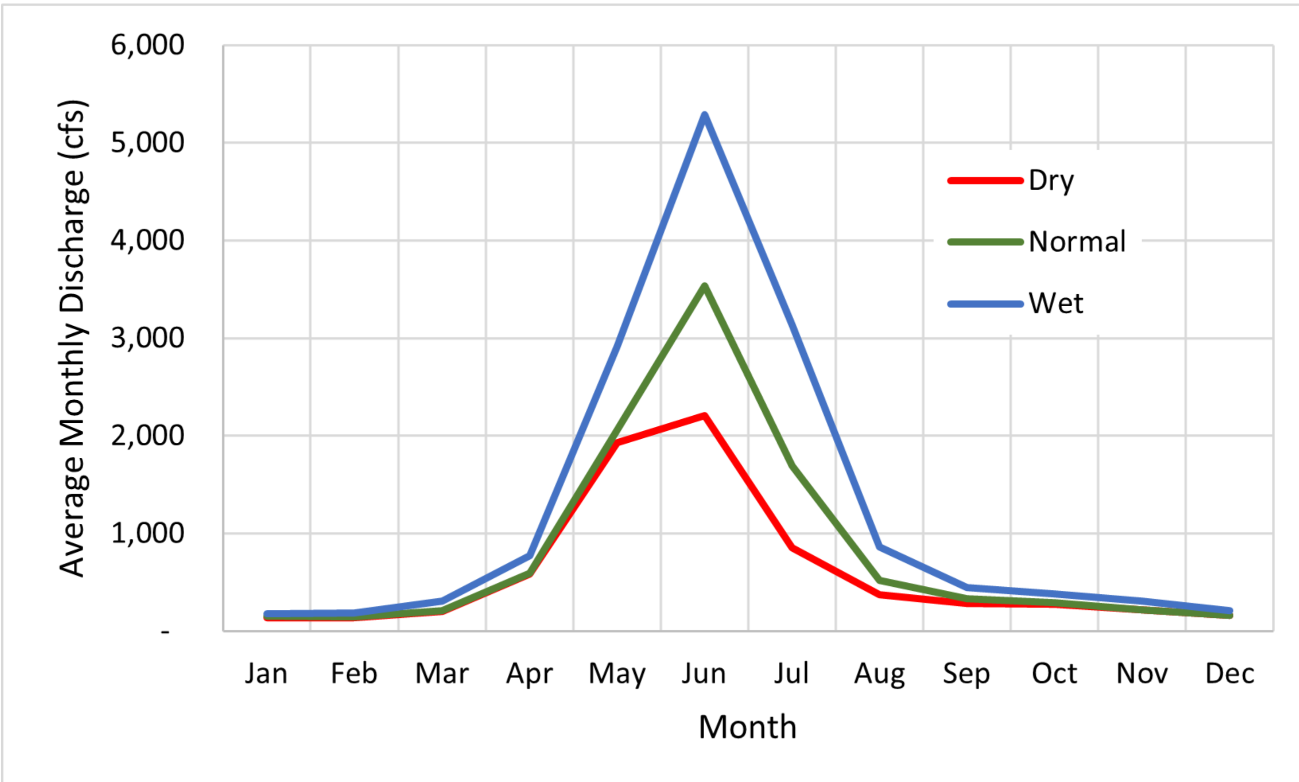


TABLE 5-6. AVERAGE MONTHLY DISCHARGE: NORTH FORK SHOSHONE RIVER AT WAPITI, WYOMING (USGS06279940 AND USGS 06280000) GAGES FOR DRY, NORMAL AND WET YEARS

North Fork Shoshone River at Wapiti (USGS 06279940 and 06280000)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 10)	139	138	202	586	1,927	2,211	852	373	286	273	214	164
Normal Years (n = 29)	149	147	206	590	2,060	3,535	1,697	517	336	294	221	162
Wet Years (n = 10)	178	186	310	775	2,916	5,287	3,138	860	446	382	311	209

At the South Fork Shoshone River near Valley, WY gage, the observed average annual discharge during dry, normal, and wet years is 285, 411, and 556 cfs, respectively. Monthly streamflow peaks in June ranged from 1,126 cfs during a dry year to 2,457 cfs during a wet year (Figure 5-15). Monthly streamflow is lowest in February, ranging from 69 cfs during a dry year to 78 cfs during a wet year (Table 5-7).

FIGURE 5-15. AVERAGE MONTHLY DISCHARGE: SOUTH FORK SHOSHONE RIVER NEAR VALLEY, WYOMING (USGS 06280300) GAGE FOR DRY, NORMAL, AND WET YEARS

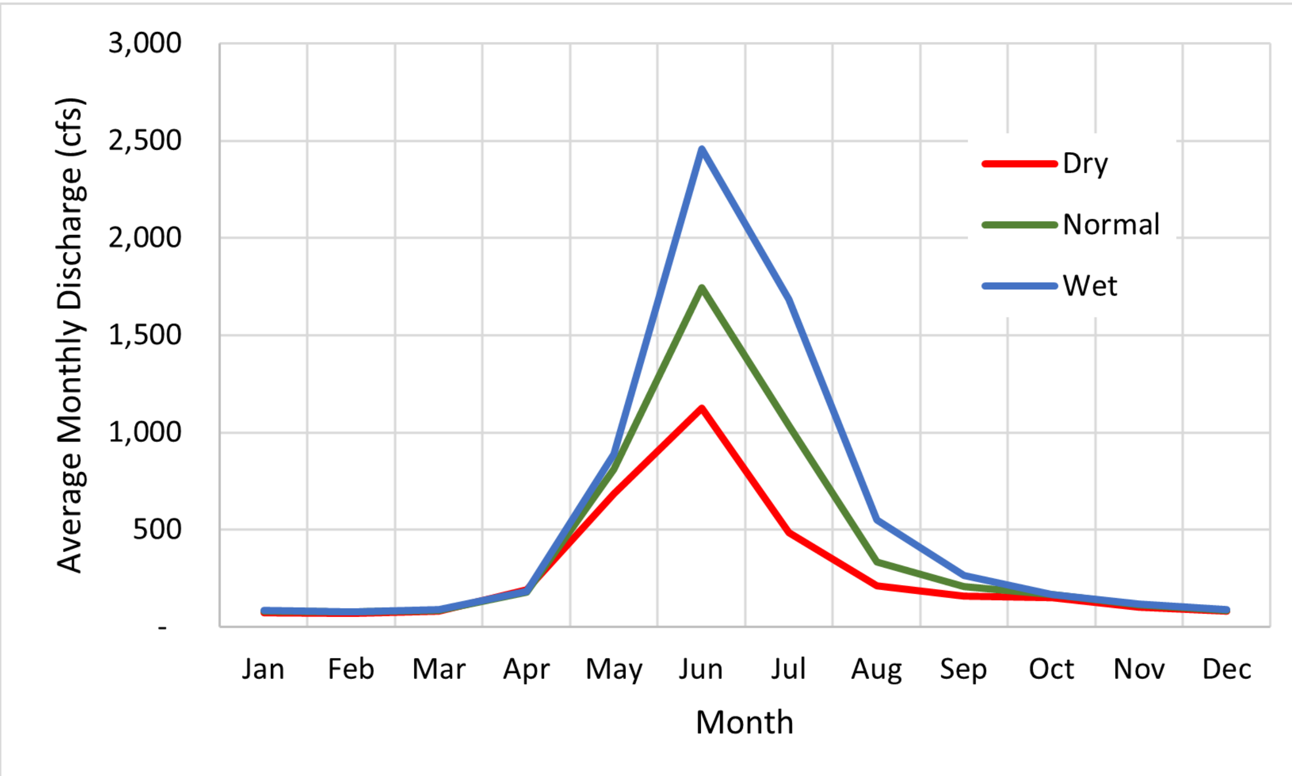


TABLE 5-7. AVERAGE MONTHLY DISCHARGE: SOUTH FORK SHOSHONE NEAR VALLEY, WYOMING (USGS 06280300) GAGE FOR DRY, NORMAL, AND WET YEARS

South Fork Shoshone River Near Valley (USGS 06280300)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 13)	74	69	81	193	686	1,126	484	213	157	150	103	82
Normal Years (n = 39)	81	76	86	181	812	1,743	1,034	334	208	166	115	86
Wet Years (n = 13)	83	78	91	181	890	2,457	1,684	550	265	168	116	89

At South Fork Shoshone River above Buffalo Bill Reservoir, WY observed average annual discharge during dry, normal, and wet years is 197, 376, and 604 cfs, respectively. Monthly streamflow peaks in June ranged from 840 cfs during a dry year to 2,733 cfs during a wet year (Figure 5-16). Dry and normal year monthly streamflow is lowest in August and September, ranging from 19 cfs during a dry year to 54 cfs during a normal year (Table 5-8). Wet year monthly streamflow is lowest in February at 112 cfs.

FIGURE 5-16. AVERAGE MONTHLY DISCHARGE: SOUTH FORK SHOSHONE RIVER ABOVE BUFFALO BILL RESERVOIR, WYOMING (USGS 06281000) GAGE FOR DRY, NORMAL, AND WET YEARS

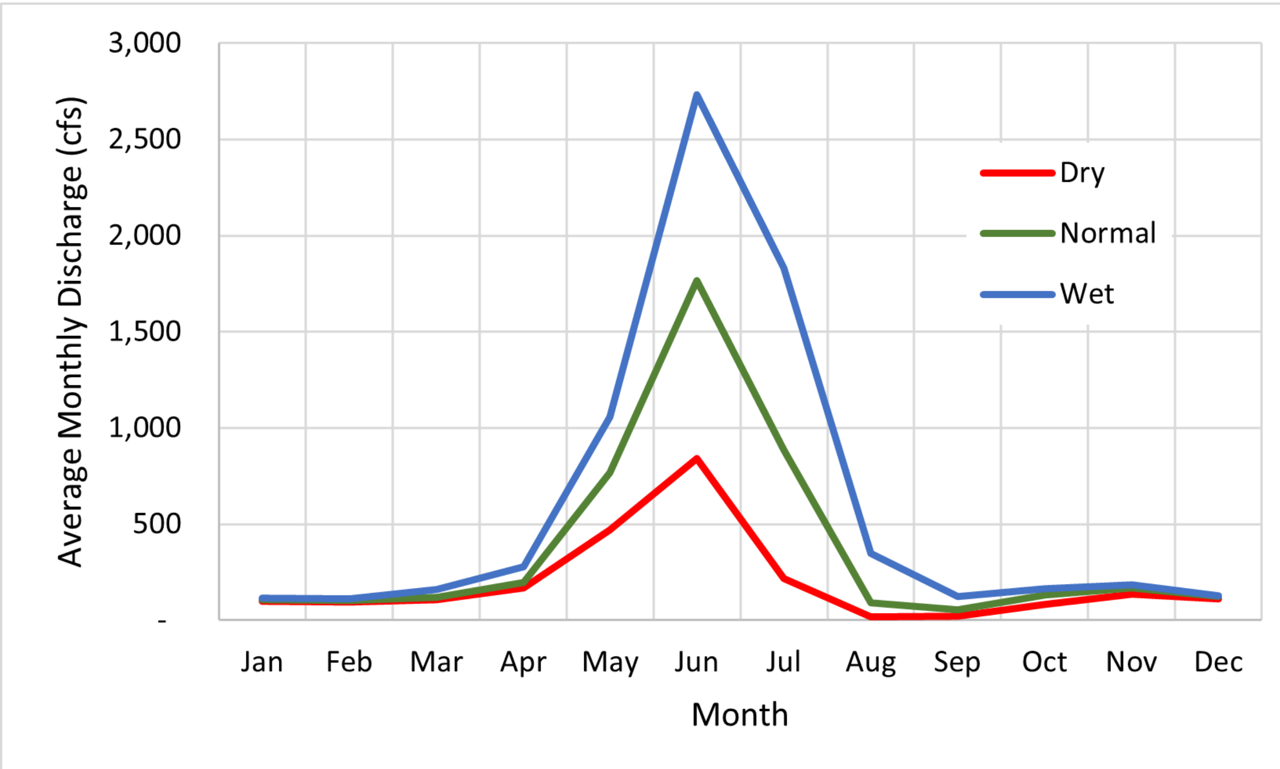


TABLE 5-8. AVERAGE MONTHLY DISCHARGE: SOUTH FORK SHOSHONE RIVER ABOVE BUFFALO BILL RESERVOIR, WYOMING (USGS 06281000) GAGE FOR DRY, NORMAL, AND WET YEARS

South Fork Shoshone River Above Buffalo Bill Reservoir (USGS 06281000)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 11)	99	95	108	167	470	840	217	19	21	81	136	112
Normal Years (n = 32)	109	103	118	195	769	1,765	887	92	54	131	167	124
Wet Years (n = 11)	116	112	159	280	1,055	2,733	1,832	347	122	163	187	126

At Shoshone River below Buffalo Bill Reservoir, WY observed average annual discharge during dry, normal, and wet years is 667, 1,089, and 1,532 cfs, respectively. Monthly streamflow peaks in June ranged from 1,410 cfs during a dry year to 4,949 cfs during a wet year (Figure 5-17). Monthly streamflow is lowest in January, February, and March, ranging from 227 cfs during a March dry year to 481 cfs during a January wet year (Table 5-9).

FIGURE 5-17. AVERAGE MONTHLY DISCHARGE: SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR, WYOMING (USGS 06282000) GAGE FOR DRY, NORMAL, AND WET YEARS

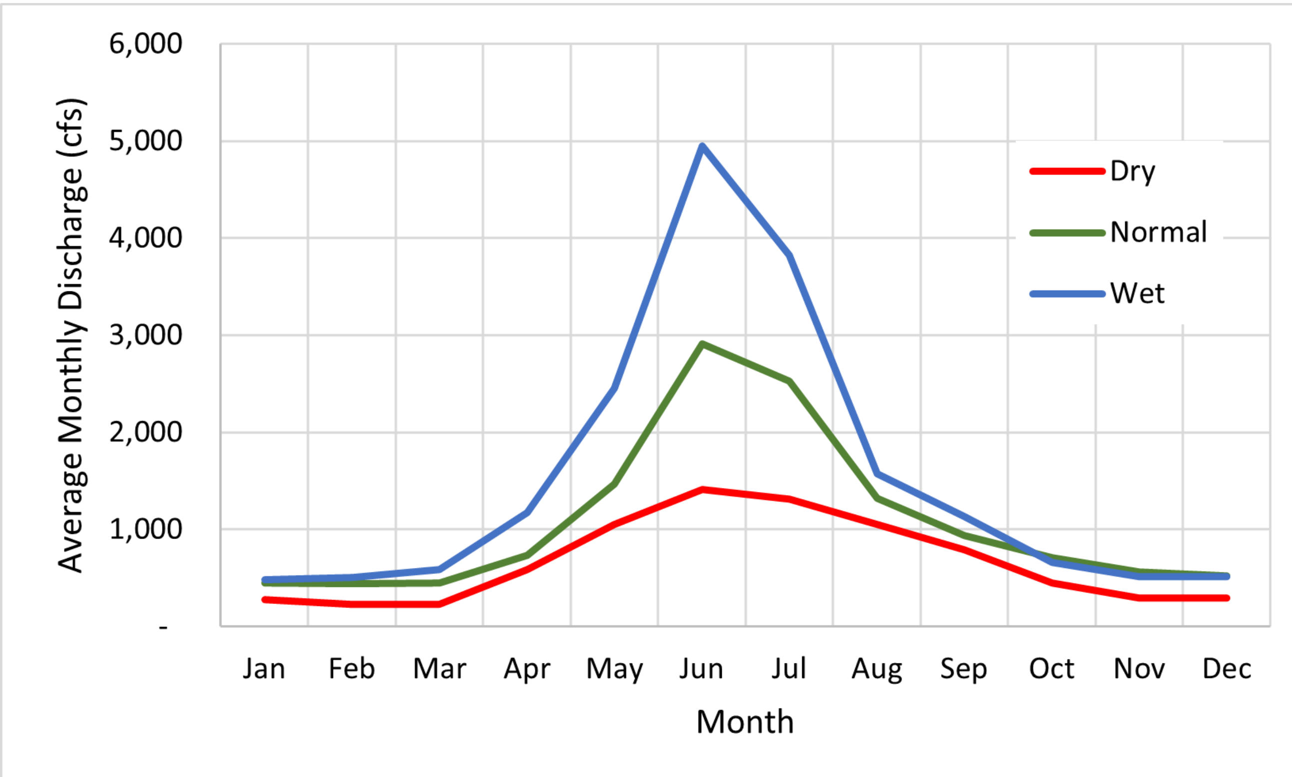


TABLE 5-9. AVERAGE MONTHLY DISCHARGE: SHOSHONE RIVER BELOW BUFFALO BILL RESERVOIR, WYOMING (USGS 06282000) GAGE FOR DRY, NORMAL, AND WET YEARS

Shoshone River Below Buffalo Bill Reservoir (USGS 06282000)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 19)	279	231	227	589	1,056	1,410	1,314	1,049	788	446	298	295
Normal Years (n = 56)	451	442	451	735	1,469	2,912	2,524	1,320	934	706	567	522
Wet Years (n = 19)	481	506	589	1175	2,451	4,949	3,820	1,571	1131	657	510	513

At Shoshone River near Lovell, WY, just slightly downstream of the Study Area, the observed average annual discharge during dry, normal, and wet years is 482, 873, and 1,525 cfs, respectively. Monthly streamflow peaks in June, ranging from 725 cfs during a dry year to 4,078 cfs during a wet year (Figure 5-18). Monthly streamflow is lowest between January and April, with 334 cfs in April during a dry year to 563 cfs in January during a wet year (Table 5-10).

FIGURE 5-18. AVERAGE MONTHLY DISCHARGE: SHOSHONE RIVER NEAR LOVELL, WYOMING (USGS 06285100) GAGE FOR DRY, NORMAL, AND WET YEARS

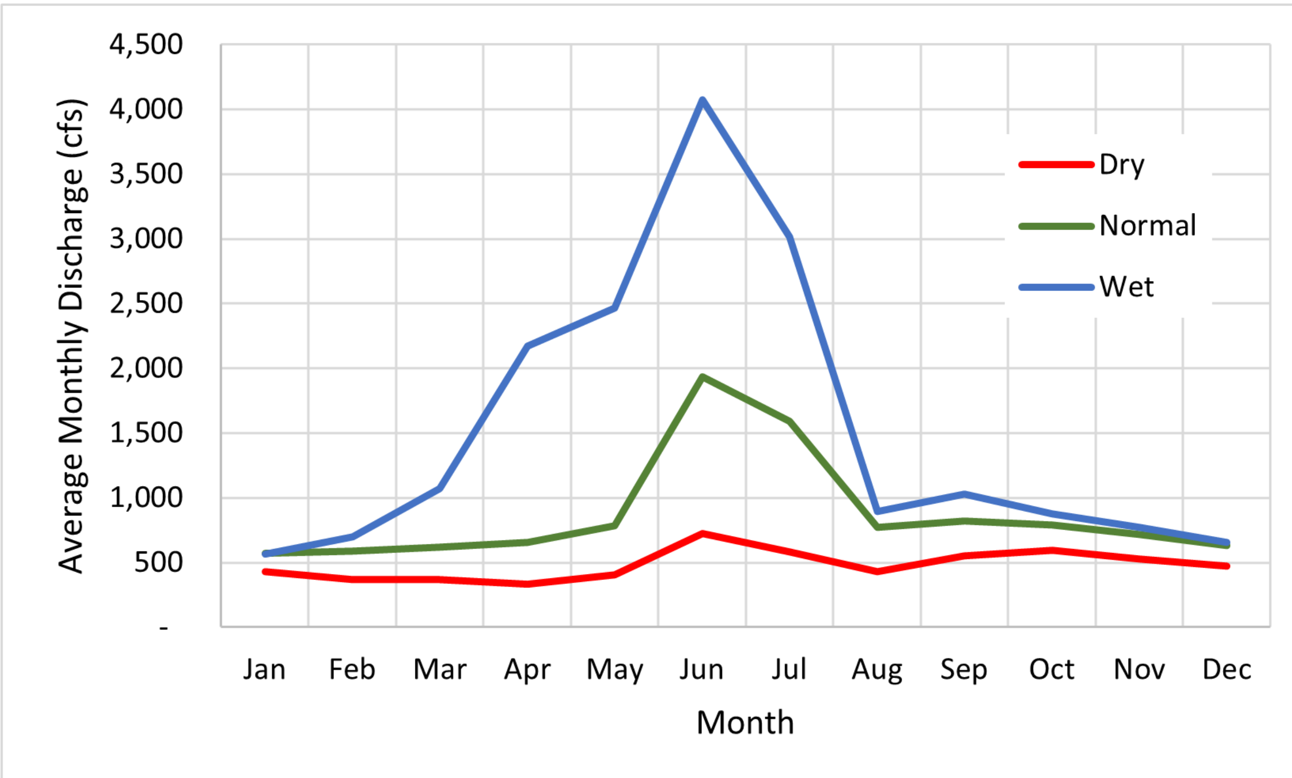


TABLE 5-10. AVERAGE MONTHLY DISCHARGE: SHOSHONE RIVER NEAR LOVELL, WYOMING (USGS 06285100) GAGE FOR DRY, NORMAL, AND WET YEARS

Shoshone River Near Lovell (USGS 06285100)	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 11)	429	371	367	334	405	725	583	428	549	592	526	472
Normal Years (n = 34)	573	587	618	655	782	1,934	1,590	772	823	792	715	632
Wet Years (n = 11)	563	701	1,074	2,171	2,464	4,078	3,015	892	1,030	877	773	656

5.5 WET/NORMAL/DRY FLOW AT HUC10 WATERSHEDS

Three HUC10 watersheds make up the South Fork Shoshone River Watershed, three HUC10 watersheds make up the North Fork Shoshone River Watershed, and two HUC10 watersheds make up the remainder of the Shoshone River Watershed in the Study Area. Six HUC10 watersheds make up the Clarks Fork Yellowstone River Watershed in Wyoming. Estimates were completed for wet, normal, and dry flow for these watersheds. Two small HUC12 watersheds drain from Wyoming to the Clarks Fork Yellowstone River. Water from these watersheds does not enter the Clarks Fork Yellowstone River in Wyoming; therefore, these watersheds are not included in this HUC10 watershed analysis. Ratios that represented the drainage area for each HUC10 to the nearest long-term gage (defined as having a period of record greater than 20 years within the previous 30 years) were developed to calculate monthly flow for dry, normal, and wet years. These ratios were used with the nearest long-term gage time series to calculate flow for Figures 5-19 through 5-32 and Tables 5-11 through 5-24 for each of the 14 HUC10 watersheds.

Flow was estimated using a ratio of the area draining to the South Fork Shoshone River near Valley, WY gage to the area draining to the Upper South Fork Shoshone River (HUC 1008001301) outlet (0.735). The observed average annual discharge during dry, normal, and wet years is estimated to be 210 cfs, 302 cfs, and 409 cfs, respectively. Monthly streamflow peaks in June ranged from 827 cfs during a dry year to 1,806 cfs during a wet year (Figure 5-19). Monthly streamflow is lowest in February, with 51 cfs during a dry year to 58 cfs during a wet year (Table 5-11).

FIGURE 5-19. AVERAGE MONTHLY DISCHARGE: UPPER SOUTH FORK SHOSHONE RIVER (HUC 1008001301) FOR DRY, NORMAL, AND WET YEARS

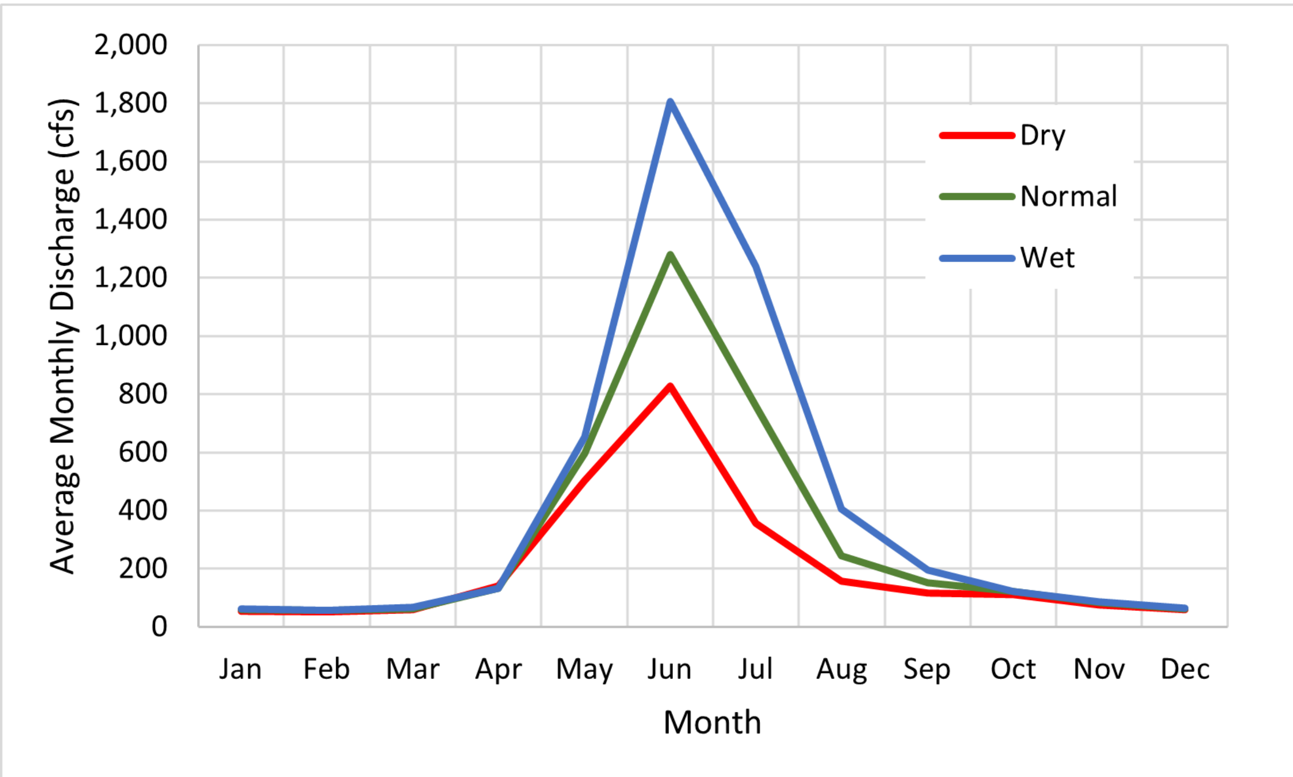


TABLE 5-11. AVERAGE MONTHLY DISCHARGE: UPPER SOUTH FORK SHOSHONE RIVER (HUC 1008001301) FOR DRY, NORMAL, AND WET YEARS

Upper South Fork Shoshone River HUC 1008001301	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 13)	55	51	59	142	504	827	356	156	115	110	75	60
Normal Years (n = 39)	60	56	63	133	597	1,281	760	245	153	122	84	63
Wet Years (n = 13)	61	58	67	133	654	1,806	1,238	405	195	123	85	65

Flow was estimated using a ratio of the area draining to the South Fork Shoshone River near Valley, WY gage to the area draining to the Middle South Fork Shoshone River (HUC 1008001302) outlet (1.707). The observed average annual discharge during dry, normal, and wet years is estimated to be 487, 701, and 948 cfs, respectively. Monthly streamflow peaks in June ranged from 1,921 cfs during a dry year to 4,193 cfs during a wet year (Figure 5-20). Monthly streamflow is lowest in February, with 118 cfs during a dry year to 134 cfs during a wet year (Table 5-12).

FIGURE 5-20. AVERAGE MONTHLY DISCHARGE: MIDDLE SOUTH FORK SHOSHONE RIVER (HUC 1008001302) FOR DRY, NORMAL, AND WET YEARS

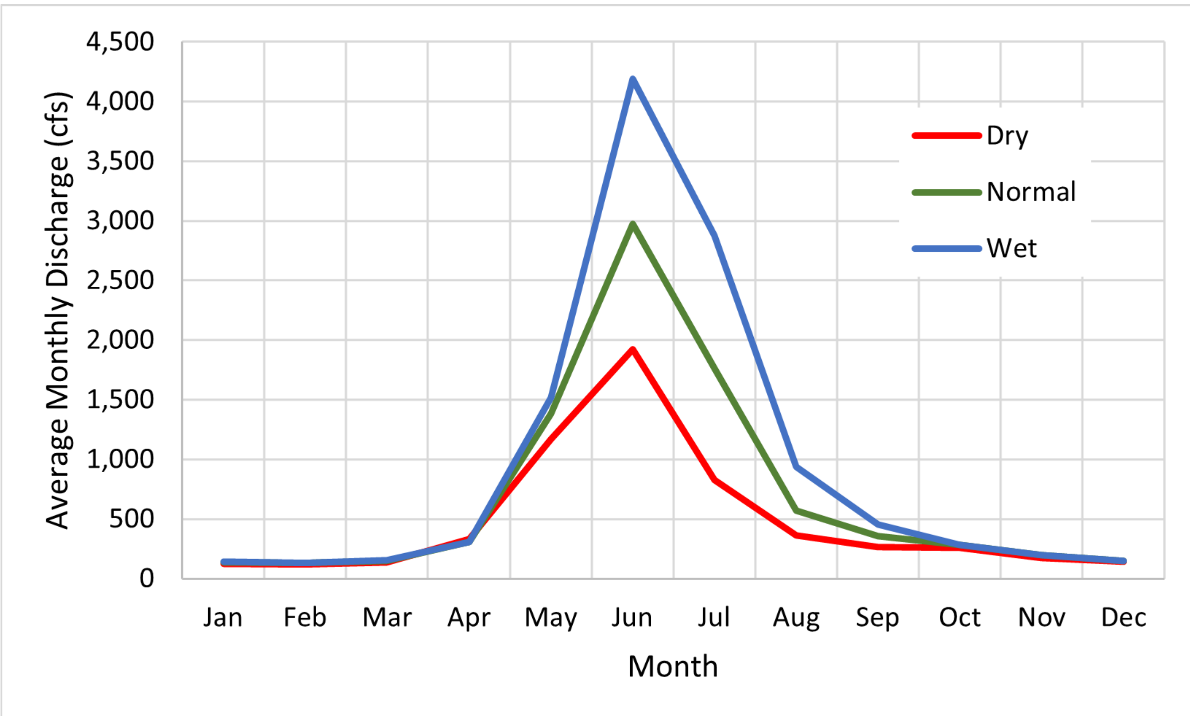


TABLE 5-12. AVERAGE MONTHLY DISCHARGE: MIDDLE SOUTH FORK SHOSHONE RIVER (HUC 1008001302) FOR DRY, NORMAL, AND WET YEARS

Middle South Fork Shoshone River HUC 1008001302	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 13)	127	118	138	330	1,170	1,921	827	363	268	257	175	140
Normal Years (n = 39)	139	130	147	308	1,385	2,974	1,764	570	355	283	196	147
Wet Years (n = 13)	142	134	155	310	1,518	4,193	2,874	939	452	286	198	151

Flow was estimated using a ratio of the area draining to the South Fork Shoshone River above Buffalo Bill Reservoir, WY gage to the area draining to the Lower South Fork Shoshone River (HUC 1008001303) outlet (1.112). The observed average annual discharge during dry, normal, and wet years is estimated to be 219, 418, and 672 cfs, respectively. Monthly streamflow peaks in June ranged from 934 cfs during a dry year to 3,040 cfs during a wet year (Figure 5-21). Monthly streamflow is lowest in February, with 105 cfs during a dry year to 124 cfs during a wet year (Table 5-13).

FIGURE 5-21. AVERAGE MONTHLY DISCHARGE: LOWER SOUTH FORK SHOSHONE RIVER (HUC 1008001303) FOR DRY, NORMAL, AND WET YEARS

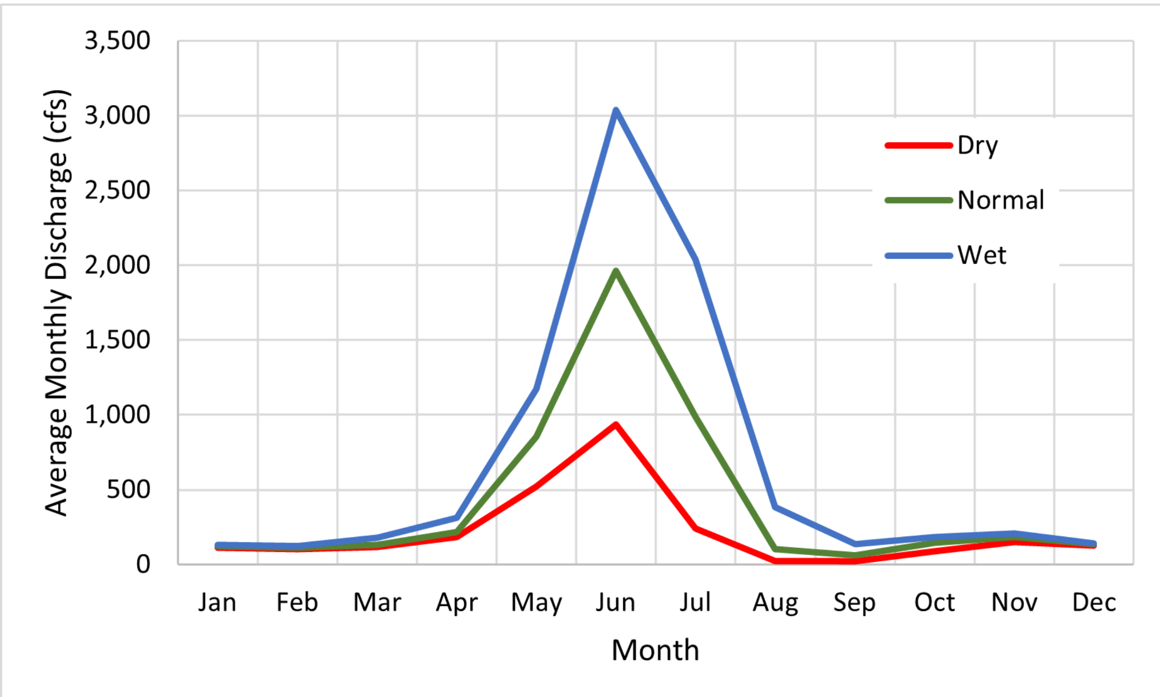


FIGURE 5-13. AVERAGE MONTHLY DISCHARGE: LOWER SOUTH FORK SHOSHONE RIVER (HUC 1008001303) FOR DRY, NORMAL, AND WET YEARS

Lower South Fork Shoshone River HUC 1008001303	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 11)	110	105	120	185	522	934	242	21	23	90	151	125
Normal Years (n = 32)	121	114	131	217	855	1,963	986	102	60	145	186	138
Wet Years (n = 11)	129	124	177	311	1,173	3,040	2,038	386	135	182	208	140

Flow was estimated using a ratio of the area draining to the North Fork Shoshone River at Wapiti, WY gage to the area draining to the Upper North Fork Shoshone River (HUC 1008001201) outlet (0.0.229). The observed average annual discharge during dry, normal, and wet years is estimated to be 146, 190, and 287 cfs, respectively. Monthly streamflow peaks in June ranged from 507 cfs during a dry year to 1,212 cfs during a wet year (Figure 5-22). Monthly streamflow is lowest in January, with 32 cfs during a dry year to 41 cfs during a wet year (Table 5-14).

FIGURE 5-22. AVERAGE MONTHLY DISCHARGE: UPPER NORTH FORK SHOSHONE RIVER (HUC 1008001201) FOR DRY, NORMAL, AND WET YEARS

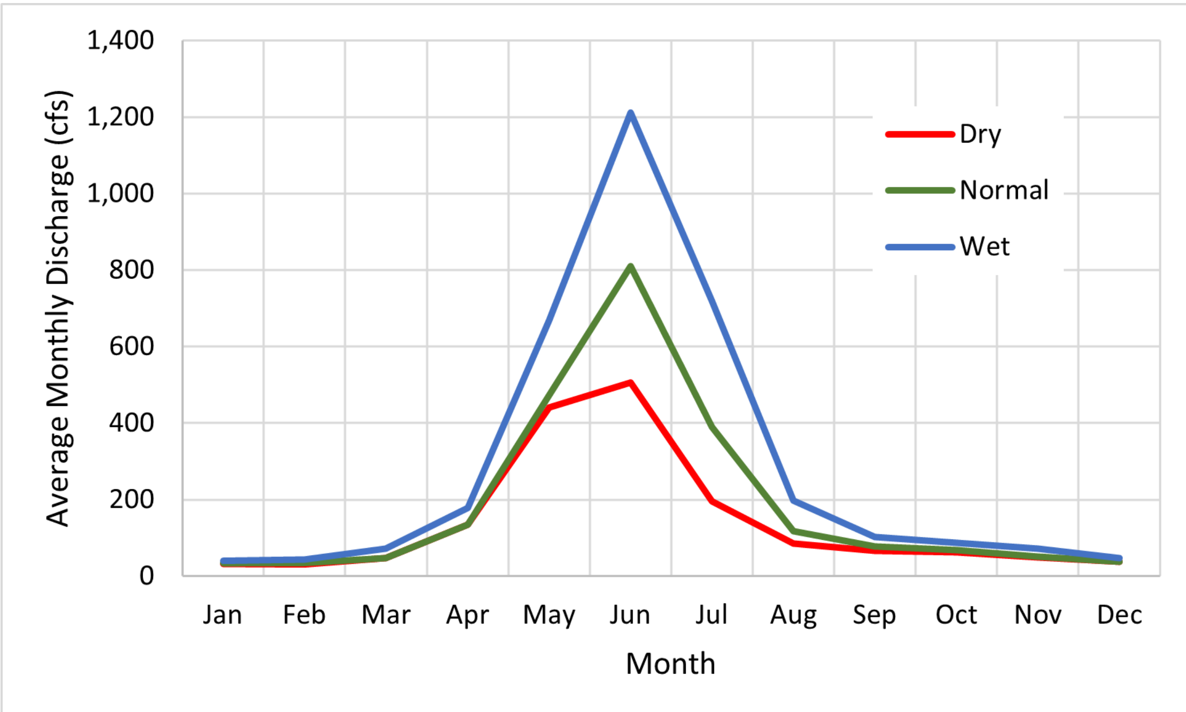


TABLE 5-14. AVERAGE MONTHLY DISCHARGE: UPPER NORTH FORK SHOSHONE RIVER (HUC 1008001201) FOR DRY, NORMAL, AND WET YEARS

Upper North Fork Shoshone River HUC 1008001201	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 10)	32	32	46	134	442	507	195	86	65	63	49	38
Normal Years (n = 29)	34	34	47	135	472	810	389	118	77	67	51	37
Wet Years (n = 10)	41	43	71	178	668	1,212	719	197	102	88	71	48

Flow was estimated using a ratio of the area draining to the North Fork Shoshone River at Wapiti, WY gage to the area draining to the Middle North Fork Shoshone River (HUC 1008001202) outlet (0.745). The observed average annual discharge during dry, normal, and wet years is estimated at 475, 617, and 934 cfs, respectively. Monthly streamflow peaks in June ranged from 1,648 cfs during a dry year to 3,941 cfs during a wet year (Figure 5-23). Monthly streamflow is lowest in January and February, with 103 cfs in February during a dry year to 133 cfs in January during a wet year (Table 5-15).

FIGURE 5-23. AVERAGE MONTHLY DISCHARGE: MIDDLE NORTH FORK SHOSHONE RIVER (HUC 1008001202) FOR DRY, NORMAL, AND WET YEARS

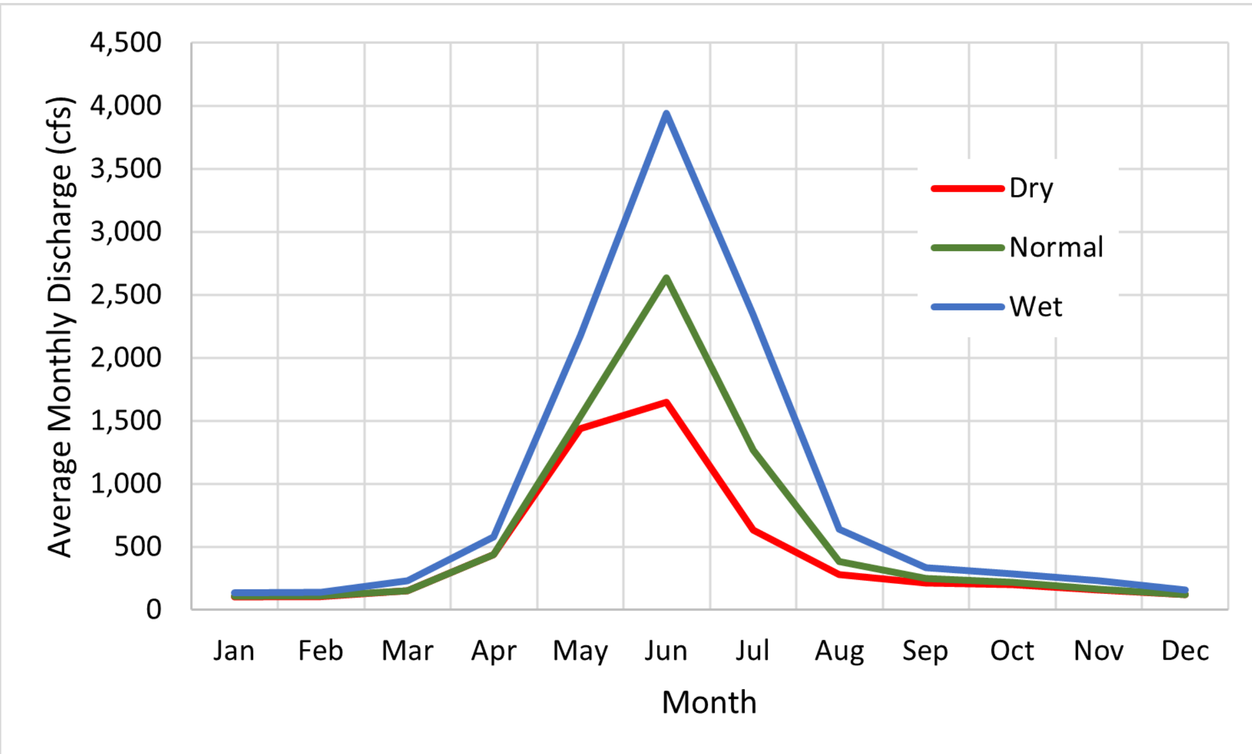


TABLE 5-15. AVERAGE MONTHLY DISCHARGE: MIDDLE NORTH FORK SHOSHONE RIVER (HUC 1008001202) FOR DRY, NORMAL, AND WET YEARS

Middle North Fork Shoshone River HUC 1008001202	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 10)	104	103	150	437	1,436	1,648	635	278	213	204	160	122
Normal Years (n = 29)	111	109	154	440	1,536	2,635	1,265	385	250	219	165	121
Wet Years (n = 10)	133	139	231	578	2,174	3,941	2,339	641	332	285	232	156

Flow was estimated using a ratio of the area draining to the North Fork Shoshone River at Wapiti, WY gage to the area draining to the Lower North Fork Shoshone River (HUC 1008001203) outlet (1.102). The observed average annual discharge during dry, normal, and wet years is estimated at 703, 912, and 1,380 cfs, respectively. Monthly streamflow peaks in June ranged from 2,435 cfs during a dry year to 5,825 cfs during a wet year (Figure 5-24). Monthly streamflow is lowest in January and February, with 152 cfs in February during a dry year to 196 cfs in January during a wet year (Table 5-16).

FIGURE 5-24. AVERAGE MONTHLY DISCHARGE: LOWER NORTH FORK SHOSHONE RIVER (HUC 1008001203) FOR DRY, NORMAL, AND WET YEARS

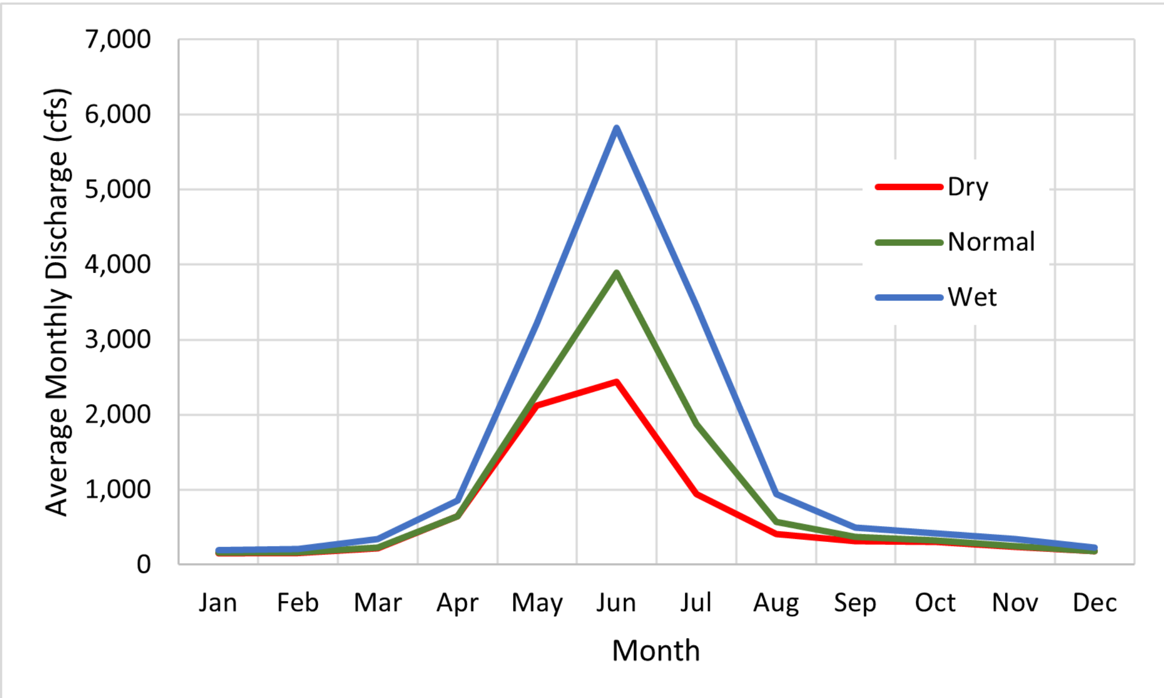


TABLE 5-16. AVERAGE MONTHLY DISCHARGE: LOWER NORTH FORK SHOSHONE RIVER (HUC 1008001203) FOR DRY, NORMAL, AND WET YEARS

Lower North Fork Shoshone River HUC 1008001203	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 10)	153	152	222	646	2,123	2,435	939	411	315	301	236	181
Normal Years (n = 29)	165	162	227	650	2,270	3,895	1,870	569	370	324	244	179
Wet Years (n = 10)	196	205	341	854	3,213	5,825	3,457	947	491	421	342	230

Flow was estimated using a ratio of the area draining to the Shoshone River below Buffalo Bill Reservoir, WY gage to the area draining to the Trail Creek-Shoshone River (HUC 1008001401) outlet (1.201). The observed average annual discharge during dry, normal, and wet years is estimated to be 801, 1,307, and 1,840 cfs, respectively. Monthly streamflow peaks in June ranged from 1,693 cfs during a dry year to 5,942 cfs during a wet year (Figure 5-25). Monthly streamflow is lowest in January and February, with 278 cfs in February during a dry year to 577 cfs in January during a wet year (Table 5-17).

FIGURE 5-25. AVERAGE MONTHLY DISCHARGE: TRAIL CREEK-SHOSHONE RIVER (HUC 1008001401) FOR DRY, NORMAL, AND WET YEARS

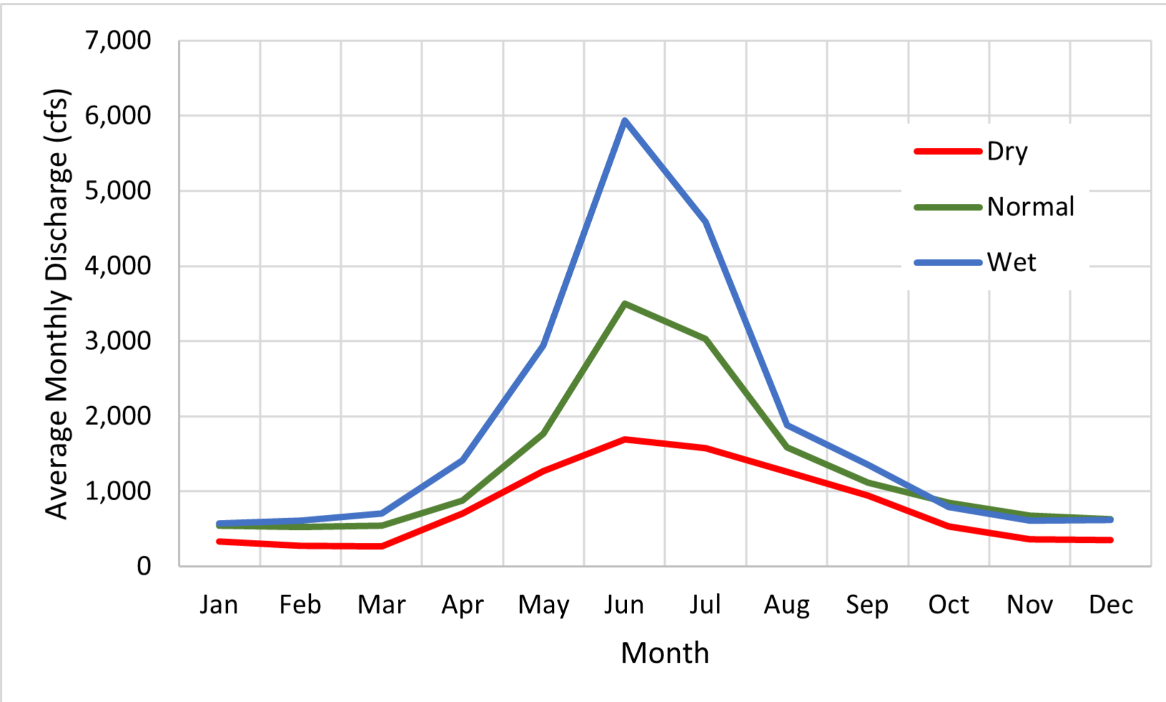


TABLE 5-17. AVERAGE MONTHLY DISCHARGE: TRAIL CREEK-SHOSHONE RIVER (HUC 1008001401) FOR DRY, NORMAL, AND WET YEARS

Trail Creek-Shoshone River HUC 1008001401	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 19)	335	278	273	707	1,267	1,693	1,577	1,260	946	536	357	354
Normal Years (n = 56)	541	530	541	882	1,764	3,496	3,030	1,585	1,121	848	680	627
Wet Years (n = 19)	577	607	708	1,410	2,942	5,942	4,586	1,886	1,358	788	613	615

Flow was estimated using a ratio of the area draining to the Shoshone River near Lovell, WY gage to the area draining to the Bitter Creek-Shoshone River (HUC 1008001402) outlet (0.902). The observed average annual discharge during dry, normal, and wet years is estimated to be 435, 788, and 1,367 cfs, respectively. Monthly streamflow peaks in June ranged from 654 cfs during a dry year to 3,678 cfs during a wet year (Figure 5-26). Monthly streamflow is lowest in January and February, with 335 cfs in February during a dry year to 508 cfs in January during a wet year (Table 5-18).

FIGURE 5-26. AVERAGE MONTHLY DISCHARGE: BITTER CREEK-SHOSHONE RIVER (HUC 1008001402) FOR DRY, NORMAL, AND WET YEARS

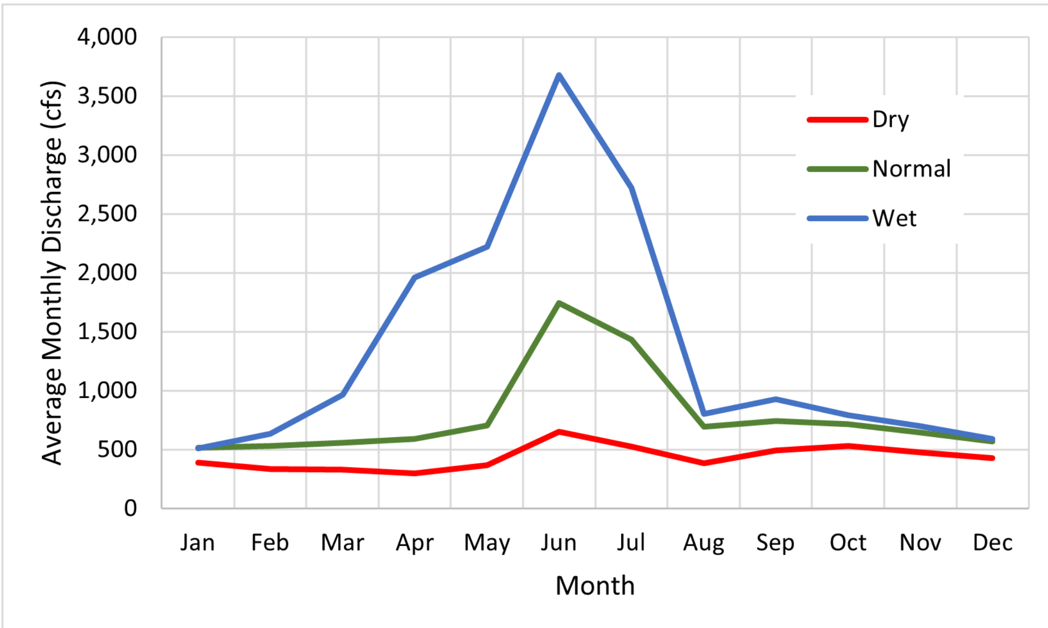


TABLE 5-18. AVERAGE MONTHLY DISCHARGE: BITTER CREEK-SHOSHONE RIVER (HUC 1008001402) FOR DRY, NORMAL, AND WET YEARS

Bitter Creek-Shoshone River HUC 1008001402	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 11)	387	335	331	301	365	654	526	386	496	534	474	426
Normal Years (n = 34)	517	529	558	591	705	1,745	1,435	696	742	715	645	570
Wet Years (n = 11)	508	632	969	1,958	2,222	3,678	2,720	805	929	791	698	592

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Crandall Creek (HUC 1008001601) outlet (0.149). The observed average annual discharge during dry, normal, and wet years is estimated to be 100, 137, and 199 cfs, respectively. Monthly streamflow peaks in June ranged from 439 cfs during a dry year to 857 cfs during a wet year (Figure 5-27). Monthly streamflow is lowest in February, with 30 cfs during a dry year to 38 cfs during a wet year (Table 5-19).

FIGURE 5-27. AVERAGE MONTHLY DISCHARGE: CRANDALL CREEK (HUC 1008001601) FOR DRY, NORMAL, AND WET YEARS

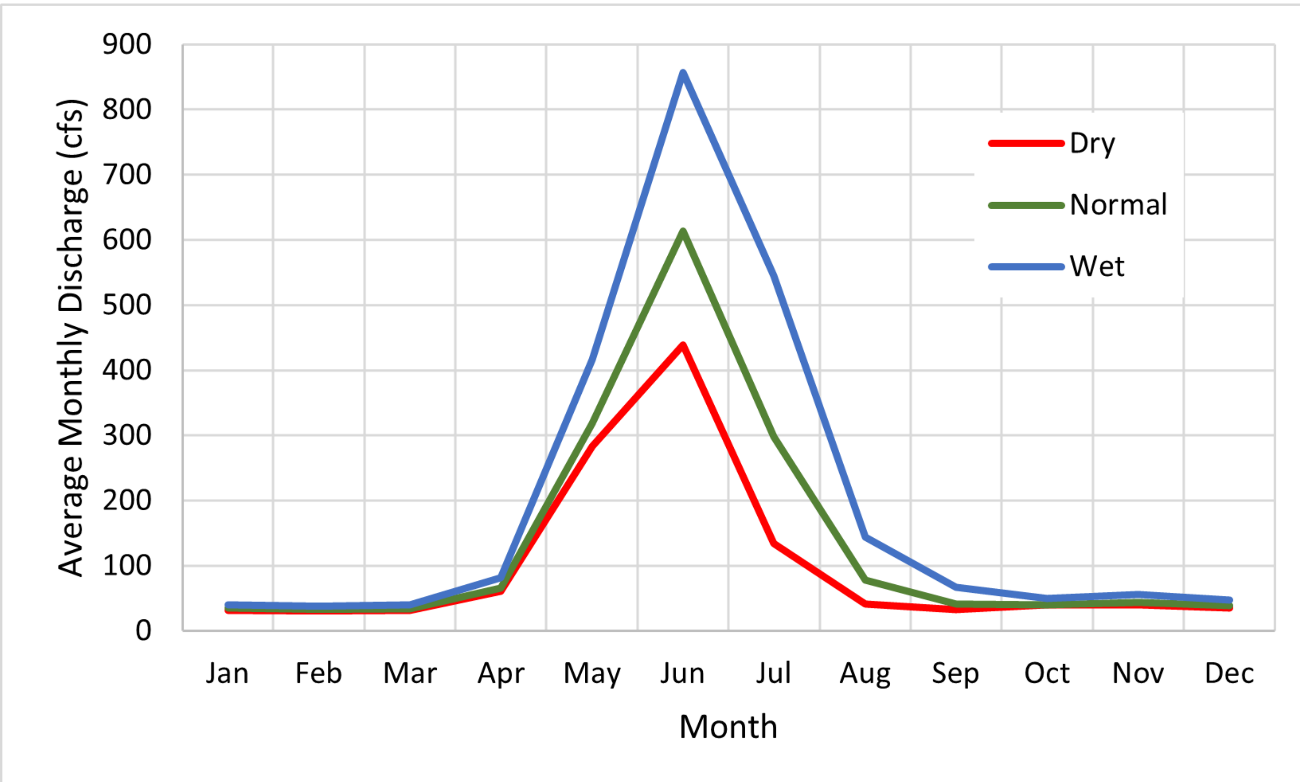


TABLE 5-19. AVERAGE MONTHLY DISCHARGE: CRANDALL CREEK (HUC 1008001601) FOR DRY, NORMAL, AND WET YEARS

Crandall Creek HUC 1008001601	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	32	30	31	61	283	439	135	41	33	40	40	35
Normal Years (n = 61)	35	33	34	66	319	614	298	78	41	40	44	39
Wet Years (n = 20)	40	38	40	82	417	857	545	144	67	50	56	47

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Pilot Creek-Clarks Fork Yellowstone River (HUC 1008001602) outlet (0.225). The observed average annual discharge during dry, normal, and wet years is estimated to be 151, 207, and 301 cfs, respectively. Monthly streamflow peaks in June ranged from 663 cfs during a dry year to 1,295 cfs during a wet year (Figure 5-28). Monthly streamflow is lowest in February, with 46 cfs during a dry year to 57 cfs during a wet year (Table 5-20).

FIGURE 5-28. AVERAGE MONTHLY DISCHARGE: PILOT CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001602) FOR DRY, NORMAL, AND WET YEARS

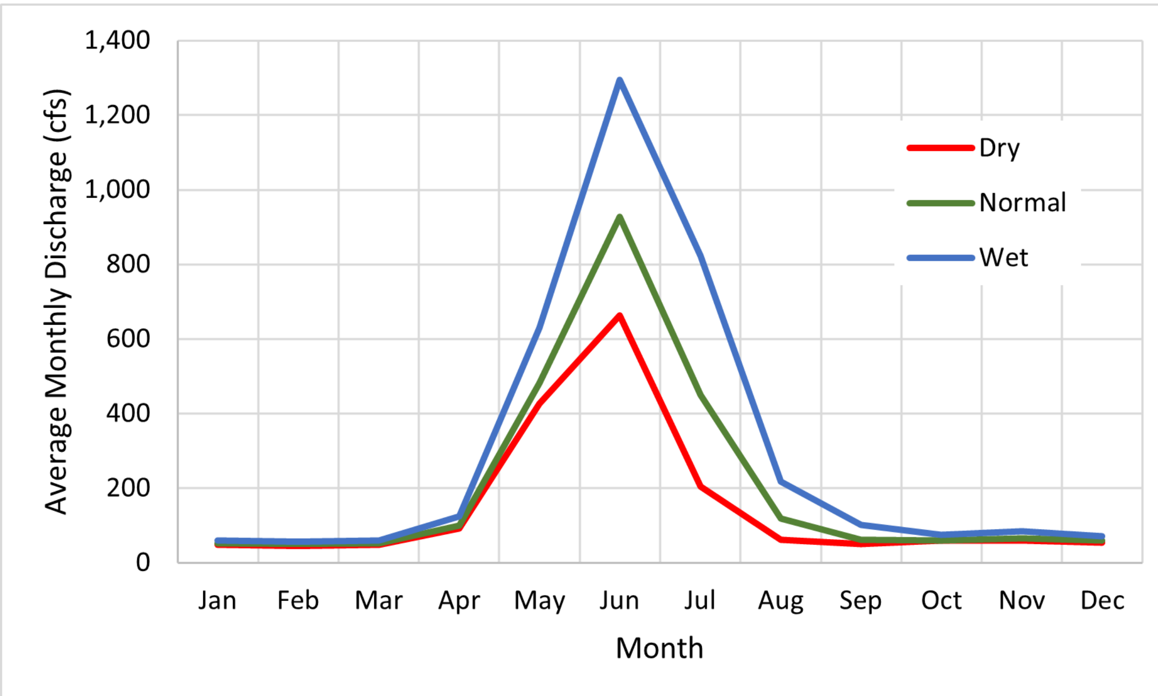


TABLE 5-20. AVERAGE MONTHLY DISCHARGE: PILOT CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001602) FOR DRY, NORMAL, AND WET YEARS

Pilot Creek-Clarks Fork Yellowstone River HUC 1008001602	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	48	46	48	92	427	663	203	62	49	60	60	53
Normal Years (n = 61)	53	51	51	100	481	928	450	118	62	60	66	59
Wet Years (n = 20)	60	57	60	123	630	1,295	823	218	102	76	85	71

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Sunlight Creek (HUC 1008001603) outlet (0.140). The observed average annual discharge during dry, normal, and wet years is estimated to be 94, 129, and 187 cfs, respectively. Monthly streamflow peaks in June ranged from 412 cfs during a dry year to 805 cfs during a wet year (Figure 5-29). Monthly streamflow is lowest in February, with 28 cfs during a dry year to 35 cfs during a wet year (Table 5-11).

FIGURE 5-29. AVERAGE MONTHLY DISCHARGE: SUNLIGHT CREEK (HUC 1008001603) FOR DRY, NORMAL, AND WET YEARS

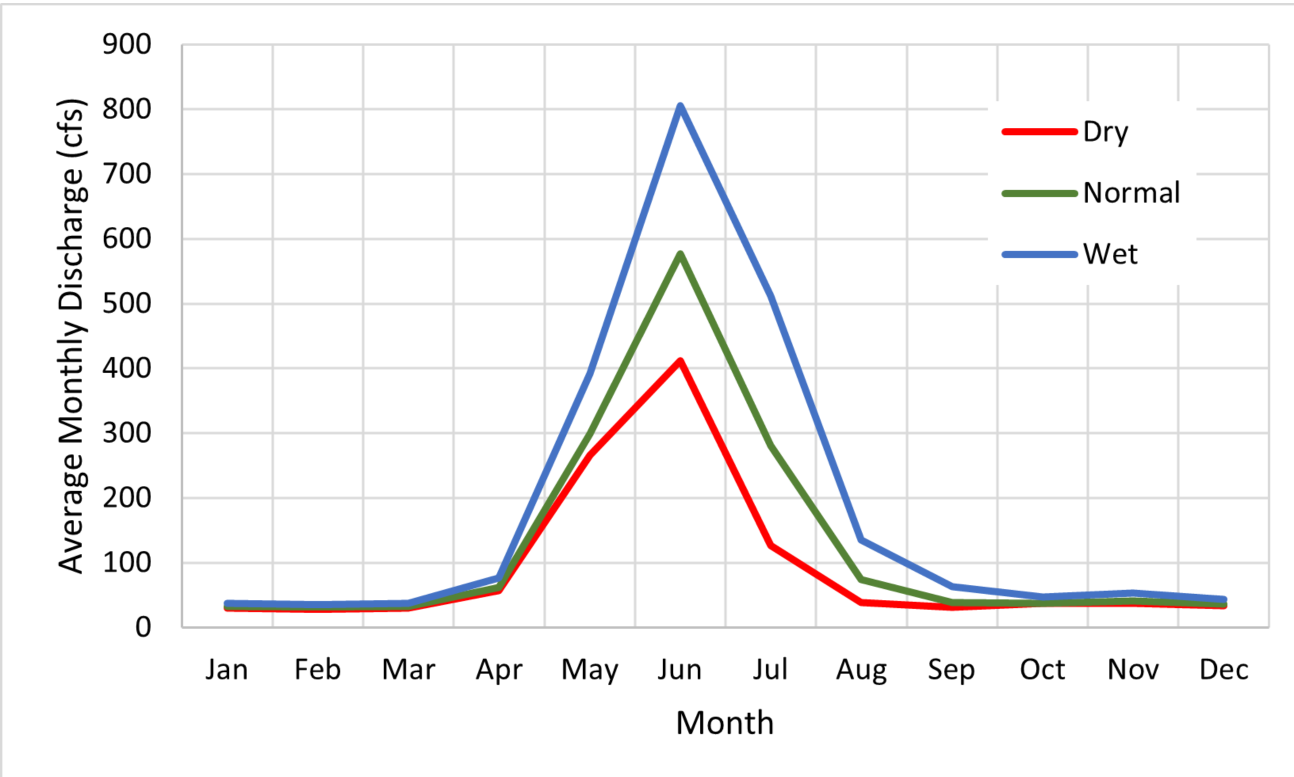


TABLE 5-21. AVERAGE MONTHLY DISCHARGE: SUNLIGHT CREEK (HUC 1008001603) FOR DRY, NORMAL, AND WET YEARS

Sunlight Creek HUC 1008001603	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	30	28	30	57	266	412	127	38	31	37	38	33
Normal Years (n = 61)	33	31	32	62	299	577	280	73	38	38	41	36
Wet Years (n = 20)	37	35	37	77	392	805	512	136	63	47	53	44

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Dead Indian Creek – Clarks Fork Yellowstone River (HUC 1008001604) outlet (0.665). The observed average annual discharge during dry, normal, and wet years is estimated at 445, 610, and 887 cfs, respectively. Monthly streamflow peaks in June ranged from 1,954 cfs during a dry year to 3,819 cfs during a wet year (Figure 5-30). Monthly streamflow is lowest in February, with 135 cfs during a dry year to 168 cfs during a wet year (Table 5-22).

FIGURE 5-30. AVERAGE MONTHLY DISCHARGE: DEAD INDIAN CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001604) FOR DRY, NORMAL, AND WET YEARS

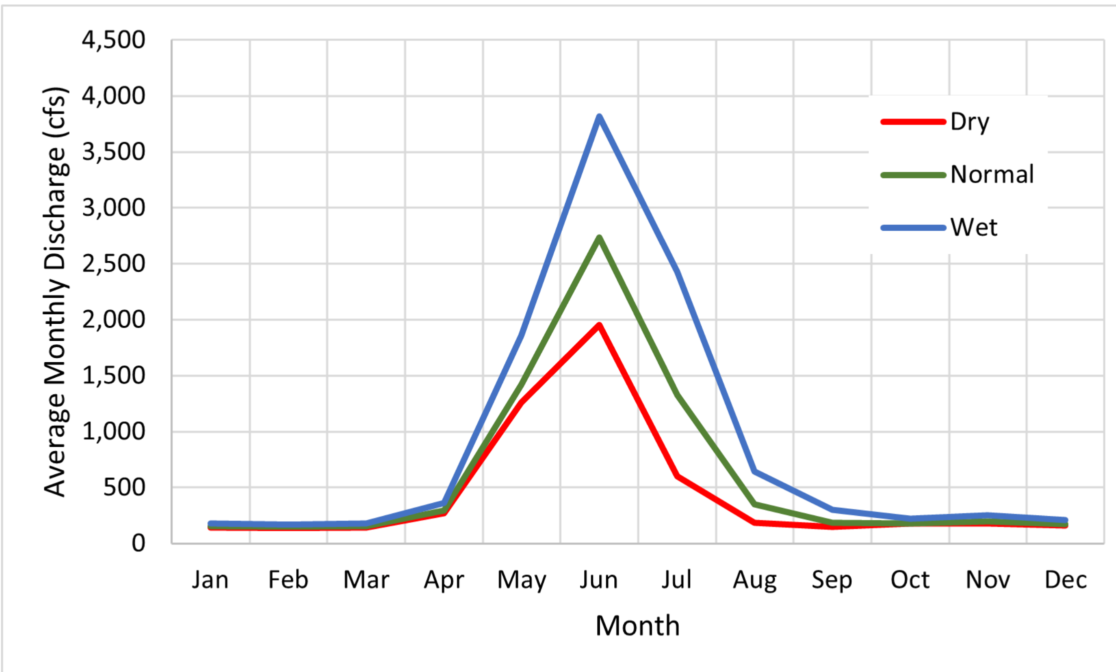


TABLE 5-22. AVERAGE MONTHLY DISCHARGE: DEAD INDIAN CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001604) FOR DRY, NORMAL, AND WET YEARS

Dead Indian Creek-Clarks Fork Yellowstone River HUC10 1008001604	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	141	135	140	270	1,260	1,954	600	182	146	176	178	157
Normal Years (n = 61)	155	149	151	294	1,420	2,737	1,328	348	182	178	194	173
Wet Years (n = 20)	176	168	176	364	1,859	3,819	2,427	644	299	223	250	209

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Bennett Creek-Clarks Fork Yellowstone River (HUC 1008001605) outlet (0.974). The observed average annual discharge during dry, normal, and wet years is estimated to be 652, 894, and 1,299 cfs, respectively. Monthly streamflow peaks in June ranged from 2,862 cfs during a dry year to 5,594 cfs during a wet year (Figure 5-31). Monthly streamflow is lowest in February, with 198 cfs during a dry year to 246 cfs during a wet year (Table 5-23).

FIGURE 5-31. AVERAGE MONTHLY DISCHARGE: BENNETT CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001605) FOR DRY, NORMAL, AND WET YEARS

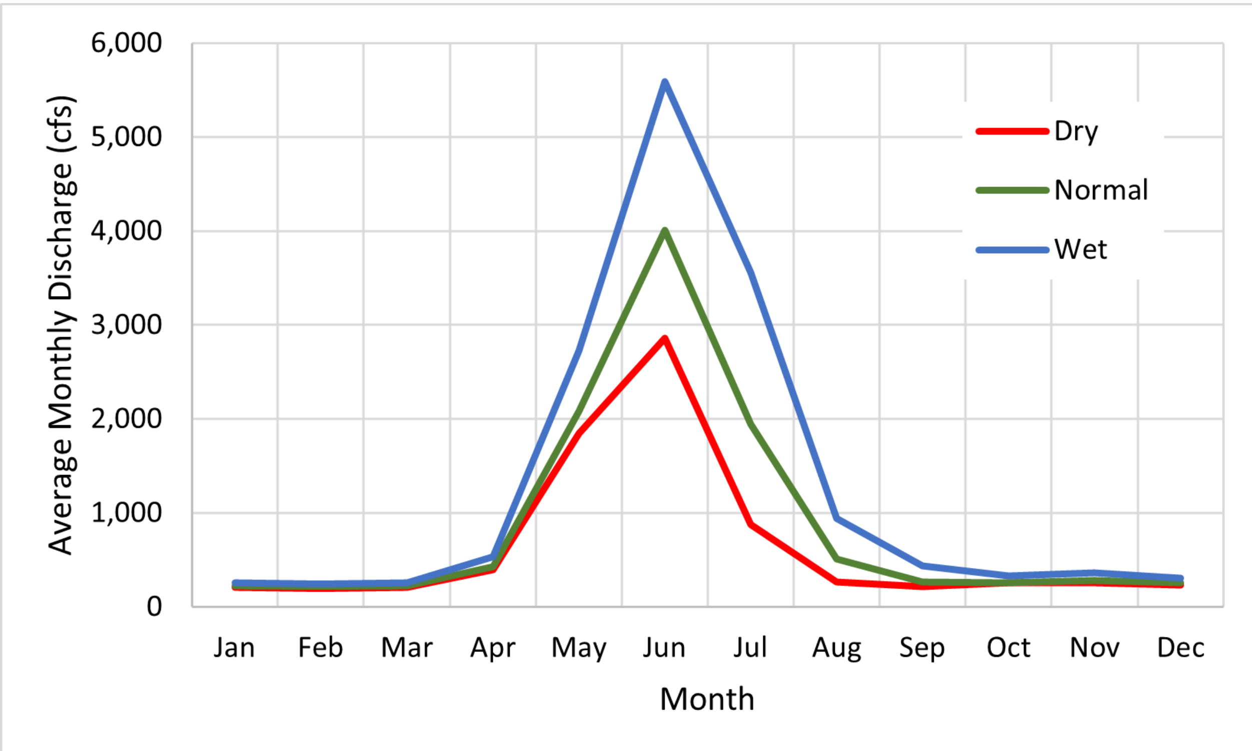


TABLE 5-23. AVERAGE MONTHLY DISCHARGE: BENNETT CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001605) FOR DRY, NORMAL, AND WET YEARS

Bennett Creek-Clarks Fork Yellowstone River HUC10 1008001605	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	207	198	205	396	1,846	2,862	879	267	213	258	261	230
Normal Years (n = 61)	227	219	222	431	2,080	4,009	1,946	510	266	261	284	253
Wet Years (n = 20)	258	246	258	533	2,723	5,594	3,556	943	439	326	366	306

Flow was estimated using a ratio of the area draining to the Clarks Fork Yellowstone River near Belfry, MT gage to the area draining to the Bear Creek-Clarks Fork Yellowstone River (HUC 1008001606) outlet (1.188). The observed average annual discharge during dry, normal, and wet years is estimated at 796, 1,090, and 1,585 cfs, respectively. Monthly streamflow peaks in June ranged from 3,492 cfs during a dry year to 6,826 cfs during a wet year (Figure 5-32). Monthly streamflow is lowest in February, with 241 cfs during a dry year to 301 cfs during a wet year (Table 5-24).

FIGURE 5-32. AVERAGE MONTHLY DISCHARGE: BEAR CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001606) FOR DRY, NORMAL, AND WET YEARS

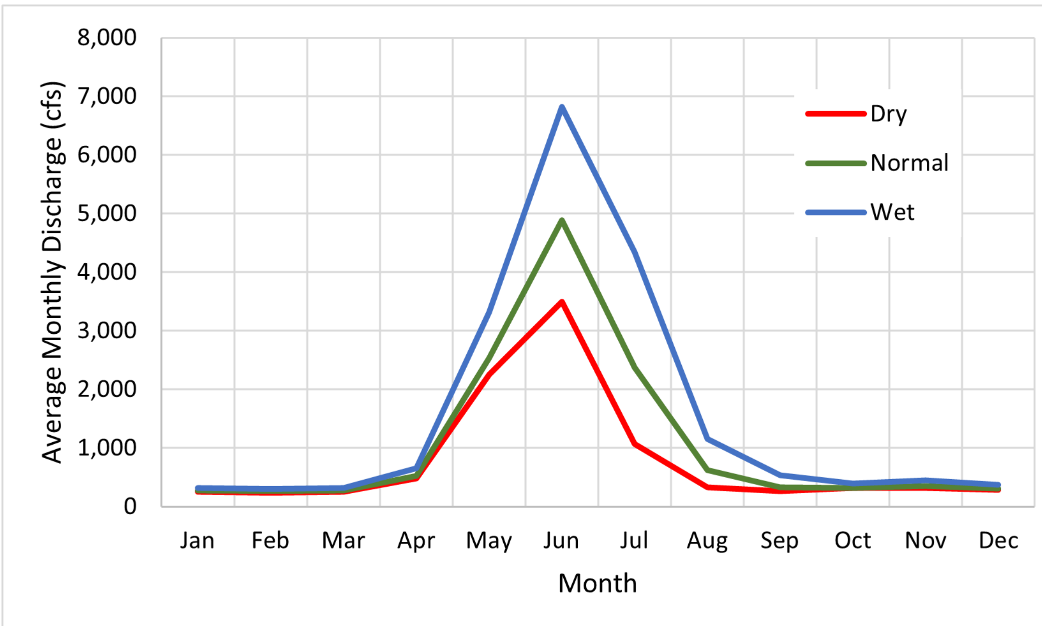


TABLE 5-24. AVERAGE MONTHLY DISCHARGE: BEAR CREEK-CLARKS FORK YELLOWSTONE RIVER (HUC 1008001606) FOR DRY, NORMAL, AND WET YEARS

Bear Creek-Clarks Fork Yellowstone River HUC10 1008001606	January	February	March	April	May	June	July	August	September	October	November	December
Dry Years (n = 20)	252	241	251	483	2,252	3,492	1,072	326	260	315	318	281
Normal Years (n = 61)	277	267	270	526	2,538	4,891	2,374	623	325	318	347	309
Wet Years (n = 20)	315	301	315	651	3,322	6,826	4,338	1,150	535	398	446	373

5.6 TEMPORARY STREAM GAGING STATIONS

In addition to the USGS gaging stations, two temporary gaging stations were installed at the request of the Sponsors to obtain additional streamflow data on Bitter Creek and Sage Creek. The gaging stations and their locations are listed in Table 5-25. These gages consisted of a pressure transducer with a built-in datalogger protected by polyvinyl chloride (PVC) housing. The transducer setups are depicted in Figures 5-33 and 5 34. The transducer at Sage Creek was programmed to collect water depth (stage) readings at 15-minute intervals, while the transducer at Bitter Creek was programmed to collect stage readings at 30-minute intervals. Trihydro staff installed the transducers in April 2023 and retrieved them in July 2023.

TABLE 5-25. TEMPORARY STREAM GAGING STATIONS

Gage Name	General Location	Drainage Area Square Miles (acres)	Latitude/ Longitude	Elevation (ft)
Bitter Creek	Located 4 miles northeast of Powell, WY, County Road 07, then approximately 1,300 feet east or downstream of the county road.	29.4 (18,752)	44.7858 -108.7151	4,320
Sage Creek	Located roughly 5.5 miles northeast of Cody, WY, on Hwy 14, then approximately 0.75 miles west.	98.4 (62,976)	44.5587 –108.9967	4,730

Field measurements coupled with hydraulic modeling were used to developed depth vs stream discharge relationships at each location. Using these relationships, the data collected by the data loggers (flow depth) was converted to stream discharge. Figures 5-35 and 5-36 display the hydrographs for the estimated streamflow discharges at Bitter Creek and Sage Creek, respectively. Table 5-26 summarizes the results of the temporary stream-gaging effort and the streamflow statistics and yield estimates for the WWDC temporary gaging stations on Bitter Creek and Sage Creek.

FIGURE 5-33. TRANSDUCER INSTALLED ON BITTER CREEK

FIGURE 5-34. TRANSDUCER INSTALLED ON SAGE CREEK

TABLE 5-26. SUMMARY OF TEMPORARY STREAM GAGE HYDROLOGY

Stream Gage	Bitter Creek	Sage Creek
Drainage Area (mi2)	29.3	98.4
Drainage Area (acres)	18,752	62,976
Start Date	4/7/2023	4/7/2023
End Date	7/22/2023	7/22/2023
Average Discharge (cfs)	159	8.7
Median Discharge (cfs)	180	8.2
Total Yield (ac-ft)	33,538	1,850
Mean Yield (ac-ft/mi2)	1,145	18.8
Peak Discharge (cfs)	337.2	24.9
Date of Peak	6/21/2023	6/11/2023
Minimum Discharge (cfs)	3.8	1.8

FIGURE 5-35. HYDROGRAPH FOR TEMPORARY GAGE ON BITTER CREEK

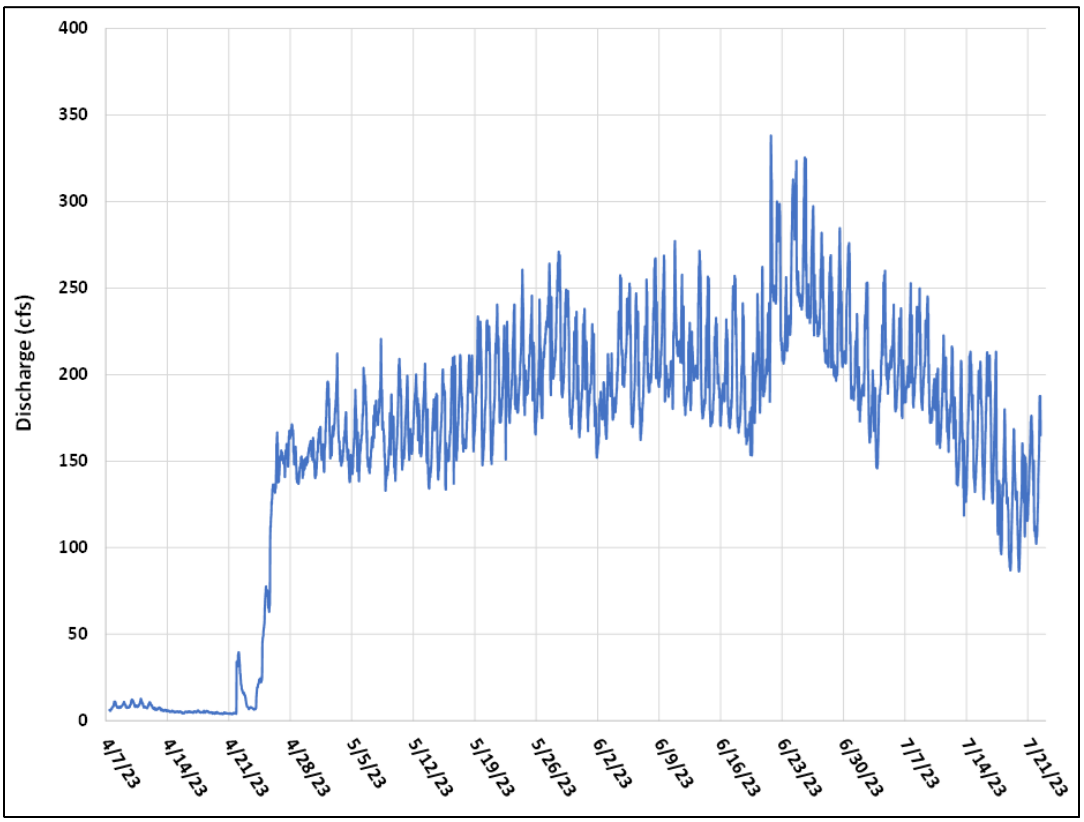
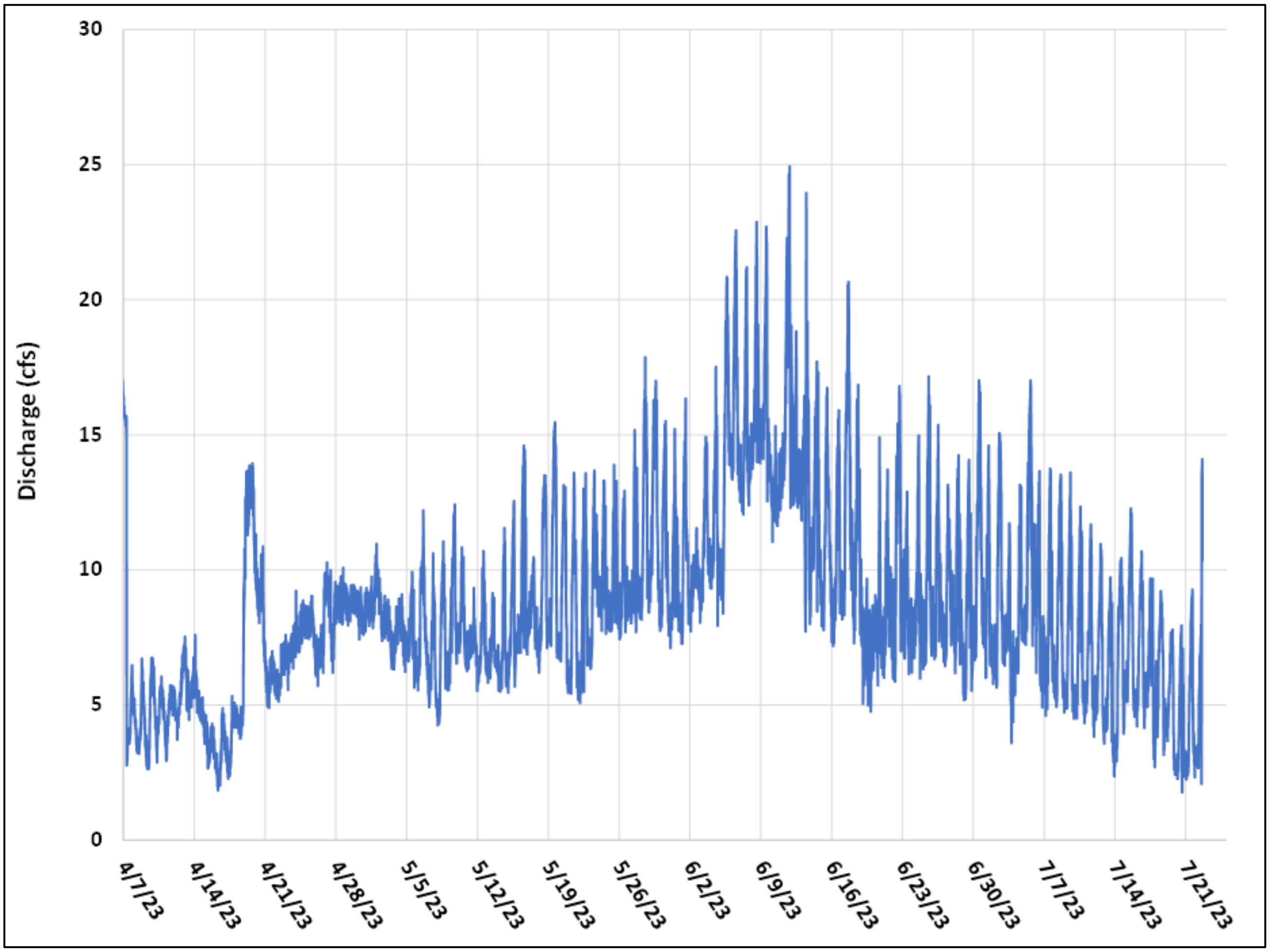


FIGURE 5-36. HYDROGRAPH FOR TEMPORARY GAGE ON SAGE CREEK



5.7 HYDROLOGIC MODELING

The issue of sediment contribution to the Shoshone River system is a prominent concern, prompting extensive efforts by multiple entities to devise effective mitigation strategies. We understand that, in support of these collective endeavors, the Sponsors are inclined to explore the feasibility of developing a comprehensive hydrologic watershed model. This model would serve to bolster future planning initiatives and assess the effectiveness of proposed projects aimed at reducing sediment delivery to the Shoshone River system.

Currently, within the Study Area, we are aware of modeling initiatives conducted in conjunction with the WWDC's river basin planning efforts. Specifically, the Wind/Bighorn River Basin Plan, completed in 2003 and updated in 2010 on behalf of the WWDC, employed a spreadsheet-based water budget approach to ascertain flows available for storage within specified reaches across the basin. The upper Shoshone River watershed and the Clarks Fork watershed were included within this effort. The spreadsheet model employs a 'checkbook' accounting methodology, tracking various factors such as reach inflows, outflows, crop consumptive use, irrigation return flows, and stream gauge data for the determination of water potentially available for storage projects. Due to its cumbersome nature in terms of modification and its inability to accommodate water quality considerations, it may not align with the Sponsors' objectives.

Additionally, within the context of TMDL efforts in the region, Hydrological Simulation Program - Fortran (HSPF) modeling was conducted. HSPF is a hydrologic simulation model developed to assess runoff processes related to sediment and soil contaminants. Although the model may be incomplete, it could provide a foundational point for future watershed modeling endeavors.

Nonetheless, the most comprehensive utility could be achieved through the development of a GIS-based model. Such a model could leverage the wealth of spatial data available for the Study Area, encompassing features such as soil mapping, basin delineation, vegetation, elevation, and more. By initiating modeling efforts within a subsection of the Study Area where data is available, the strategy and intricacies of modeling can be refined and expanded to other basin sections as additional data, time, and funding become available. The incorporation of hydrologic tools within the GIS framework would serve as the foundation for this model.

6.0 TASK 5: MANAGEMENT AND REHABILITATION PLAN

A principal objective of this Level I Study was to develop a watershed management and rehabilitation plan that is practical, feasible, and focused on beneficial watershed health improvements. This plan is intended to be used by the Sponsors to prioritize and implement improvements.

6.1 PRIMARY WATERSHED ISSUES AND CONCERNS

Important issues and concerns were identified through consultation with the Sponsors, landowners, stakeholders, and agencies. The initial consultations occurred at the Project scoping meetings and public workshops discussed in Section 2.0. The purpose of these meetings was to solicit feedback from the local community on water resource issues and concerns and discuss ideas for potential solutions. We also contacted approximately 64 (sixty-four) individuals, some of whom we met initially at the Project meetings. Site visits were conducted throughout the Study Area as requested by individual landowners to further assess the issues and discuss potential projects. The following is a list of known primary issues.

- Sediment accumulation at the Willwood Dam. Section 5.0 provides a narrative on the dam, historical problems, and the Willwood Working Groups and their ongoing efforts.
- Streambank erosion along the watershed's rivers and streams and the associated sediment contribution to the Shoshone River.
- Streambank erosion due to irrigation return flows.
- Sediment contribution to the Shoshone River from the McCullough Peaks.
- Production land being rendered non-productive due to saturation from irrigation return flows and subsurface seepage.
- Seepage losses along unlined irrigation ditches.
- Aging irrigation infrastructure.
- River and stream channel migration and the associated threats to production land and infrastructure.
- New subdivisions, groundwater depletion due to the number of new wells, and groundwater contamination due to the number of new septic systems.
- Reduced groundwater recharge due to conversion from flood to sprinkler irrigation.

- Wasteful irrigation within subdivisions.
- Fish passage and entrainment at irrigation diversions.

6.2 POTENTIAL PROJECT OPPORTUNITIES

Consultation and site visits with landowners and stakeholders resulted in the identification and development of 46 (forty-six) potential projects. The Wyoming Game and Fish Department (WGFD) and the Shoshone National Forest (SNF) provided information on areas of concern and Project recommendations as shown in Section 6.4, however, specific projects were not developed for this plan for reasons discussed in Section 6.4.

Potential projects were organized into the four general categories described below.

- **Environmental Enhancement Opportunities (ENV):** Projects within this category include streambank stabilization and fishery improvements. Benefits include water quality improvements through sediment reduction to the watershed's rivers and streams and increased fish production for wildlife food supply and recreation.
- **Fire Suppression Improvements (FS):** One project was identified to replace a local subdivision water storage tank and make it suitable to fill fire trucks for emergency response.
- **Irrigation System Improvements and Rehabilitation (IRR):** Projects within this category include irrigation structure replacement and rehabilitation, ditch to pipe conversions, spring improvements for irrigation supply, and irrigation storage facilities. Benefits include increased efficiency and water conservation.
- **Livestock/Wildlife Watering Opportunities (L/W):** Most of the potential projects identified fall into this category. Projects include spring developments and pipelines for livestock water, stock tank installation, well installation, and pond/reservoir construction and rehabilitation. Benefits include improved watershed, livestock, and wildlife health through increased watering opportunities.

Conceptual designs were prepared for the identified projects, and they are included in Appendix 6A.
Appendix 1A: Map 46 displays the location of each potential project.

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 Cody Conservation District (CCD) and Powell Clarks Fork Conservation District (PCFCD) have no

obligation to participate as Sponsors of the projects for potential funding. Decisions to sponsor a project will be made by the CCD board and the PCFCD board on a case-by-case basis.

6.2.1 ENVIRONMENTAL ENHANCEMENT OPPORTUNITIES (ENV)

Environmental components of the watershed management plan largely consist of streambank stabilization projects. Landowners identified select reaches with erosion issues to be addressed. Many of these sites have seen worsening erosion issues in recent years and landowners commonly cited flooding in June 2022 for causing most of the observable damage. Figure 6-1 illustrates significant erosion along North Fork Crandall Creek with fencing being lost.

FIGURE 6-1. STREAMBANK EROSION ON NORTH FORK CRANDALL CREEK (SEPTEMBER 2022)

Streambank stabilization concepts generally include bioengineered treatment, consisting of slope grading, geotextile placement, riprap installation, and vegetation planting. However, there are many other stabilization tools and methods available for consideration, as discussed in Section 6.2.1.1. The primary benefits of these specific streambank stabilization projects are to reduce sediment contribution and protect production land and existing infrastructure.

This Study has a limited scope and does not delve deeply into stream channel conditions. During meetings with landowners, we documented streambank areas with stability issues. As a result, we have identified only a few specific locations where streambank stabilization projects could be beneficial. Considering the vast Study Area, the complexity of the stream system, and the diverse range of land uses within it, it is likely that additional locations may require further investigation. Most local rivers and streams have streambank erosion issues due to naturally erosive soils.

The watershed management plan outlines specific projects to illustrate the types of local initiatives that can provide public benefits and improve watershed health. For a detailed list of the streambank stabilization projects identified in this Study, refer to Table 6-1. Detailed project descriptions, figures, and cost estimates can be found in Appendix 6A.

TABLE 6-1. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: ENVIRONMENTAL COMPONENTS

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
ENV-001	Koller-002	Ishawooa Creek Streambank Stabilization	Construct bioengineered treatment along 400 feet of streambank.
ENV-002	Nugent-001	Nugent Pond No. 1 Improvements	Install solar-powered aeration system to promote fishery.
ENV-003	Montgomery-002	North Fork Streambank Stabilization	Construct bioengineered treatment along 300 feet of streambank.
ENV-004	HMR-001	Crandall Creek Streambank Stabilization	Construct bioengineered treatment 900 feet of streambank.
ENV-005	Hoene-001	Clarks Fork Streambank Stabilization	Construct bioengineered treatment at two select locations and install interception ditch to prevent streambank saturation.
ENV-006	Jensen-001	Sediment Retention Structure	Install sheet pile grade control structures and construct riprap armor downstream of structures.
ENV-007	Morrison-004	Wildlife Pond	Excavate off-channel pond.
ENV-008	B4-002	Streambank Protection	Construct bioengineered treatment along 300 feet of streambank.
ENV-009	Mick-001	North Fork Streambank Stabilization	Construct bioengineered treatment along 200 feet of streambank.

6.2.1.1 CHANNEL AND STREAMBANK STABILIZATION STRATEGIES

While the streambank stabilization strategy identified for the various ENV projects of this Study focuses on bioengineered treatments, there are various approaches that can be taken during channel restoration and stabilization efforts.

One common strategy involves the construction of rock vortex weirs. Figure 6-2 shows a typical design, while Figure 6-3 shows a constructed weir on Sunlight Creek. Vortex weirs slow water velocities along the streambanks upstream of the weirs and direct the water away from the banks downstream of the weirs.

FIGURE 6-2. ROCK VORTEX WEIR STRUCTURE DIAGRAM (ADAPTED FROM ROSGEN, 2006)

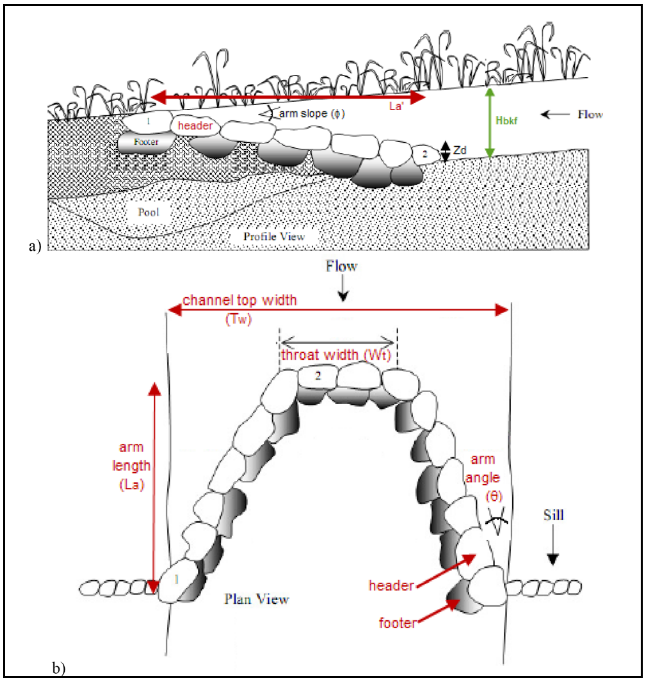


FIGURE 6-3. ROCK VORTEX WEIR ON SUNLIGHT CREEK (GOOGLE EARTH 2015)

There are many other strategies and methods available to address channel and streambank stabilization issues. Each specific stream and location will require a site-specific evaluation to determine the best method or combination of methods that will likely be the most successful. Table 6-2 lists various channel and streambank stabilization strategies and methods.

Monitoring of these projects is highly recommended. At a minimum, monitoring should include periodic visual inspection to determine the effectiveness and ability of the structure to withstand high flow events. Evidence of existing or induced erosion, movement of structure 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

TABLE 6-2. SUMMARY OF POTENTIAL CHANNEL AND STREAMBANK STABILIZATION STRATEGIES AND METHODS

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

For guidance on the appropriate strategy and method, consult a professional engineer and/or geomorphologist with expertise in stream restoration.

6.2.2 FIRE SUPPRESSION IMPROVEMENTS (FS)

The management and rehabilitation plan includes one fire suppression project, located in the Country Club Ranchette Subdivision, as shown in Table 6-3. Rural community fire suppression can be eligible for funding under the WWDC

SWPP. This project will have the direct benefit to prevent fire damage in the Project area. This project will be called the Sunset Lane Water Tank, owned by the Country Club Ranchette Lane Water Association, and will involve replacing an existing storage tank that needs frequent repairs. The new tank will have matching storage capacity and compatible fittings with equipment used by Park County Fire Department.

TABLE 6-3. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: FIRE SUPPRESSION COMPONENTS

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
FS-001	RLWA-001	Sunset Lane Water Tank	Remove and replace water tank and install fittings to fill fire trucks.

6.2.3 IRRIGATION SYSTEM IMPROVEMENTS AND REHABILITATION (IRR)

Through the Project outreach efforts, individual landowners and stakeholders came forward with requests for the Project team to assess existing irrigation infrastructure. Several types of projects were identified, including irrigation structure replacement and rehabilitation, irrigation storage, and ditch to pipe conversions. Many irrigation structures are aging and are no longer capable of efficiently controlling water. Figure 6-4 shows a check structure and turnout in need of replacement. In addition, unlined irrigation ditches experience seepage losses and contribute sediment to waterways through ditch bank erosion. These projects will improve watershed health and provide public benefits, including increased efficiency, water conservation, and improved water quality. Table 6-4 tabulates the specific irrigation projects included in the watershed management plan. Detailed project descriptions, figures, and cost estimates can be found in Appendix 6A.

FIGURE 6-4. AGING CHECK STRUCTURE ON NORTH BUCK CREEK

TABLE 6-4. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: IRRIGATION COMPONENTS

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
IRR-001	Morrison-002	Morrison Check Structure and Turnout Replacement	Remove and replace existing check structure and turnout.
IRR-002	Nugent-002	Nugent Pond No. 2 Reconstruction	Rehabilitate existing irrigation pond.
IRR-003	Nugent-003	Nugent Pond No. 3	Construct a new irrigation pond.
IRR-004	Nugent-004	Nugent Spring Improvement	Rehabilitate existing spring and supply water to irrigation ponds.
IRR-005	Montgomery-001	Ditch to Pipe	Convert open ditch to irrigation pipe.
IRR-006	Whitlock-001	Ditch to Pipe	Convert open ditch to irrigation pipe.
IRR-007	Vogt-001	Vogt Ditch Splitter	Remove and replace existing hydraulic control structure.
IRR-008	Neff-001	Neff Ditch Throwback	Rehabilitate existing hydraulic control structure.
IRR-009	Boot and Bottle-001	Boot and Bottle Irrigation	Improve irrigation for memorial area.
IRR-010	Harrison-001	Harrison Ditch to Pipe Project	Convert open ditch to irrigation pipe.
IRR-011	Harrison-002	Splitter box replacement	Install hydraulic control structure.
IRR-012	TCR-001	Trout Creek Lateral Diversion Replacement	Remove and replace existing hydraulic control structure.
IRR-013	TCR-002	Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.
IRR-014	TCR-003	Sediment trap replacement	Remove and replace existing concrete vault.
IRR-015	TCR-010	Trout Creek Lateral Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.

6.2.4 LIVESTOCK/WILDLIFE WATERING OPPORTUNITIES (L/W)

Most of the landowner consultations and site visits resulted in opportunities to improve and construct livestock and wildlife watering facilities. Potential projects include pond/reservoir construction and rehabilitation, well installation, spring development, stock tank installation, and pipeline construction. Table 6-5 lists the livestock/wildlife watering components of the watershed management plan. Detailed project descriptions, figures, and cost estimates can be found in Appendix 6A.

TABLE 6-5. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: LIVESTOCK/WILDLIFE WATERING COMPONENTS

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
L/W-001	Morrison-001	Morrison Pond	Construct excavated pond.
L/W-002	Morrison-003	Morrison Springs	Develop two springs and install pipelines to existing stock tanks.
L/W-003	Christofferson-001	Christofferson Pond	Construct excavated pond.
L/W-004	Koller-001	Koller Wildlife Water Source and Solar Well	Grade shallow watering area and install well with solar-powered pump.
L/W-005	Nichols-001	Nichols Pond Improvements	Rehabilitate existing pond.
L/W-006	Whitlock-002	Whitlock Stock Tank	Install 1,200-gallon rubber tire stock tank.
L/W-007	Vogt-002	Vogt Stock Reservoir	Construct dam and reservoir.
L/W-008	Broussard-001	Broussard Stock Tank	Install pipeline and 1,200-gallon rubber tire stock tank.
L/W-009	Arnote-001	Arnote Reservoir No. 1	Construct dam and reservoir
L/W-010	Arnote-002	Arnote Reservoir No. 2	Construct dam and reservoir.
L/W-011	Bales-001	Bales Stock Tank/Pipeline Project	Install infiltration gallery, vertical wet well with solar pump, pipeline, 5,000-gallon storage tank, and 1,200-gallon rubber tire stock tank.
L/W-012	B4-001	Well Construction	Install well with solar-powered pump.
L/W-013	TCR-004	Four Bear Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-014	TCR-005	Four Bear Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-015	TCR-006	Logan Mountain Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-016	TCR-007	Trout Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-017	TCR-008	Trout Creek Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-018	TCR-009	Murray Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-019	FOAL-001	FOAL Project Generic	Rehabilitate existing stock reservoir(s).
L/W-020	Roberts-001	Roberts Drainage System and Pond	Install underdrain and conveyance pipeline and construct excavated pond.
L/W-021	Corbett-001	Tippecanoe Reservoir Rehabilitation	Replace existing low-level outlet structure, sluice gate, gate stem, and operator wheel.

Providing reliable livestock and wildlife watering facilities can realize several benefits.

- Preservation of riparian corridors and streambanks through 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.

Figure 6-5 illustrates an existing wildlife pond in the Sunlight Basin that a landowner would like to improve.

FIGURE 6-5. WILDLIFE POND IN THE SUNLIGHT BASIN

6.3 CLARKS FORK/UPPER SHOSHONE WATERSHED MANAGEMENT AND REHABILITATION PLAN

The Clarks Fork/Upper Shoshone Watershed Management and Rehabilitation Plan (Plan) is focused on identifying and conceptually developing practical, cost-effective, and feasible Project opportunities that will address key issues in the watershed as discussed in Section 6.1. Identifying projects that will be eligible for WWDC SWPP funding is also of high importance. This Plan is intended to serve as a guidance document to the Sponsors regarding Project recommendations for improved watershed health.

As discussed in Section 6.2, Project opportunities were categorized into four general categories.

- Environmental Enhancement Opportunities (ENV)
- Fire Suppression Improvements (FS)
- Irrigation System Improvements and Rehabilitation (IRR)
- Livestock/Wildlife Watering Opportunities (L/W)

Table 6-6 summarizes the potential Project opportunities that were identified and developed for the Plan, while Appendix 6A includes detailed project descriptions, conceptual design figures, and conceptual cost estimates. Field photos are also included for select projects.

These projects will address several key issues in the watershed as discussed in Section 6.1. Furthermore, based on WWDC SWPP guidelines (https://wwdc.state.wy.us/small_water_projects/SmallWaterProjectsProgramGuidanceDocument.html), most projects and project components should be eligible for funding. However, it should be noted that the WWDC SWPP Manager will evaluate each project individually and make the final decision on eligibility at the time of application. It should also be noted that it will be the responsibility of the landowners working with the Sponsors to further develop these projects and apply for SWPP funding.

This Plan only includes projects that were identified during consultations and site visits with landowners and stakeholders that chose to be engaged in the Study. There are many additional landowners and stakeholders within the Study Area that may be aware of other significant issues and have ideas for project opportunities. Those landowners and stakeholders may reach out to the Sponsors at any time to pursue a project and apply for SWPP funding.

TABLE 6-6. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: ALL COMPONENTS

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
ENV-001	Koller-002	Ishawooa Creek Streambank Stabilization	Construct bioengineered treatment along 400 feet of streambank.
ENV-002	Nugent-001	Nugent Pond No. 1 Improvements	Install solar-powered aeration system to promote fishery.

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
ENV-003	Montgomery-002	North Fork Streambank Stabilization	Construct bioengineered treatment along 300 feet of streambank.
ENV-004	HMR-001	Crandall Creek Streambank Stabilization	Construct bioengineered treatment 900 feet of streambank.
ENV-005	Hoene-001	Clarks Fork Streambank Stabilization	Construct bioengineered treatment at two select locations and install interception ditch to prevent streambank saturation.
ENV-006	Jensen-001	Sediment Retention Structure	Install sheet pile grade control structures and construct riprap armor downstream of structures.
ENV-007	Morrison-004	Wildlife Pond	Excavate off-channel pond.
ENV-008	B4-002	Streambank Protection	Construct bioengineered treatment along 300 feet of streambank.
ENV-009	Mick-001	North Fork Streambank Stabilization	Construct bioengineered treatment along 200 feet of streambank.
FS-001	RLWA-001	Sunset Lane Water Tank	Remove and replace water tank and install fittings to fill fire trucks.
IRR-001	Morrison-002	Morrison Check Structure and Turnout Replacement	Remove and replace existing check structure and turnout.
IRR-002	Nugent-002	Nugent Pond No. 2 Reconstruction	Rehabilitate existing irrigation pond.
IRR-003	Nugent-003	Nugent Pond No. 3	Construct a new irrigation pond.
IRR-004	Nugent-004	Nugent Spring Improvement	Rehabilitate existing spring and supply water to irrigation ponds.
IRR-005	Montgomery-001	Ditch to Pipe	Convert open ditch to irrigation pipe.
IRR-006	Whitlock-001	Ditch to Pipe	Convert open ditch to irrigation pipe.
IRR-007	Vogt-001	Vogt Ditch Splitter	Remove and replace existing hydraulic control structure.
IRR-008	Neff-001	Neff Ditch Throwback	Rehabilitate existing hydraulic control structure.
IRR-009	Boot and Bottle-001	Boot and Bottle Irrigation	Improve irrigation for memorial area.
IRR-010	Harrison-001	Harrison Ditch to Pipe Project	Convert open ditch to irrigation pipe.
IRR-011	Harrison-002	Splitter box replacement	Install hydraulic control structure.
IRR-012	TCR-001	Trout Creek Lateral Diversion Replacement	Remove and replace existing hydraulic control structure.
IRR-013	TCR-002	Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.
IRR-014	TCR-003	Sediment trap replacement	Remove and replace existing concrete vault.

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION
IRR-015	TCR-010	Trout Creek Lateral Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.
L/W-001	Morrison-001	Morrison Pond	Construct excavated pond.
L/W-002	Morrison-003	Morrison Springs	Develop two springs and install pipelines to existing stock tanks.
L/W-003	Christofferson-001	Christofferson Pond	Construct excavated pond.
L/W-004	Koller-001	Koller Wildlife Water Source and Solar Well	Grade shallow watering area and install well with solar-powered pump.
L/W-005	Nichols-001	Nichols Pond Improvements	Rehabilitate existing pond.
L/W-006	Whitlock-002	Whitlock Stock Tank	Install 1,200-gallon rubber tire stock tank.
L/W-007	Vogt-002	Vogt Stock Reservoir	Construct dam and reservoir.
L/W-008	Broussard-001	Broussard Stock Tank	Install pipeline and 1,200-gallon rubber tire stock tank.
L/W-009	Arnote-001	Arnote Reservoir No. 1	Construct dam and reservoir
L/W-010	Arnote-002	Arnote Reservoir No. 2	Construct dam and reservoir.
L/W-011	Bales-001	Bales Stock Tank/Pipeline Project	Install infiltration gallery, vertical wet well with solar pump, pipeline, 5,000-gallon storage tank, and 1,200-gallon rubber tire stock tank.
L/W-012	B4-001	Well Construction	Install well with solar-powered pump.
L/W-013	TCR-004	Four Bear Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-014	TCR-005	Four Bear Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-015	TCR-006	Logan Mountain Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-016	TCR-007	Trout Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-017	TCR-008	Trout Creek Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-018	TCR-009	Murray Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.
L/W-019	FOAL-001	FOAL Project Generic	Rehabilitate existing stock reservoir(s).
L/W-020	Roberts-001	Roberts Drainage System and Pond	Install underdrain and conveyance pipeline and construct excavated pond.
L/W-021	Corbett-001	Tippecanoe Reservoir Rehabilitation	Replace existing low-level outlet structure, sluice gate, gate stem, and operator wheel.

6.3.1 PROJECT DEVELOPMENT CONSIDERATIONS

It must be emphasized that the Project information presented in this Plan is conceptual only, including the project descriptions, figures, and cost estimates in Appendix 6A. The potential projects have been developed solely based on discussions with landowners/stakeholders, field observations, and engineering assumptions. Each project will require further evaluation and design prior to applying for SWPP funding. Engaging competent and qualified professionals for project design is highly recommended, as engineer-stamped designs will be required for SWPP funding. Furthermore, potential permitting listed in the project descriptions (Appendix 6A) may or may not be fully inclusive. Project owners will be responsible for identifying and obtaining all necessary permits required for project construction.

The following list provides a summary of key items that should be considered or performed when developing projects identified in the Plan.

- Permitting for streambank stabilization projects will likely be intensive, as a Section 404 Permit from the U.S. Army Corps of Engineers (USACE) and a Park County Floodplain Development Permit will be required.
- Streambank stabilization and stream restoration projects should involve a competent and highly qualified professional engineer, hydrologist, and/or geomorphologist to ensure the proper strategy/method is implemented.
- Subsurface investigations should be performed for proposed ponds/reservoirs to determine the ability of the facility to hold water or whether a liner will be required to prevent seepage losses.
- Soil testing and evaluation is highly recommended for onsite materials proposed for earthen dam construction to ensure suitability against seepage.
- Subsurface investigations will be required for proposed wells to determine proper depth.
- Water supply evaluations are highly recommended for proposed spring developments and ponds/reservoirs to ensure adequate water supply and optimal pond/reservoir size.
- Water quality testing is recommended for proposed spring developments.
- Irrigation and stock supply pipelines and irrigation structures will need to be designed and adequately sized through hydraulic analysis.
- Stock tanks will need to be adequately sized for the number of livestock.
- Permitting through the Wyoming State Engineer's Office (WSEO) will be required for new ponds/reservoirs, pond/reservoir enlargements and modifications, new wells/spring developments, and well/spring modifications. Furthermore, Wyoming Safety of Dams approval will be required for any jurisdictional dams.

6.3.2 PROJECT EVALUATION MATRIX

In an effort to help the Sponsors and the WWDC prioritize projects for completion or funding, a summary matrix was prepared. The matrix consists of a tabulation of the individual projects of the Plan and various attributes for each. Table 6-7 provides a summary of the project evaluation attributes, and Table 6-8 presents the project evaluation matrix.

TABLE 6-7. PROJECT EVALUATION ATTRIBUTES

ATTRIBUTE	PROJECT EVALUATION CATEGORIES		
	LESS PREFERABLE	→	MORE PREFERABLE
WWDC Priority[1, 2]	LOW: WWDC Priority 5 or 6	MEDIUM: WWDC Priority 3 or 4	HIGH: WWDC Priority 1, 2, or "Shovel Ready"
Land Ownership	Includes Federal	Mixed	Private Only
Practicability	Challenging Effort	Moderate Effort	Routine Effort
Ease of Permitting	Federal Permits/NEPA	Local or State permits	Permits approved or none required

Notes:

[1] Per the SWPP Operating Criteria (2021), new development projects (Account I) are prioritized as follows:

1 - Source Water Development
2 - Storage
3 - Pipelines, Conveyance Facilities, Solar Platforms, and Windmills
4 - Irrigation
5 - Environmental
6 - Recreational

[2] Per the SWPP Operating Criteria (2021), rehabilitation projects (Account II) are prioritized as follows:

1 - Diversion Structures and Spring Developments
2 - Storage
3 - Pipelines, Conveyance Facilities, Solar Platforms, and Windmills
4 - Irrigation (other than the above)
5 - Environmental
6 - Recreational

TABLE 6-8. CLARKS FORK/UPPER SHOSHONE WATERSHED PLAN: PROJECT EVALUATION MATRIX

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
ENV-001	Koller-002	Ishawooa Creek Streambank Stabilization	Construct bioengineered treatment along 400 feet of streambank.	Yes	New	Low	Includes Federal	Challenging	Federal/NEPA	$59,702.50
ENV-002	Nugent-001	Nugent Pond No. 1 Improvements	Install solar-powered aeration system to promote fishery.	No	Rehab	Low	Private Only	Routine	Approved/Exempt	$14,175.00
ENV-003	Montgomery-002	North Fork Streambank Stabilization	Construct bioengineered treatment along 300 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$112,970.00
ENV-004	HMR-001	Crandall Creek Streambank Stabilization	Construct bioengineered treatment 900 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$321,860.00
ENV-005	Hoene-001	Clarks Fork Streambank Stabilization	Construct bioengineered treatment at two select locations and install interception ditch to prevent streambank saturation.	Yes	New	Low	Private Only	Moderate	Federal/NEPA	$ 54,857.00
ENV-006	Jensen-001	Sediment Retention Structure	Install sheet pile grade control structures and construct riprap armor downstream of structures.	Yes	New	Low	Private Only	Moderate	Approved/Exempt	$28,201.25
ENV-007	Morrison-004	Wildlife Pond	Excavate off-channel pond.	Yes	New	High	Private Only	Moderate	Approved/Exempt	$133,045.00
ENV-008	B4-002	Streambank Protection	Construct bioengineered treatment along 300 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$112,970.00
ENV-009	Mick-001	North Fork Streambank Stabilization	Construct bioengineered treatment along 200 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$38,046.25
FS-001	RLWA-001	Sunset Lane Water Tank	Remove and replace water tank and install fittings to fill fire trucks.	Yes	Rehab	High	Private Only	Moderate	Local/State	$ 96,250.00
IRR-001	Morrison-002	Morrison Check Structure and Turnout Replacement	Remove and replace existing check structure and turnout.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$13,341.63
IRR-002	Nugent-002	Nugent Pond No. 2 Reconstruction	Rehabilitate existing irrigation pond.	Yes	Rehab	High	Private Only	Moderate	Local/State	$92,592.50

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
IRR-003	Nugent-003	Nugent Pond No. 3	Construct a new irrigation pond.	Yes	New	High	Private Only	Moderate	Local/State	$123,282.50
IRR-004	Nugent-004	Nugent Spring Improvement	Rehabilitate existing spring and supply water to irrigation ponds.	Yes	New and Rehab	High	Private Only	Moderate	Local/State	$9,242.75
IRR-005	Montgomery-001	Ditch to Pipe	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$175,312.50
IRR-006	Whitlock-001	Ditch to Pipe	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$276,065.63
IRR-007	Vogt-001	Vogt Ditch Splitter	Remove and replace existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$15,860.63
IRR-008	Neff-001	Neff Ditch Throwback	Rehabilitate existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$11,412.50
IRR-009	Boot and Bottle-001	Boot and Bottle Irrigation	Improve irrigation for memorial area.	Yes	New	Medium	Private Only	Moderate	Local/State	$9,900.00
IRR-010	Harrison-001	Harrison Ditch to Pipe Project	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$86,350.00
IRR-011	Harrison-002	Splitter box replacement	Install hydraulic control structure.	Yes	New	Medium	Private Only	Moderate	Approved/Exempt	$21,085.63
IRR-012	TCR-001	Trout Creek Lateral Diversion Replacement	Remove and replace existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Moderate	Approved/Exempt	$27,410.63
IRR-013	TCR-002	Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$74,023.13
IRR-014	TCR-003	Sediment trap replacement	Remove and replace existing concrete vault.	Yes	Rehab	Medium	Private Only	Moderate	Approved/Exempt	$137,500.00
IRR-015	TCR-010	Trout Creek Lateral Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$294,456.25
L/W-001	Morrison-001	Morrison Pond	Construct excavated pond.	Yes	New	High	Private Only	Moderate	Local/State	$232,595.00
L/W-002	Morrison-003	Morrison Springs	Develop two springs and install pipelines to existing stock tanks.	Yes	New	High	Private Only	Moderate	Local/State	$21,785.50
L/W-003	Christofferson-001	Christofferson Pond	Construct excavated pond.	Yes	New	High	Private Only	Moderate	Local/State	$664,262.50
L/W-004	Koller-001	Koller Wildlife Water Source and Solar Well	Grade shallow watering area and install well with solar-powered pump.	Yes	New	High	Private Only	Moderate	Local/State	$81,262.50

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
L/W-005	Nichols-001	Nichols Pond Improvements	Rehabilitate existing pond.	Yes	Rehab	High	Private Only	Moderate	Local/State	$66,000.00
L/W-006	Whitlock-002	Whitlock Stock Tank	Install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Routine	Approved/Exempt	$ 5,527.50
L/W-007	Vogt-002	Vogt Stock Reservoir	Construct dam and reservoir.	Yes	New	High	Private Only	Moderate	Local/State	$70,785.00
L/W-008	Broussard-001	Broussard Stock Tank	Install pipeline and 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Approved/Exempt	$26,626.88
L/W-009	Arnote-001	Arnote Reservoir No. 1	Construct dam and reservoir	Yes	New	High	Private Only	Moderate	Local/State	$21,972.50
L/W-010	Arnote-002	Arnote Reservoir No. 2	Construct dam and reservoir.	Yes	New	High	Private Only	Moderate	Local/State	$21,972.50
L/W-011	Bales-001	Bales Stock Tank/Pipeline Project	Install infiltration gallery, vertical wet well with solar pump, pipeline, 5,000-gallon storage tank, and 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Challenging	Federal/NEPA	$63,314.63
L/W-012	B4-001	Well Construction	Install well with solar-powered pump.	Yes	New	High	Private Only	Challenging	Local/State	$27,362.50
L/W-013	TCR-004	Four Bear Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$14,770.25
L/W-014	TCR-005	Four Bear Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Includes Federal	Moderate	Federal/NEPA	$14,770.25
L/W-015	TCR-006	Logan Mountain Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$14,770.25
L/W-016	TCR-007	Trout Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Includes Federal	Moderate	Federal/NEPA	$14,770.25
L/W-017	TCR-008	Trout Creek Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$14,770.25
L/W-018	TCR-009	Murray Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$14,770.25

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
L/W-019	FOAL-001	FOAL Project Generic	Rehabilitate existing stock reservoir(s).	Yes	Rehab	High	Includes Federal	Moderate	Federal/NEPA	$21,972.50
L/W-020	Roberts-001	Roberts Drainage System and Pond	Install underdrain and conveyance pipeline and construct excavated pond.	Yes	New	High	Private Only	Challenging	Local/State	$261,497.50
L/W-021	Corbett-001	Tippecanoe Reservoir Rehabilitation	Replace existing low-level outlet structure, sluice gate, gate stem, and operator wheel.	Yes	Rehab	High	Private Only	Moderate	Local/State	$23,100.00

6.4 FEDERAL AND STATE AGENCY PROJECT RECOMMENDATIONS

During this Study, Trihydro consulted with the Wyoming Game and Fish Department (WGFD), Shoshone National Forest (SNF), and Natural Resources Conservation Service (NRCS) for recommendations on potential watershed improvement projects. Multiple attempts were made to contact and consult with the Bureau of Land Management (BLM), but the attempts were unsuccessful.

6.4.1 WGFD PROJECT RECOMMENDATIONS

Laura Burckhardt, WGFD Aquatic Habitat Biologist, provided an extensive list of areas of concern and Project recommendations as shown in Table 6-9. Considerable field investigation and evaluation will be required to develop specific projects, scopes of work, and cost estimates, which was outside of the scope and budget for this Study. Nevertheless, WGFD can further develop specific projects and work with the Sponsors to pursue SWPP funding.

TABLE 6-9. WGFD PROJECT RECOMMENDATIONS

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
Clarks Fork	Clarks Fork	Entrainment evaluation in diversions	No	Yes	No
Clarks Fork	Luce Reservoir	Screening outlet structure	Yes	Yes	No
Clarks Fork	Big Sand Coulee	Riparian improvement for beaver reintroduction on BLM land. Area needs to be fenced off.	Yes		
Clarks Fork	Multiple	Please download the Yellowstone Cutthroat Trout Assessment GIS data: https://fwp.mt.gov/gis/maps/yctAssessment/. Within this file, any creek that shows up within "YCT_HIST_DIST_2016" is a fish bearing stream where passage at irrigation diversions, irrigation efficiency improvements, and water quality improvements are desired (unless otherwise noted in this list). Screening may be desired on all diversions. Creeks where there are permitted water rights include: Big Sand Coulee, Line Creek, Bennett, Little Sand Coulee, Pat O'Hara Creek, Paint Creek, Newmeyer Creek, Elk Creek, Sunlight Creek, Russell Creek, Crandall Creek & tributaries.		Yes	Yes
Clarks Fork	Paint Creek	Provide passage and install screens (optional) at all diversions.	Yes	Yes	
Clarks Fork	Clarks Fork	Install screens at diversions.			
Shoshone	Sulphur Creek	Work with Lakeview Irrigation District & Cody Canal to: 1) Evaluate opportunities to end irrigation return flows and wasting/ dumping into Sulphur Creek; 2) Pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion (irrigation infrastructure not under responsibility of Lakeview & Cody Canal); 3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction; and 4) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.	Yes	Yes	No
Shoshone	Sulphur Creek	Pipe laterals and canal system to improve efficiency and reduce erosion (see Master Plan documents for Lakeview and Cody Canal).		Yes	No

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
Shoshone	Sulphur Creek	Implement road crossing improvement projects to reduce bank erosion.	Yes	Yes	No
Shoshone	Sulphur Creek	Implement road improvement projects to reduce rill and gully erosion on roads	Yes	No	No
Shoshone	Sulphur Creek	Amend regulations for reservoir or in-canal storage on Cody Canal system to reduce sediment and erosion in Diamond Creek, Sulphur Creek, Sage Creek, and Dry Creek.	Yes	Yes	No
Shoshone	Sage Creek	Provide passage and consider screening opportunities at in-channel irrigation diversions.	Yes	Yes	No
Shoshone	Sage Creek (and tributaries)	Work with Cody Canal and private landowners to: 1) Evaluate opportunities to end irrigation return flows and wasting/dumping into Sage Creek; 2) Pipe lateral canals within subdivisions (irrigation infrastructure not under responsibility of Cody Canal); and 3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction.	No	Yes	No
Shoshone	Spring Creek	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion. 2) Provide passage at in-channel irrigation diversions and ponds. 3) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.	No	Yes	No

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
Shoshone	Cottonwood Creek (and tributaries)	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion. 2) Provide passage at in-channel irrigation diversions and ponds. 3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction. 4) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.	No	Yes	No
Shoshone	Cottonwood Creek (and tributaries)	Pipe laterals and canal system to improve efficiency and reduce erosion (see Master Plan documents for Heart Mountain Canal).	No	Yes	No
Shoshone	Idaho Creek (and tributaries)	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion. 2) Provide passage at in-channel irrigation diversions and ponds. 3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction. 4) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.	No	Yes	No
Shoshone	Idaho Creek (and tributaries)	Pipe laterals and canal system to improve efficiency and reduce erosion (see Master Plan documents for Heart Mountain Canal).	No	Yes	No
Shoshone	Dry Gulch	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion. 2) Pipe laterals and canal system to improve efficiency and reduce erosion (see Master Plan documents for Heart Mountain Canal). 3) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.	No	Yes	No

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
Shoshone	Dry Creek	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No
		2) Pipe laterals and canal system to improve efficiency and reduce erosion (see Master Plan documents for Cody Canal).			
		3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction.			
		4) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.			
Shoshone	Mainstem Shoshone	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No
		2) Pipe laterals and canal system to improve efficiency and reduce erosion (Heart Mountain, Cody, Lakeview, Shoshone, and Garland Canal Systems).			
Shoshone	Good draw	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No
		2) Pipe laterals and canal system to improve efficiency and reduce erosion (Heart Mountain Canal Systems).			
Shoshone	Iron Creek (and tributaries)	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No
		2) Pipe laterals and canal system to improve efficiency and reduce erosion (Heart Mountain Canal Systems).			
		3) Investigate opportunities to reduce sediment deposition and dumping from the settling pond at the end of the Corbett Tunnel and flowing into Garland Canal.			
Shoshone	Buck Creek	Provide passage at Garland Canal crossing of Buck Creek.	No	Yes	No
Shoshone	Eaglenest Creek	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
		2) Pipe laterals and canal system to improve efficiency and reduce erosion (Heart Mountain Canal Systems).			
		3) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.			
		4) Provide passage at in-channel irrigation diversions and ponds.			
Shoshone	Alkali Creek	1) Work with private landowners to pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion.	No	Yes	No
		2) Pipe laterals and canal system to improve efficiency and reduce erosion.			
		3) Investigate opportunities to reduce sediment deposition and dumping from the settling pond at the end of the Corbett Tunnel and flowing into Garland Canal.			
South Fork Shoshone	Diamond Creek	Work with Lakeview Irrigation District & Cody Canal to:	No	Yes	No
		1) Evaluate opportunities to end irrigation return flows and wasting/dumping into Diamond Creek;			
		2) Pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting and bank erosion (Irrigation infrastructure not under responsibility of Lakeview & Cody Canal);			
		3) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction;			
		4) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality; and			
		5) Investigate opportunities to dredge sediment out of existing wetlands and the South Fork Dike Pond.			
South Fork Shoshone	Irrigated lands between Carter Creek and Diamond Creek	1) Pipe lateral canals within subdivisions to improve irrigation efficiency and reduce water wasting from Lakeview Canal system.	No	Yes	No
		2) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction.			
		3) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.			

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
South Fork Shoshone	Marquette Creek	1) The most downstream irrigation diversion (44.42303, -109.22711) is a fish barrier and WGFD wants it to remain as a barrier and/or replaced as a permanent barrier. Passage is desired at all upstream diversions. Screening opportunities should also be considered.		Yes	Yes
		2) Investigate irrigation rehabilitation projects to improve water quality through sediment reduction.			
		3) Investigate wetland development and stream habitat improvement opportunities to reduce sediment and improve water quality.			
South Fork Shoshone	Belknap Creek	Investigate feasibility of rehabilitation at Belknap Lake.	No	Yes	Yes
South Fork Shoshone	South Fork Shoshone	Prevent fish entrainment at Lakeview Ditch, Wilson-McKissack Ditch, Neff Ditch, Castle Rock Ditch, Brown Ditch, Nelson Ditch, Cody Canal, and other mainstem ditches.			
South Fork Shoshone	Multiple	Please download the Yellowstone Cutthroat Trout Assessment GIS data: https://fwp.mt.gov/gis/maps/yctAssessment/. Within this file, any creek that shows up within "YCT_HIST_DIST_2016" is a fish bearing stream where passage at irrigation diversions, irrigation efficiency improvements, and water quality improvements are desired (unless otherwise noted in this list). Screening may be desired on all diversions.			
		These creeks, not otherwise listed, include Carter Creek, Sheep Creek, Bear Creek, Bull Creek, Belknap, Hardpan Creek, Bobcat Creek, Ishawooa Creek, Boulder Creek, Legg Creek, Deer Creek, Cabin Creek, Twin Creek, Aldrich Creek, and Fall Creek.			
North Fork Shoshone	Trout Creek	Prevent fish entrainment in irrigation and private pond diversions. There is an unpermitted pond that is entraining fish and sweeping all of Trout Creek.	No	Yes	No

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
North Fork Shoshone	Multiple	Please download the Yellowstone Cutthroat Trout Assessment GIS data: https://fwp.mt.gov/gis/maps/yctAssessment/. Within this file, any creek that shows up within "YCT_HIST_DIST_2016" is a fish bearing stream where passage at irrigation diversion and irrigation efficiency improvements, and water quality improvement is desired (unless otherwise noted in this list). Screening may be desired on all diversions. Creeks where there are permitted water rights include: Jim Creek, Whit Creek, Green Creek, Big Creek, Canyon Creek, Nameit Creek, Pagoda Creek, Elk Fork Creek, Blackwater Creek, Gunbarrel Creek, and Grinell Creek.		Yes	Yes
South Fork Shoshone	Rock Creek	Dewatered by irrigation. Potential unpermitted transfer to Belknap Creek.			
South Fork Shoshone	Aldrich Creek	Dewatered by irrigation.			
South Fork Shoshone	Deer Creek	Dewatered by irrigation.			
South Fork Shoshone	Cabin Creek	Dewatered by irrigation.			
South Fork Shoshone	Ishawooa Creek	Dewatered by irrigation.			
South Fork Shoshone	Bull Creek	Dewatered by irrigation.			
Clarks Fork	Bennett Creek	Dewatered by irrigation, channel instability and riparian degradation.			
Clarks Fork	Line Creek	Dewatered by irrigation, channel instability and riparian degradation.			

STREAM	TRIBUTARY	PROJECT DESCRIPTION	BLM LAND?	PRIVATE LAND?	USFS LAND?
North Fork Shoshone	Jim Creek	Dewatered by irrigation.			
North Fork Shoshone	Canyon Creek	Dewatered by irrigation.			
North Fork Shoshone	Green Creek	Dewatered by irrigation.			
South Fork Shoshone	Diamond Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Sulphur Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Cottonwood Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Idaho Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Dry Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Sage Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Penny Gulch	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Iron Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Buck Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Eaglenest Creek	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			
Shoshone	Mainstem Shoshone	Channel instability due to irrigation wastewater return flows from Irrigation Districts.			

6.4.2 SNF PROJECT RECOMMENDATIONS

Amelia Rothleutner, SNF Hydrologist, provided a list of areas of concern and Project recommendations as shown in Table 6-10. Considerable field investigation and evaluation will be required to develop specific projects, scopes of work, and cost estimates, which was outside of the scope and budget for this Study. Nevertheless, SNF can further develop specific projects and work with the Sponsors to pursue SWPP funding.

TABLE 6-10. SNF PROJECT RECOMMENDATIONS

PROJECT NAME	SOURCE WATER	GENERAL LOCATION	LATITUDE	LONGITUDE	PROJECT DESCRIPTION	CONCERNS
Wapiti Stream Restoration, Habitat and Pasture Improvement Project	North Fork Shoshone River	Lower North Fork Shoshone River	44°27'52.09"N	109°36'49.23"W	Stabilize the North Fork Shoshone River to improve aquatic and riparian habitat while providing protection of U.S. Highway 14/16/20 and the historic Wapiti Ranger Station. Current irrigation ditch for Ranger Station will be piped and switched to wheel-line irrigation to improve efficiency.	Sediment source, habitat, public safety, flood risk
Sweetwater Creek Bank Stabilization	Sweetwater Creek, trib. North Fork Shoshone River	Lower North Fork Shoshone River	44°28'8.40"N	109°37'41.38"W	Repair stream bank adjacent to Sweetwater Road which is currently closed under special order for public safety.	Sediment source, habitat, public safety
Pahaska Levee Repair	North Fork Shoshone River	Upper North Fork Shoshone River	44°30'18.26"N	109°57'47.82"W	Levee washed out and damaged during 2022 flood event and will be repaired.	Protection for sewer lagoon, sediment source
Kitty Creek	Kitty Creek, trib. North Fork Shoshone River	Middle North Fork Shoshone River	44°27'26.70"N	109°51'29.84"W	August 2022 debris flow deposited a large amount of sediment at confluence with North Fork.	Sediment source, safety, flood protection

PROJECT NAME	SOURCE WATER	GENERAL LOCATION	LATITUDE	LONGITUDE	PROJECT DESCRIPTION	CONCERNS
South Fork Bank Stabilization	South Fork Shoshone River	Middle South Fork Shoshone River	44°9'15.59"N	109°36'15.61"W	Continue large wood stream restoration work started in 2011.	Sediment source, infrastructure protection, habitat improvement
Silver Creek Debris Flow	Silver Creek, trib. South Fork Shoshone River	Middle South Fork Shoshone River	44°1'27.30"N	109°40'8.24"W	Debris flow is currently impounding water.	Sediment source, public safety
Pilot Creek Alluvial Fan Restoration	Pilot Creek, trib. Clarks Fork River	Pilot Creek-Clarks Fork Yellowstone River	44°57'15.81"N	109°48'34.35"W	Stream avulsed during 2022 flood event and caused ponding and deposition at Pilot parking area.	Sediment source, infrastructure protection
East Fork Painter Gulch	East Fork Painter Gulch, trib. Painter Gulch, trib. Sunlight Creek, trib. Clarks Fork River	Sunlight Creek	44°46'20.68"N	109°33'21.92"W	Stream avulsed during June 2022 flood event and is now disconnected from floodplain and is running down road.	Sediment source, infrastructure protection, flood risk, habitat
Forest Stockwater Inventory	Multiple	North Zone Shoshone National Forest	N/A	N/A	Continue clean up of all stock water rights on the Forest. There are discrepancies between USFS, SEO and water rights adjudication in the Big Horn Adjudication. Add wildlife escape ramps to new and existing infrastructure.	Ensure all water rights are accurately documented.

PROJECT NAME	SOURCE WATER	GENERAL LOCATION	LATITUDE	LONGITUDE	PROJECT DESCRIPTION	CONCERNS
Harmful cyanobacterial bloom (HCB), stream condition, habitat and riparian/wetland monitoring	Multiple	North Zone Shoshone National Forest	N/A	N/A	In need of increased monitoring of water quality issues such as HCBs, stream condition, habitat and riparian/wetland monitoring. HCBs have been documented in high elevation areas of the Shoshone National Forest.	Public health, water quality
Reducing road based sediment sources	Multiple	Shoshone National Forest	N/A	N/A	Roads and trails are a significant source of sediment to waterways. Need to identify priority areas for improvement.	Water quality, sediment source

6.4.3 NRCS PROJECT RECOMMENDATIONS

Many landowners and farmers in the Study area have changed their irrigation methods from flood to sprinkler, with funding assistance from the NRCS; others would like to pursue that change. During our site visits, select landowners mentioned wanting to install center pivots. We explained that most center pivot system components are considered on-farm improvements by the WWDC, which are not eligible for SWPP funding. However, select components may be eligible for SWPP funding, such as a diversion and headgate. Landowners wishing to pursue SWPP funding for center pivot system components should contact the WWDC SWPP Manager, Jodie Pavlica.

Trihydro consulted with Rory Karhu, NRCS District Conservationist, to discuss irrigation conversion projects. According to Rory, there are dozens of projects in the works with private landowners to convert flood irrigation to sprinkler irrigation. The NRCS Environmental Quality Incentives Program (EQIP) is a major funding source to agricultural producers for sprinkler irrigation projects. Landowners should contact Rory Karhu, or the local NRCS office, for more information.

7.0 TASK 6: COST ESTIMATES

Conceptual-level cost estimates have been prepared for each project included in the proposed Management and Rehabilitation Plan, as described in Chapter 6. Several informational sources were consulted to obtain the most current material and labor costs for the various project items. Sources of cost information include:

- NRCS Wyoming Practice Scenarios – Fiscal Year 2023
- Wyoming Department of Transportation (WYDOT) 2022 Weighted Average Bid Prices
- Local suppliers and online sources
- Previous bids for similar work
- Engineering judgement and assumptions based on previous experience

Unit and lump sum costs include materials and labor. Mobilization is included for each project at 10% of the total of all other bid items, which is a standard percentage for many construction projects. Of course, mobilization costs will vary depending on the contractor, project size, complexity, and location. Contingencies are included at 15% of the project subtotal (construction subtotal), which may be low for conceptual-level cost estimates for select projects. It is standard practice to include contingencies as a reserve to protect against a cost overrun due to known and unknown risks and project changes during construction. Costs associated with engineering and technical assistance are also included for each project at 10% of the project subtotal (construction subtotal). This is to account for final design, construction engineering, and permitting costs. Actual costs associated with engineering and technical assistance will be project specific. For example, 10% may be high for larger, more expensive projects and low for smaller, less expensive projects.

Project components that may not be eligible for WWDC Small Water Projects Program (SWPP) funding are identified in the cost estimates. The components identified are based on feedback from the SWPP Manager, Jodie Pavlica. There may be projects and other components that are not eligible as well. Each project will be evaluated individually for eligibility by the SWPP Manager when the SWPP application is submitted to the WWDO by the Sponsors.

Project locations, items, and quantities were estimated based on input from the landowners, estimated dimensions, and engineering experience and judgement. Proposed pipe diameters were either provided by the landowner or selected based on engineering judgement. Proposed pond/reservoir sizes were also provided by the landowners. Irrigation structure sizes were based on the existing structures or the estimated dimensions of the irrigation facilities in which the structures will be installed.

Table 7-1 presents a summary of estimated costs for each project. Itemized cost estimates for each project are included in Appendix 6A.

TABLE 7-1. PROJECT COST ESTIMATE SUMMARY

Project ID	Sponsor Reference	Project Subtotal	Contingencies (15% of subtotal)	Engineering and Technical Assistance (10% of subtotal)	Total Estimated Cost
ENV-001	Koller-002	$47,762.00	$7,164.30	$4,776.20	$59,702.50
ENV-002	Nugent-001	$11,550.00	$1,575.00	$1,050.00	$14,175.00
ENV-003	Montgomery-002	$90,376.00	$13,556.40	$9,037.60	$112,970.00
ENV-004	HMR-001	$257,488.00	$38,623.20	$25,748.80	$321,860.00
ENV-005	Hoene-001	$43,885.60	$6,582.84	$4,388.56	$54,857.00
ENV-006	Jensen-001	$22,561.00	$3,384.15	$2,256.10	$28,201.25
ENV-007	Morrison-004	$106,436.00	$15,965.40	$10,643.60	$133,045.00
ENV-008	B4-002	$90,376.00	$13,556.40	$9,037.60	$112,970.00
ENV-009	Mick-001	$30,437.00	$4,565.55	$3,043.70	$38,046.25
FS-001	RLWA-001	$77,000.00	$11,550.00	$7,700.00	$96,250.00
IRR-001	Morrison-002	$10,673.30	$1,601.00	$1,067.33	$13,341.63
IRR-002	Nugent-002	$74,074.00	$11,111.10	$7,407.40	$92,592.50
IRR-003	Nugent-003	$98,626.00	$14,793.90	$9,862.60	$123,282.50
IRR-004	Nugent-004	$7,394.20	$1,109.13	$739.42	$9,242.75
IRR-005	Montgomery-001	$140,250.00	$21,037.50	$14,025.00	$175,312.50
IRR-006	Whitlock-001	$220,852.50	$33,127.88	$22,085.25	$276,065.63
IRR-007	Vogt-001	$12,688.50	$1,903.28	$1,268.85	$15,860.63
IRR-008	Neff-001	$9,130.00	$1,369.50	$913.00	$11,412.50
IRR-009	Boot and Bottle-001	$7,920.00	$1,188.00	$792.00	$9,900.00
IRR-010	Harrison-001	$69,080.00	$10,362.00	$6,908.00	$86,350.00
IRR-011	Harrison-002	$16,868.50	$2,530.28	$1,686.85	$21,085.63
IRR-012	Trout Creek Ranch-001	$21,928.50	$3,289.28	$2,192.85	$27,410.63
IRR-013	Trout Creek Ranch-002	$59,218.50	$8,882.78	$5,921.85	$74,023.13

Project ID	Sponsor Reference	Project Subtotal	Contingencies (15% of subtotal)	Engineering and Technical Assistance (10% of subtotal)	Total Estimated Cost
IRR-014	Trout Creek Ranch-003	$110,000.00	$16,500.00	$11,000.00	$137,500.00
IRR-015	Trout Creek Ranch-010	$235,565.00	$35,334.75	$23,556.50	$294,456.25
L/W-001	Morrison-001	$186,076.00	$27,911.40	$18,607.60	$232,595.00
L/W-002	Morrison-003	$17,428.40	$2,614.26	$1,742.84	$21,785.50
L/W-003	Christofferson-001	$531,410.00	$79,711.50	$53,141.00	$664,262.50
L/W-004	Koller-001	$65,010.00	$9,751.50	$6,501.00	$81,262.50
L/W-005	Nichols-001	$52,800.00	$7,920.00	$5,280.00	$66,000.00
L/W-006	Whitlock-002	$4,422.00	$663.30	$442.20	$5,527.50
L/W-007	Vogt-002	$56,628.00	$8,494.20	$5,662.80	$70,785.00
L/W-008	Broussard-001	$21,301.50	$3,195.23	$2,130.15	$26,626.88
L/W-009	Arnote-001	$17,578.00	$2,636.70	$1,757.80	$21,972.50
L/W-010	Arnote-002	$17,578.00	$2,636.70	$1,757.80	$21,972.50
L/W-011	Bales-001	$50,651.70	$7,597.76	$5,065.17	$63,314.63
L/W-012	B4-001	$21,890.00	$3,283.50	$2,189.00	$27,362.50
L/W-013	Trout Creek Ranch-004	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-014	Trout Creek Ranch-005	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-015	Trout Creek Ranch-006	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-016	Trout Creek Ranch-007	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-017	Trout Creek Ranch-008	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-018	Trout Creek Ranch-009	$11,816.20	$1,772.43	$1,181.62	$14,770.25
L/W-019	FOAL-001	$17,578.00	$2,636.70	$1,757.80	$21,972.50
L/W-020	Roberts-001	$209,198.00	$31,379.70	$20,919.80	$261,497.50
L/W-021	Corbett-001	$18,480.00	$2,772.00	$1,848.00	$23,100.00

8.0 TASK 7: ECONOMIC ANALYSIS

Funding and financing sources for proposed projects within the watershed, as well as associated technical support and assistance, are available from a variety of local, private, state, and federal entities. The funding opportunities summarized in this Study are dependent on local coordination and voluntary cooperation.

Local coordination is pivotal for developing viable financing approaches that can be employed in implementing proposed projects and realizing improvements in the watershed. Land and water users, as well as managers interested in executing conservation projects and programs, should be aware of the partnership opportunities and program incentives available to successfully achieve their watershed improvement goals and objectives.

The subsequent sections provide information on agencies and organizations that offer technical and financial assistance programs, which could potentially support proposed projects and alternatives. Funding and program information for potential conservation and watershed Project and program assistance were primarily obtained from the following sources:

- **Water Management and Conservation Assistance Programs Directory**, Fifth Edition (WWDC 2014). This directory provides an overview of local, state, and federal programs with potential project funding, available here: 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 comprehensive list 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

Significant competition for funding associated with many of the sources presented is frequently encountered by applicants. To increase the potential for funding success, applicants may wish to have other funds available to leverage against these opportunities. Contacts for key local groups who can provide current information on funding sources relevant to watershed projects include, but are not limited to, the following:

- Bureau of Land Management/Cody Field Office (307) 578-5900
- NRCS Powell Field Office (307) 754-9301
- Wyoming Water Development Office (307) 777-7626

Table 8-1 summarizes the potential funding sources mentioned in this section.

8.1 LOCAL AGENCIES

Agencies within the Cody and Powell areas that can provide funding assistance include area conservation districts and county weed and pest departments. Details on assistance they can be provide is included in the following section.

8.1.1 CONSERVATION DISTRICTS

The Study Area primarily falls within Park County, with a small portion extending into Big Horn County. Conservation districts play a vital role as representatives of local communities with responsibilities related to natural resource management. Local conservation district boards serve as a crucial link between local landowners, resource users, and state and federal government agencies. These districts are key providers of information and education at the grassroots level, offering valuable technical assistance based on local expertise and resources.

Conservation districts can aid in the development and implementation of program and project designs, as well as in securing funding through proposal preparation, presentation, and grant pursuit. They often contribute funding assistance, including in-kind support such as staff time and technical expertise. Conservation districts are capable of administering programs, projects, and grants on behalf of recipients involved in state and federal natural resource initiatives. Moreover, they can assist in establishing collaborative programs and projects that leverage resources from multiple partners.

For additional information and resources, visit the website https://conservewy.com or see the contact information provided below:

Cody Conservation District
1501 Stampede Avenue, Suite 2046
Cody, WY 82414
conservecody@gmail.com
(307) 548-8335

Powell Clarks Fork Conservation District
1017 Hwy 14A
Powell, WY 82435
ann.trosper@wy.nacdnet.net
(307) 272-6678

TABLE 8-1. SUMMARY OF POTENTIAL FUNDING SOURCES

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
Local					
Park County Weed and Pest	n/a	Technical assistance, Cost-share programs, inspection service	https://parkcountyweeds.org/	307-754-4521	
Cody Conservation District	n/a	Liaison, in-kind administrative and technical assistance, program coordination/partnering	https://codyconservationdistrict.com/	307-548-8335	conservecody@gmail.com
Powell Clarks Fork Conservation District	n/a		https://www.pcfcd.org/	307-272-6678	ann.trosper@wy.nacdnet.net
NRCS Powell Office	n/a	See Federal NRCS	https://www.nrcs.usda.gov/contact/find-a-service-center	307-754-9301 Ext. 116	rory.karhu@usda.gov
State					
Wyoming Department of Environmental Quality - Water Quality Division	Nonpoint Source Implementation Grants (319 and 205j Programs)	Water quality BMPs	https://deq.wyoming.gov/water-quality/watershed-protection/nonpoint-source/	Alex Jeffers 307-777-6733	alex.jeffers@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 Cody Regional Office 307-527-7125	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	elizabeth.blackwell@wyo.gov
	Joint Powers Act Loan Program	Aids cities, counties, and special districts in providing needed services			

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
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	Jason Mead, P.E. (Interim Director) jason.mead@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/	307-578-5900 (Cody FO) 307-332-8400 (Lander FO)	BLM_WY_Cody_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	https://www.usbr.gov/watersmart/	Lyle Myler (Area Manager) 307-261-5671	lmyler@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

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
USDA - Farm Service Agency (USDA-FSA)	Conservation Reserve Program (CRP)	Removal of highly erodible lands from production	https://www.fsa.usda.gov/programs-and-services/conservation-programs/index	Andrea Bryce Agricultural Program Specialist 307-261-5081	andrea.bryce@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://www.fws.gov/program/wildlife-restoration/	Christina Milloy Wildlife and Sport Fish Restoration Program 703-862-5761	Christina_Milloy@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/	Kelly Niland - Grant Administrator 703-358-2171	kelly_niland@fws.gov
	North American Wetlands Conservation Act Program	Various wetlands conservation projects	https://www.fws.gov/service/north-american-wetlands-conservation-act-nawca-grants-us-standard	Guy Foulks - Senior Grant Administrator 703-358-1784	info@iwjv.org

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
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 Shoshone National Forest Office 307-527-6241 Cheyenne Office 307-772-2314 ext. 3 Clarks Fork, Greybull, and Wapiti Ranger District 307-527-6921	jackie.byam@wy.usda.gov
	Watershed Protection and Flood Prevention Operations Program (WFPO)		https://www.nrcs.usda.gov/programs-initiatives/watershed-and-flood-prevention-operations-wfpo-program		
	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)		https://www.nrcs.usda.gov/programs-initiatives/rcpp-regional-conservation-partnership-program		
	Agricultural Management Assistance (AMA)		https://www.nrcs.usda.gov/programs-initiatives/ama-agricultural-management-assistance		
	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/programs-initiatives/watershed-rehabilitation		
	Sage Grouse Initiative (SGI)		http://www.sagegrouseinitiative.com/	Jackie Byam State Conservationist 307-233-6750	jackie.byam@wy.usda.gov

Agency/Entity	Program Name	Project Type(s)	Internet Site	Telephone	Email
US Army Corps of Engineers	See website for program names	Planning, Floodplain Management, 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	Glenn Pauley State Director 307-233-6700	glenn.pauley@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	chris.west@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

8.1.2 COUNTY WEED AND PEST DISTRICTS

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

Park County Weed & Pest Control
1016 Rd 13
Powell, WY 82435
(307) 754-4521
https://parkcountyweeds.org/

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

8.2 STATE PROGRAMS

There are numerous funding and partnership opportunities through state agencies. Some of the agencies discussed in this section include the Wyoming Department of Environmental Quality, Wyoming Game and Fish Department, Wyoming Office of State Land and Investments, Wyoming Water Development Commission, and the Wyoming Natural Resource Trust.

8.2.1 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. 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 under Grant Resources at the WDEQ Non-point source website: https://deq.wyoming.gov/water-quality/watershed-protection/nonpoint-source/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." (WWDC, 2014) Also from the WWDC site:

- **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.
- **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. For more information related to these funds, contact Paul Dey at Wyoming Game and Fish (paul.dey@wyo.gov).
- **Wyoming Sage Grouse Conservation Fund**: The WSGCF is a special fund established by the Wyoming Legislature 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. 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

8.2.2 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.

Effective as of March 1, 2023, Wyoming Senate Bill SF0071 replaced the historical Farm Loan Program and Joint Powers Act Loan Program. Bill SF0071 authorizes a total of $225 million in loans for projects related to this Study. State permanent funds up to $50 million are available for investments in farms, and state mineral trust funds up to $175 million are authorized for loans to irrigation and water conservancy boards, among other candidates. Loans issues to conservancy boards must fund the replacement or major maintenance of systems storing, transmitting, diverting, or distributing water. Other agencies may jointly apply for mineral trust funds for projects specified under W.S. 16-1-104(c), namely projects facilitating surface water drainage or water and soil conservation.

More information is available at: https://wyoleg.gov/2023/Summaries/SF0071.pdf

8.2.3 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 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*

8.2.3.1 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.

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.

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.

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 below.

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 anticipate demands for water within a certain area and provide reconnaissance level information regarding costs and scheduling.
- The WWDC's operating criteria contain detailed information on each of the programs presented above including project eligibility criteria and application processes. Of specific pertinence to WWDC watershed studies, is the Small Water Project Program (SWPP) which is discussed in greater detail below.

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.

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

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

B. **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 expenses will be contingent upon meeting minimum water quality and quantity requirements.

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

D. **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.

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

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

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

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

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

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

K. **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 potential projects include the following:

- Small water projects must adequately demonstrate a public benefit. Public benefit may be demonstrated for projects included in WWDC Watershed Studies. Eligible projects may be located on Federal, State, public, or private lands.
- Applications shall be received by January 1 of each calendar year. Applications meeting criteria requirements will be considered during the regularly scheduled WWDC meeting in March. Applications shall include a project application, sponsor project referral, project location map, project cost estimates, and any letters of authorization or commitment of participation that may be available from other funding sources.
- Projects that improve watershed condition and function, provide multiple benefits, and meet the funding criteria specified in W.S. 99-3-703(j)(vii) or W.S. 99-3-704(g)(vii), are eligible for consideration.
- The sponsoring entity will be required to address the WWDC and provide testimony and other additional supporting evidence that justifies SWPP funding whenever the public benefit documentation, submitted with the application, is deemed to be insufficient by the WWDC.
- Projects that have completed the following requirements prior to application will be classified as "Shovel Ready" and may be considered as a funding priority at the Commission's discretion.
  - Permit procurement
  - State and Federal agency notifications
  - Land procurement, right of way, or easement acquisition
  - Have finalized all other financial agreements

8.2.4 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 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 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. More information on the application process is available here: https://wwnrt.wyo.gov/how-to-apply/how-to-apply

8.3 FEDERAL AGENCIES

Federal funding sources discussed included programs within the Bureau of Land Management, United States Bureau of Reclamation, Environmental Protection Agency, Farm Service Agency, Natural Resource Conservation Service, and Fish and Wildlife Service.

8.3.1 BUREAU OF LAND MANAGEMENT (BLM)

Range Improvement Planning and Development

Range Improvement Planning and Development is a cooperative effort not only with the livestock operator but also with other outside interests including 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 BLM 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 BLM'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.

Watershed and Water Quality Improvement

Watershed and Water Quality Improvement are cooperative efforts between the BLM and 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 BMPs to address identified acid mine drainage and runoff problems from mine tailings and waste rock piles.

Riparian Habitat Management Program

The Bureau of Land Management's (BLM) Riparian Habitat Management Program aims to collaborate with external entities on riparian improvement projects. This program's objective is to ensure that riparian and wetland areas are maintained, restored, improved, protected, and expanded to function properly in terms of productivity, biological diversity, and sustainability. The overarching goal is to achieve an advanced ecological status for these areas, except when resource management objectives, including proper functioning conditions, necessitate an earlier successional stage. The program encompasses extensive efforts in riparian-wetland information, inventory, training, research, and strengthening partnerships and cooperative management processes.

Partnerships play a crucial role in riparian improvement projects and research related to riparian issues. Funding for these endeavors is allocated annually, contingent on budget allocations from Congress. All cooperative projects submitted to the program compete for the available funds in the riparian program.

8.3.2 UNITED STATES BUREAU OF RECLAMATION (USBR)

The United States Bureau of Reclamation (USBR) has a mission to manage, develop, and safeguard water and associated resources in a manner that is both environmentally and economically sustainable for the benefit of the public. USBR plays a significant role, often in partnership with states, water users, and other stakeholders, in enhancing water resources and promoting water use efficiency in the western United States.

Under the USBR's Sustain and Manage America's Resources for Tomorrow (WaterSMART) Program, a comprehensive framework has been established to provide federal leadership and assistance in promoting the efficient use of water. This program integrates water and energy policies to support the sustainable utilization of all natural resources and fosters coordination among various department bureaus and offices focused on water conservation efforts. Through WaterSMART, the department strives to implement a sustainable water management strategy that addresses the nation's water needs by supporting projects aimed at conserving water, enhancing water use efficiency, increasing the use of renewable energy, improving energy efficiency, protecting endangered and threatened species, facilitating water markets, and addressing climate-related impacts on water resources. The overarching goal is to prevent water-related crises and conflicts while ensuring the long-term sustainability of water resources.

The WaterSmart Program includes numerous funding opportunities many which have been recently added due to the Bipartisan Infrastructure Law (BIL) PL 117-58. Opportunities include the following Programs, Water and Energy Efficiency Grants, Small-Scale Water Efficiency Projects, Water Strategy Grants, Project Design Grants, Aquatic Ecosystem Restoration Program, Title XVI Projects, Large-Scale Water Recycling Program, Desalination Construction, Basin Studies, Baseline Assessments and Pilots, Reservoir Operations Pilots, Applied Science Grants, Water Conservation Field Services Program, Drought Response Program, and the Cooperative Watershed Management Program. USBR funding opportunities are continuously updated and may change depending on available future funding allocations. Details on grants likely applicable to the Study Area are included below.

Project Design Grants: cost share funding provided in a new grant opportunity in 2023 focused on final design of medium and large-scale on-the ground water supply construction, water management construction, and restoration projects.

Water and Energy Efficiency Grants (WEG): focuses on projects that result in quantifiable water savings, implement renewable energy, and support sustainability efforts. Project examples include canal lining and piping projects, municipal metering projects, and Supervisory Control and Data Acquisition (SCADA) and automation projects. USBR provides funding in two groups. In Funding Group I, up to $500,000 in federal funding is available per project, for smaller on-the-ground projects. In funding Group II, up to $2 million is available per project. In Funding Group III, up to $5 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.

Water Strategy Grants: provides assistance to states, tribes, and local government to establish or expand water markets or water marketing activities. These grants do not fund on-the-ground water efficiency projects.

Small-Scale Water Efficiency Projects: focus on water efficiency projects such as landscape irrigation measures, municipal metering, SCADA, which are relatively limited in scope. Example eligible projects include flow measurement installation, automation of water delivery systems, or canal lining to address seepage. Funding up to $100,000 is available, with a maximum project cost of $225,000.

Environmental Water Resources Projects: focused on projects that provide environmental benefits and have been developed through a collaborative process and established strategy for increased water resource reliability. Eligible projects will result in quantifiable water efficiency improvements and ecological benefits. Example projects include infrastructure improvements to mitigate drought-related impacts, watershed management, or water resources restoration projects providing ecological benefit. Funding requires 25% or greater non-federal cost share and funding for up to $2 million for a 3-year period.

Aquatic Ecosystems Restoration Program: a new program in 2023, this grant provides cost shared funding to states, tribes, and other entities to study, design and construct aquatic ecosystem restoration projects that are collaboratively developed, have widespread regional benefits, and result in the improvement of the health of fisheries, wildlife, and aquatic habitat. Example projects include fish passage improvement, stream, and wetland restoration, etc.

Applied Science Grant: funding is focused on developing hydrologic information, water management tools, and improving modeling and forecasting capabilities. Work will support water management objectives such as management of water deliveries, drought management, water rights administration, watershed health, etc.

Cooperative Watershed Management Program (CWMP): provides funding to grassroots, local watershed groups to encourage diverse stakeholders to develop collaborative solutions to address their water management needs. Funding is provided for the support of watershed groups on a competitive basis for the development of watershed groups, watershed restoration planning, and watershed management project design.

The Water Conservation Field Services Program (WCFSP): 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.

For more information, access the following or contact Brad Cannon:

https://www.usbr.gov/watersmart/
https://www.usbr.gov/waterconservation/
Brad Cannon
(307) 261-5671
bcannon@usbr.gov

8.3.3 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 $6.6 million in Urban Waters Small Grants to 114 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. https://www.epa.gov/urbanwaterspartners/urban-waters-small-grants-101; https://www.epa.gov/urbanwaterspartners/urban-waters-small-grants
  - **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 8.4.2for 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; 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 8.2.1).

8.3.4 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
  - Filter strips
  - Grass waterways
  - Wetlands buffer
  - Shelter belts
  - Living snow fences
  - Contour grass strips
  - Wetland restoration
  - Salt tolerant vegetation
  - Shallow water areas for wildlife
  - Buffers for wildlife habitat
- **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 $125,000 while $125,001 to $250,000 requires state committee approval. Some of the conservation practices included are removing debris, restoring fences and conservation structures, and providing water for livestock in drought situations.
- **Farmable Wetlands Program**: The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer zones to improve both vegetation and water flow. FWP provides annual rental payments in return for restoring wetlands and establishing plant cover. Eligible land must have been used for agricultural purposes for 3 of the past 10 crop years.

- **Grassland Reserve Program**: The Grassland Reserve Program (FWP) is designed to prevent grazing and pastureland from being converted to cropland, urban development, or other non-grazing uses. Participants in the program voluntarily limit future development of their grazing and pastureland, 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.

8.3.5 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: https://www.fws.gov/service/financial-assistance

8.3.6 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: https://www.nrcs.usda.gov/programs-initiatives/sage-grouse-initiative

Information on all NRCS programs is available from the local contacts listed in Table 8-1.

8.3.7 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.
- **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 project's 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 $10,000,000. 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 50%.

- **Water Resources Projects:** This program is a pilot program initiated to fully fund small water resources projects for economically disadvantaged communities. Project proposals were originally due by August 21, 2023, but were extended to October 31, 2023. Future of this program is uncertain but may be renewed under the current administration. According to the program website (available at https://www.usace.army.mil/):

  "Project proposals under this pilot program are for projects under the Continuing Authorities Program (CAP). Under CAP, the Corps can plan, design, and implement certain types of water resources projects without additional project specific congressional authorization. The purpose of the CAP is to plan and implement projects of limited size, cost, scope, and complexity. While CAP projects typically require a cost-share with a non-Federal sponsor, this pilot program will fully fund the selected projects."

- **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, WY 82009
Ph: (307) 772-2300

8.3.8 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; http://www.rd.usda.gov/about-rd/agencies/rural-utilities-service

8.4 NON-PROFIT AND OTHER ORGANIZATIONS

Additional funding partners include non-profit and other organizations. Details are provided for Ducks Unlimited, Trout Unlimited, the National Fish and Wildlife Foundation.

8.4.1 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

8.4.2 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: *https://www.nfwf.org/programs* 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 Clarks Fork/ Upper Shoshone 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. Information about all of these and other NFWF grants/programs is available at their website: *https://www.nfwf.org/programs*

8.4.3 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.

8.5 ENTITY FORMATION

Many of the funding programs presented above require a legal public entity such as a watershed improvement district, 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 include the following:

A. Watershed Improvement District

B. Irrigation District

C. Water Conservancy Districts

D. Flood Control Districts

E. 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.

8.5.1 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.

8.5.2 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)].

8.5.3 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:

- Enter into contracts, to create and maintain offices; to elect, appoint and employ officers, attorneys, agents, and employees.
- Identify the lands that that are susceptible of irrigation from district sources, to allocate water to all such lands; and to levy assessment.
- Fix rates for selling or leasing water.
- Adopt plans and specifications for the works for which the district was organized.
- Appropriate and otherwise acquire water and water rights and related activities.
- Subscribe for, purchase and acquire stock in canal and similar companies.
- 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.
- Invest surplus money.
- Refund bonded indebtedness incurred by the district.
- Borrow money and incur indebtedness and to issue bonds.
- Adopt bylaws.
- Levy and collect taxes and special assessments.

8.5.4 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).

8.5.5 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)].

9.0 TASK 8: PERMITS

In this section, we provide information on the regulatory issues pertaining to the types of projects identified in this report. The purpose of this section is to outline potential environmental permitting challenges. The permitting process can be intricate, time-consuming, and costly. The Study Area encompasses lands under the administration of various entities, including the Bureau of Land Management (BLM), Bureau of Reclamation (BOR), National Park Service (NPS), the State of Wyoming, and private individuals. Depending on the project's location and nature, the permitting process may range from a straightforward water rights application to a highly complex Environmental Impact Statement (EIS) requirement.

The National Environmental Policy Act (NEPA) is applicable to all federal actions, with the lead federal agency bearing the responsibility for compliance. Other federal environmental regulations fall under the jurisdiction of federal agencies such as the Environmental Protection Agency (EPA), Bureau of Land Management (BLM), U.S. Forest Service (USFS), U.S. Army Corps of Engineers (USACE), and/or the U.S. Fish and Wildlife Service (USFWS). These regulations may be relevant to the potential projects described in this plan.

In addition to federal requirements, the state of Wyoming has its own agencies with approval requirements. These may include the Wyoming Department of Environmental Quality (WDEQ), Wyoming State Engineer’s Office (WSEO), and the Board of Land Commissioners, managed through the Office of State Lands and Investments.

Table 9-1 summarizes the various permits potentially required and the contact information for each agency.

9.1 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. 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. 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. 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 following website to help determine ownership information for any parcels that may be involved with a proposed project. *https://wyo-prop-div.wyo.gov/tax-districts/maps-gis-data*

Permits or right-of-way access are required for WYDOT and numerous municipality, 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: https://lands.wyo.gov/resources/land-and-lease-map-viewer

9.1.1 LAND, RIGHT-OF-WAY, OR EASEMENT ACQUISITION

The proposed projects described in this Study 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 state highway, county road or access to irrigation district infrastructure and would require temporary or conditional use permits obtained from those entities. Additionally, there are other projects that have components that may be located on federal lands. If a proposed project was 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 9.2.

TABLE 9-1. TABULATION OF AGENCIES AND PERTINENT PERMIT REQUIREMENTS

<table>
<tr><th>Agency</th><th>Potential Permit and/or Clearance</th><th>Website</th></tr>
<tr><td colspan="3">Federal</td></tr>
<tr><td rowspan="2">U.S. Army Corps of Engineers (USACE)</td><td>Authorization of Permit for Discharge of Dredged or Fill Material (Section 404 permit)</td><td rowspan="2">http://www.nwo.usace.army.mil/Missions/Regulatory-Program/Wyoming/
(307) 772-2300</td></tr>
<tr><td>Requires further delineation of jurisdictional wetlands and a wetland mitigation plan.</td></tr>
<tr><td>U.S. Fish and Wildlife Service (USFWS)</td><td>Endangered Species Act, Section 7 and 10 consultations</td><td rowspan="2">https://www.fws.gov/office/wyoming-ecological-services
https://www.blm.gov/wyoming</td></tr>
<tr><td>Bureau of Land Management (BLM)</td><td>BLM clearance necessary if located or crossing BLM lands, NEPA review required</td></tr>
<tr><td>United States Forest Service (USFS)</td><td>USFS clearance necessary if located on or crossing USFS lands, NEPA review required. What about a special-use permit?</td><td>https://www.fs.usda.gov/shoshone</td></tr>
</table>

Agency	Potential Permit and/or Clearance	Website
Natural Resource Conservation Service (NRCS)	NRCS approval necessary if funded by Farm Bill or USDA, NEPA review may be required	https://www.nrcs.usda.gov/conservation-basics/conservation-by-state/wyoming
State		
Wyoming State Engineer's Office (WSEO)	Ground Water Division approval of Water Well Permits	https://seo.wyo.gov/ https://seo.wyo.gov/applications-and-forms https://seo.wyo.gov/ground-water/water-well-construction
	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	https://wyoshpo.wyo.gov/index.php/faqs-help/get-a-compliance-letter
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	https://wgfd.wyo.gov/habitat
	Greater Sage-Grouse Core Area Protection	
Wyoming Department of Environmental Quality (WDEQ)	401 Certification for 404 Permits under the federal Clean Water Act	https://deq.wyoming.gov/water-quality/watershed-protection/cwa-section-401-turbidity-wetland/401-water-quality-certification/
	WYPDES Construction General Permit (CGP) for Large Construction Activity (> 5 acres) or Small Construction Activity (between 1 acre and 5 acres)	https://deq.wyoming.gov/water-quality/wypdes/
	Applicable Water Quality Standards for Wells, Reservoirs, and Streams	https://rules.wyo.gov/Search.aspx?mode=1
Wyoming Office of State Lands and Investments (OSLI)	Construction of Improvements on State Land application approval	https://lands.wyo.gov/resources/applications-forms

Agency	Potential Permit and/or Clearance	Website
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	https://wsfm.wyo.gov/electrical-safety
One Call of Wyoming	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].	https://www.onecallofwyoming.com/#
Local		
Park County	Permits for building structures, wind and solar energy systems, and floodplain development	https://parkcounty-wy.gov/planning-and-zoning/apps-fees/
Special Districts	Permits or clearances from special districts including water and sewer, sanitary and improvement, flood control, irrigation, road, and improvement/service districts	https://nrwdcodywy.com/

9.2 NEPA COMPLIANCE

NEPA (National Environmental Policy Act) obligates federal agencies to evaluate the potential environmental impacts of projects they propose to undertake, fund, or approve. NEPA is applicable to any proposed actions taking place on federal land, whenever federal funds are involved, or when formal federal agency actions are prerequisites for advancing a project. One of NEPA's principal objectives is to prevent, minimize, and address adverse environmental consequences resulting from federal actions. NEPA necessitates the analysis and documentation of both the potential adverse and beneficial effects of a proposed action, along with exploring alternatives. It also mandates an inclusive public participation process.

In the Study Area, most land is federally owned, with the USFS holding more than 58% of the land. The second most substantial ownership group within the Study Area comprises private landowners, who possess nearly 23% of the land. Map 35 provides an overview of land ownership distribution across the Study Area. For the potential projects and recommendations identified in Chapter 6 that may fall on federal lands, the lead federal agency will likely be the landowning agency. They will be responsible for ensuring compliance with NEPA and associated environmental studies, contingent on the project's location. In cases where private lands, especially wetlands, may be affected, the U.S. Army Corps of Engineers (USACE) would probably take the lead as the federal agency. The extent of NEPA documentation required for specific projects will be determined on a case-by-case basis.

9.2.1 BUREAU OF LAND MANAGEMENT

NEPA evaluations and processes for projects with the Bureau of Land Management (BLM) as the lead federal agency will be conducted by BLM staff or qualified, independent third-party experts accountable to BLM. These experts may include specialists from other federal and state agencies, operating under Memorandums of Understanding or other suitable arrangements. All NEPA-related processes and studies under the purview of BLM are overseen by the lead BLM district staff (Cody Field Office), with support from BLM state office staff.

9.2.2 OTHER STATE AND FEDERAL AGENCIES

Depending on the project, it is possible for another state or federal agency to take the lead in the NEPA process. All relevant state and federal land management agencies have management plans developed through NEPA-compliant processes where applicable. These plans will serve as guiding documents for the agencies' NEPA processes concerning any proposed projects or improvements.

9.3 PERMITTING REQUIREMENTS

Environmental resources are safeguarded by an array of state and federal regulations, including the Clean Water Act (CWA) and the Endangered Species Act (ESA). The specific permits, clearances, and approvals necessary will be contingent upon the unique characteristics and location of each project.

9.3.1 UNITED STATES ARMY CORPS OF ENGINEERS

The U.S. Army Corps of Engineers (USACE) holds regulatory authority under Section 404 of the Clean Water Act (CWA), enabling them to oversee the discharge of dredged or fill materials into U.S. wetlands or waters. These regulations aim to restore and preserve the chemical, physical, and biological integrity of U.S. waters. This oversight encompasses various elements, including diversion structures, levees, riprap, bank stabilization, channel crossing structures, dams, and development fill. The Corps issues three types of permits: 1) Individual Permits, 2) Nationwide Permits, and 3) Regional General Permits.

Any project within the Study Area with the potential to impact wetlands or waters must address Section 404 permitting requirements. Smaller projects with minor impacts are eligible for general permits, such as Nationwide Permits or Regional General Permits, while larger projects with more significant impacts will necessitate individual permits.

For most projects, an application package is required, comprising a comprehensive report outlining all aspects of the proposed project. This report should encompass efforts to avoid, minimize, and mitigate impacts. Before submitting an application, the Applicant should outline the project's purpose and need, describe any alternative considerations and reasons for their exclusion. The applicant must also address wetland impacts, typically requiring a formal wetland delineation, and be prepared to discuss the potential effects of new structures, as well as the impacts on existing flow patterns in the designated water source.

It is important to note that projects involving rehabilitation or replacement of existing irrigation infrastructure are exempt from the 404-permit process.

9.3.2 ENDANGERED SPECIES ACT

For new projects funded, authorized, or carried out by federal agencies on federal land, applicants must engage in consultations with the U.S. Fish and Wildlife Service (USFWS) in accordance with Section 7 of the Endangered Species Act. The purpose of this consultation is to ensure that the project does not pose a significant risk to the continued existence of endangered or threatened species or negatively impact critical habitats. The primary agency overseeing the project will prepare a biological assessment to evaluate its effects on plant and animal species listed or proposed for listing under the Endangered Species Act. Subsequently, the USFWS will issue an opinion regarding the potential jeopardy to the continued existence of these species or the adverse modification of critical habitat. The USFWS's approval is necessary for the preparation of a biological assessment to ensure compliance with the Endangered Species Act, and any determination of adverse impacts to protected species will necessitate the implementation of mitigation measures or alterations to the project's scope, location, or methods.

The Fish and Wildlife Coordination Act mandates that federal agencies engaged in activities that involve the management or structural alteration of natural streams or bodies of water for any purpose must proactively safeguard the fish and wildlife resources that might be impacted by these actions. It compels federal agencies or project applicants to initiate consultations with both state and federal wildlife agencies. The aim of these consultations is to prevent, mitigate, and compensate for any wildlife resource losses resulting from the project while also focusing on enhancing these resources.

9.4 MITIGATION

Mitigation measures may be required for any of the identified reservoir projects or other potential projects described in Chapter 6 to address impacts on wetlands, fish and wildlife resources, sensitive or ESA-listed species, and cultural resources.

9.4.1 WETLANDS

In the event of wetland impacts associated with future projects (as determined during the Section 404 permitting process) exceeding the threshold (typically 0.1 acres) established by the U.S. Army Corps of Engineers (USACE), comprehensive compensatory mitigation plans to replace lost wetland functions will be necessary and subject to approval. The ratio of wetland replacement mitigation will be determined during the permitting process. Required mitigation plans must adhere to the guidance provided by the "Compensatory Mitigation for Losses of Aquatic Resources; Final Rule" dated April 10, 2008, as outlined in 33 CFR Parts 325 and 332 and 40 CFR Part 230. This guidance mandates that compensatory mitigation plans incorporate 14 specified elements as outlined in Part 332 Section 332.4.

9.4.2 SENSITIVE AND ESA-LISTED SPECIES

In compliance with the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), surveys for sensitive or ESA-listed species will be mandated before the commencement of projects funded, authorized, conducted by federal agencies, or situated on federal land. In instances where sensitive species are identified, and it is not feasible to avoid impacts to these species, mitigation measures will be required. Mitigation strategies for potential impacts on raptors and big game species typically involve ceasing specific construction activities during sensitive time periods and preventing direct disturbances to these species. Impacts on vital big game habitat may necessitate more substantial mitigation efforts. If any threatened and endangered species are encountered at a particular site, specialized studies will be conducted to determine the feasibility of implementing appropriate mitigation measures. The coordination with other agencies will be the responsibility of the lead federal agency, not the applicant.

9.4.3 SAGE-GROUSE

In 2008, the State of Wyoming adopted the Greater Sage-Grouse Core Area Protection Strategy, a regulatory framework designed to enhance the protection of greater sage-grouse and restrict habitat alterations within designated sage-grouse core population areas. This policy has undergone multiple updates, with the most recent one occurring in 2019 (Wyoming Executive Order 2019-3).

The Core Area Protection Strategy primarily emphasizes avoidance, minimization, and mitigation of human-made disturbances to sage-grouse habitat. Mitigation measures are reserved for cases where avoidance and minimization are either insufficient or unfeasible. When sage-grouse habitat is impacted, the policy requires that these impacts be offset through compensatory mitigation.

The Core Area Protection Strategy includes a Compensatory Mitigation Framework that outlines mitigation requirements and mechanisms for sage-grouse habitat impacts in both core and non-core population areas. Compensatory mitigation for sage-grouse habitat impacts, or “debits,” may be accomplished via “conservation credits” or “restoration credits”. Conservation credits are created by removing or limiting a threat to sage-grouse or their habitat for the full duration of the impact or in perpetuity. Restoration credits are created by converting disturbed or low-quality habitat to suitable sage-grouse habitat. Mitigation requirements are calculated based upon location, functionality, indirect impacts, and size of both the debits and credits. Mitigation for individual projects is most commonly achieved via purchase of mitigation credits from an approved sage grouse habitat mitigation bank.

9.4.4 FISHERIES

Impacts to fishery resources may require mitigation depending on project location and scale of impacts. Impacts to fisheries are evaluated by the lead federal agency. Impacts related to reservoir projects could potentially be mitigated through minimum reservoir release requirements and creation of a minimum pool for aquatic habitat. Fish passage on main-stem sites will likely be required. Fish screening on major intakes or diversions to canals or off-channel storage sites may be required.

9.4.5 CULTURAL RESOURCES

Section 106 of the National Historic Preservation Act requires Federal agencies to analyze the effects of any undertaking (as defined in 36 CFR 800.16) on historic resources. The lead federal agency will conduct cultural and historic resource investigations to identify and document any such resources that will be impacted. This would include a class I (literature search) survey, a class II (reconnaissance inventory) survey, and if needed, a class III (intensive inventory) survey. If cultural resource impacts are unavoidable, a mitigation plan for cultural resources will be developed culminating in a Memorandum of Agreement (MOA) between the Wyoming SHPO and the lead federal agency with concurrence by the project sponsor, and possibly affected Native American tribes. The agreement would require approval from the Advisory Council on Historic Preservation.

10.0 CONCLUSIONS AND RECOMMENDATIONS

A comprehensive assessment of the Clarks Fork/Upper Shoshone River watershed was undertaken to pinpoint and assess critical resource issues and concerns linked to the watershed's overall health and functionality. The primary aim of the watershed management plan is to offer a catalogue of realistic and technically viable projects. This list of projects will empower stakeholders to move forward with their implementation.

10.1 CONCLUSIONS

Following the completion of the watershed inventory phase, the Project team proceeded to create the watershed management plan. This plan was crafted using insights obtained from the inventory phase, input gathered during a series of public meetings and site visits, and discussions with the project Sponsors. The plan includes strategies and initiatives related to the following overarching categories:

- Irrigation System Improvements and Rehabilitation (IRR)
- Livestock/Wildlife Watering Opportunities (L/W)
- Environmental Enhancement Opportunities (ENV)
- Fire Suppression Improvements (FS)

10.1.1 IRRIGATION SYSTEM IMPROVEMENTS AND REHABILITATION (IRR)

1. Irrigated agriculture is a dominant activity within the Study Area. The extent of irrigated lands, and corresponding irrigation infrastructure is significant. Irrigation districts in the Study Area include:
   - Clarks Fork Irrigation District
   - Cody Canal Irrigation District
   - Heart Mountain Irrigation District
   - Lakeview Irrigation District
   - Shoshone Irrigation District
   - Willwood Irrigation District
2. Irrigation diversions and irrigation return flows play important roles in the character of many streams in the Study Area. For example, both Sage Creek and Sulfur Creek streamflow is augmented during the irrigation season by

operation of the Cody and Lakeview Canals. Likewise, Bitter Creek streamflow consists primarily of irrigation return flows.

3. Funding assistance is available for irrigation projects 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 irrigation districts, as legal entities, are 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 Chapter 6 could potentially be funded by multiple entities.
5. A total of fifteen (15) irrigation projects were identified and incorporated into the watershed management plan. These projects are likely eligible for funding through the SWPP.
6. The Project team is aware of numerous additional projects being considered by individual stakeholders which may be only partially eligible for SWPP funding. These projects typically include on-farm irrigation improvements not eligible for SWPP funding but are eligible for NRCS EQIP funding. Certain components of these, may however, be eligible for SWPP funding. Information prepared in support of EQIP funding through the NRCS should be submitted to WWDO SWPP officer for consideration of partial eligibility.

10.1.2 LIVESTOCK/WILDLIFE WATERING OPPORTUNITIES (L/W)

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. A total of twenty-one (21) individual projects were identified.
2. Enhancing range and riparian conditions presents opportunities through the establishment and maintenance of well-distributed, dependable upland water sources and watering facilities for both wildlife and livestock. The installation of pipelines and stock tanks serves as the cornerstone of efficient grazing management and offers a cost-effective means to improve rangeland conditions. In many cases, strategic fencing is also essential to maximize the benefits derived from these initiatives.
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. Most of the livestock / wildlife watering projects identified in the Plan will be completed entirely on private lands. Consequently, permitting issues are greatly simplified. However, a few will involve coordination with the BLM or BOR. Consultation will be necessary in order to obtain the requisite permits and cultural clearances.

10.1.3 ENVIRONMENTAL ENHANCEMENT OPPORTUNITIES (ENV)

1. A total of nine (9) specific environmental enhancement opportunities were identified. Most of these entailed some sort of stream channel improvement or stabilization. The projects identified generally involve protection of private property and infrastructure from damage due to streambank erosion or channel degradation.

2. It is recognized that meandering streams will continually migrate laterally resulting in erosive banks in some locations and sediment deposition in others. However, when erosion threatens highways, irrigation structures, homes, or other infrastructure, mitigation is recommended. Likewise, mitigation is also prudent when migration threatens production land such as pastures, crops, etc.

3. Channel degradation does not appear to be systemic. Significant or system-wide indicators of channel instability were not observed nor were they presented by area stakeholders. However, lower portions of the watershed do appear to be experiencing channel degradation more regional in nature. These streams have been flagged by the WDEQ Willwood working groups as significant sources of sediment to the Shoshone River system (i.e.., Sage Creek, Sulfur Creek).

   Impairments appear to be locally identifiable and include primarily:

   - Riparian Vegetation Degradation: Impaired riparian condition and habitat.
   - 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. Imbalance can be initiated by perturbations such as land use activities, channel modifications, or addition of flow (irrigation returns or operational waste) to the system.

10.1.4 FIRE SUPPRESSION IMPROVEMENTS (FS)

One fire suppression project was identified. This project involves the replacement of an existing aging water storage facility currently used only for irrigation purposes. By facilitating the new tank with requisite connections to accommodate fire-fighting equipment to access the water, the facility could serve multiple purposes. Coordination with local fire authorities would be required.

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. Several irrigation districts within the Study Area, namely Heart Mountain, Willwood, Lakeview, and Cody Canal Irrigation Districts, have recently completed or are currently in the process of developing master plans through the WWDC. It is highly recommended that the Sponsors actively engage with these ongoing studies by participating in project meetings. Given the interplay between irrigation activities and sedimentation concerns in the Shoshone River system, there may be opportunities within these projects to mitigate these impacts. For instance, exploring alternative methods for managing irrigation deliveries and operational waste could potentially reduce the reliance on Sage and Sulfur Creeks for conveying additional flows, thus contributing to the enhancement of channel restoration efforts.

2. Most of the projects outlined in the Plan are eligible for funding through the WWDC's Small Water Project Program (SWPP). It is imperative to review these projects and promptly implement selected alternatives as they become viable. The timely completion of one or more of these projects will not only bring direct benefits to those involved but will also help generate greater interest and raise awareness regarding the advantages associated with the watershed planning process.

3. There is significant interest among irrigators in expediting the completion of projects related to on-farm improvements, particularly the construction of center pivot irrigation systems. These projects align with the Sponsors' objectives in mitigating sediment delivery to the Shoshone River system by reducing surface runoff. However, it's important to note that such projects typically do not qualify for funding through the SWPP. Following discussions with the WWDO and NRCS staff, it has been ascertained that specific elements within these projects may meet SWPP funding criteria. Therefore, it is strongly recommended that stakeholders seeking NRCS EQIP funding for sprinkler conversion projects submit their NRCS designs and cost estimates to WWDO for assessment of eligibility for certain project components. For instance, components such as point of diversion and the 'ditch to pipe' sections within sprinkler conversion projects may qualify for SWPP funding.

4. The Sponsors have expressed a keen interest in the development of a basin-wide hydrologic model, as discussed in Chapter 5: Stream Hydrology. Various modeling options are available, and the choice of model often depends on specific objectives, data availability, historical preferences, or other factors unique to different entities. To maximize funding opportunities and create an effective planning tool through collaborative efforts, it is highly recommended that the Sponsors coordinate with interested entities and, depending on the preferences of those agencies, explore the development of a hydrologic model.

In cases where no partnering entity is available, a GIS-based modeling strategy appears to offer the most significant advantages to the Sponsors. This approach can capitalize on the wealth of existing spatial and hydrologic data presented in this Study report.

5. Various alternative funding sources are available to support watershed improvements, encompassing on-farm enhancements, irrigation rehabilitation, stream restoration projects, as well as conservation and flood control initiatives. Exploring innovative funding and financing strategies should be a priority, especially once projects worthy of further evaluation and potential implementation have been identified.

   As an illustrative example, the replacement of a deteriorating ditch headgate and diversion, which also serve as impediments to fish passage according to WGFD, could potentially qualify for SWPP funding. Moreover, additional funding avenues may be accessible through organizations such as WGFD, Trout Unlimited, and other relevant sources due to the potential benefits the project offers to fisheries and stream habitat. By orchestrating a combination of funding sources, project owners may be able to secure grants that cover a substantial portion, if not the entirety, of the project costs

6. Continued communication between the Sponsors and stakeholders concerning the SWPP is important. Although numerous projects have been identified and included in this Plan, it's essential to acknowledge that, despite diligent public outreach efforts, there may still be stakeholders who remain unaware of the Study and the SWPP. As a result, we highly recommend that the Sponsors consistently reference the SWPP in future newsletters and communications to enhance awareness of its benefits.

7. Upon SWPP project completion, and with the consent of the involved participants, the Sponsors may consider incorporating references to these completed projects to illustrate the opportunities presented by the SWPP. We have observed from previous watershed studies that interest in the program tends to grow as more projects are successfully completed.

8. Community-sponsored projects aimed at enhancing stream channels and habitat have the potential to deliver a wide array of benefits to the watershed. These prospective projects may encompass activities like bank stabilization, employing methods such as willow plantings, and the construction of beaver dam analogs (BDA's).

   Beyond the direct advantages to the targeted stream, there are additional, indirect benefits that include opportunities for education and community involvement.

9. There are promising funding opportunities available for both proposed and future improvement projects within the watershed. These opportunities span a range of initiatives, including enhancements to ranches and farms, rehabilitation of irrigation systems, improvements to riparian areas and wetlands, restoration of river corridors and stream channels, and urban drainage and flood control projects.

For instance, the Saratoga Encampment Rawlins Conservation District (SERCD) and the Popo Agie Conservation District (PACD) have both recently secured funding through the USDA Regional Conservation Partnership Program (RCPP). This funding is designated for achieving various resource management objectives, from enhancing water quality and wildlife habitat to restoring streambanks. Exploring the potential for successful RCPP funding applications and partnering SWPP funding with RCPP-funded projects, where feasible, could offer a multifaceted approach to financial support.

10. 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.

11. Every effort was made to provide information within this document to support the application for SWPP funding from the WWDC with the Sponsor's sponsorship. Project narratives, conceptual designs, and cost estimates can all be incorporated directly into the SWPP application by the Sponsors.

12. The public outreach component of this project made every effort to include all interested parties. To the best of the Project team's knowledge, we reached out to and contacted all those who expressed an interest in participating. However, based on our past experience, we anticipate that additional individuals may come forward after the completion of this Level I Study, expressing a desire to participate. It is essential to inform these new participants that they are indeed eligible for SWPP funding, even if they did not participate in the initial project. They would be expected to meet the same application requirements and adhere to the same deadlines as those who were actively involved in the project.

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WRCC. 2023f. CRANDALL CREEK, WYOMING (482135). Available from: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?wy2135.

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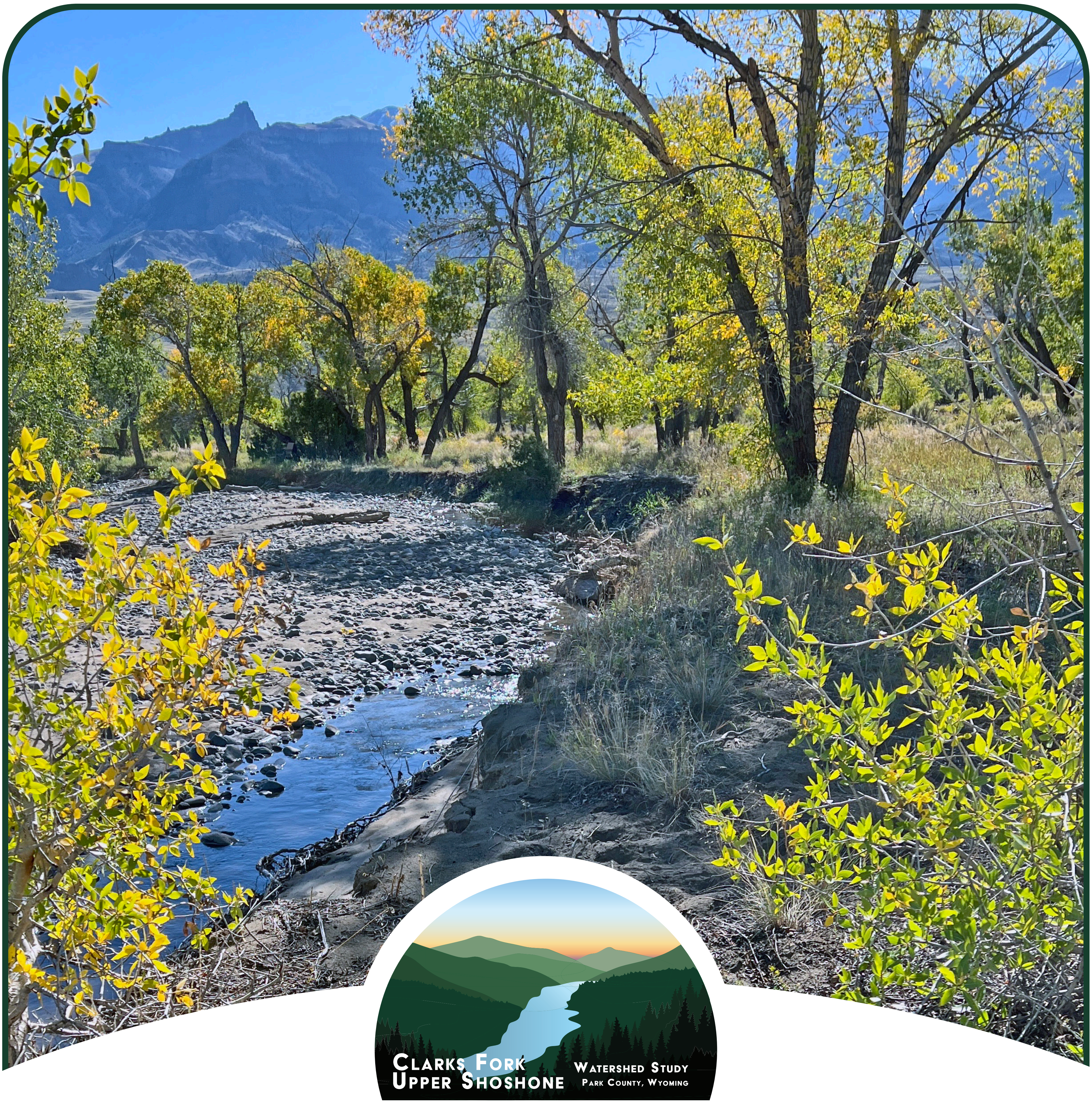
APPENDIX 1A

MAPS

(UNDER SEPARATE COVER)



Clarks Fork/Upper Shoshone Watershed Level I Study

Appendix 1A: Maps

Prepared For:

Wyoming Water Development Commission | Cody Conservation District | Powell-Clarks Fork Conservation District

Prepared By:

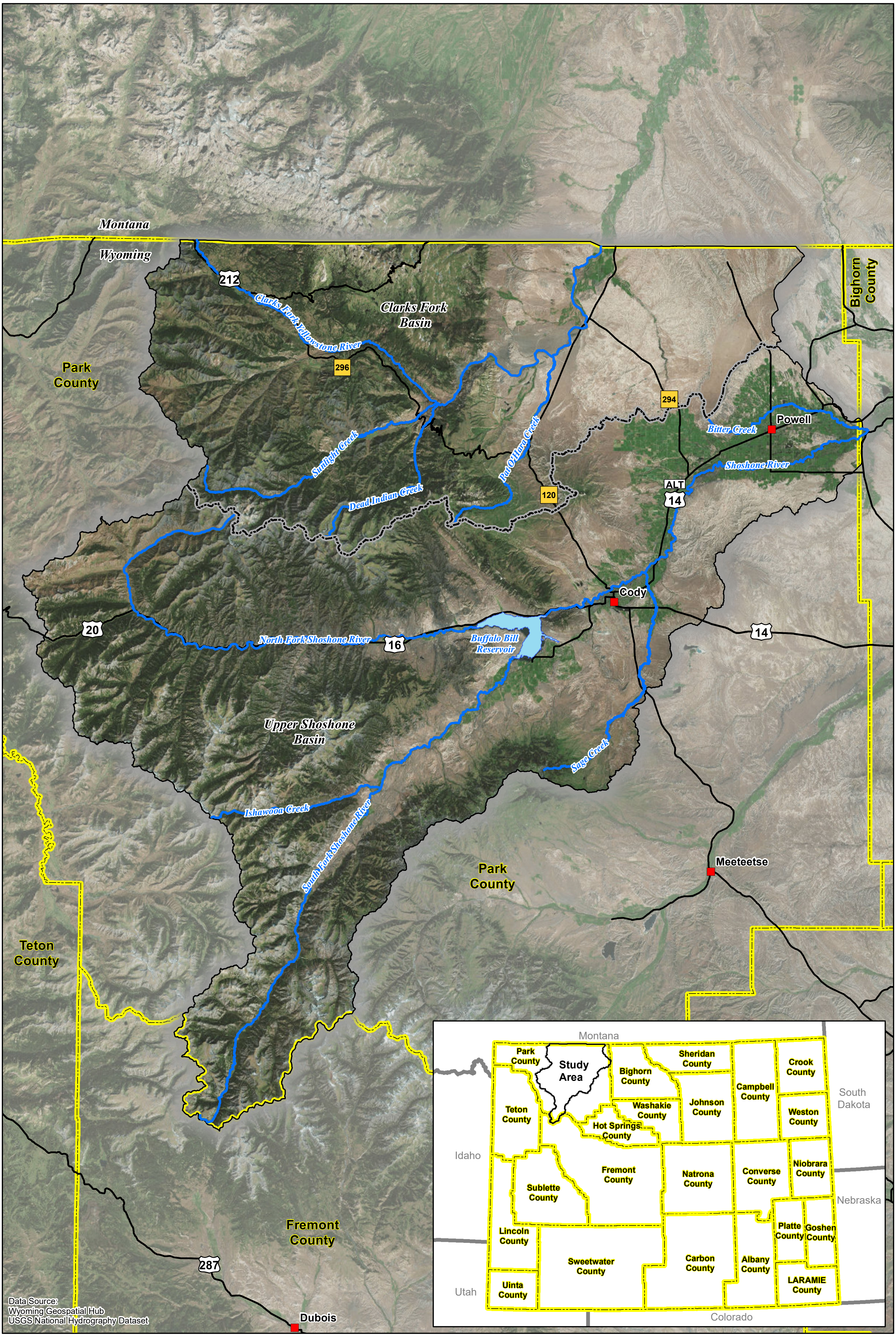
Trihydro Corporation

In Association With:

Anderson Consulting Engineers, Inc. | Hinckley Consulting

RESPEC Company LLC | Wyoming Water Rights Consulting, Inc.

LIST OF MAPS



N
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Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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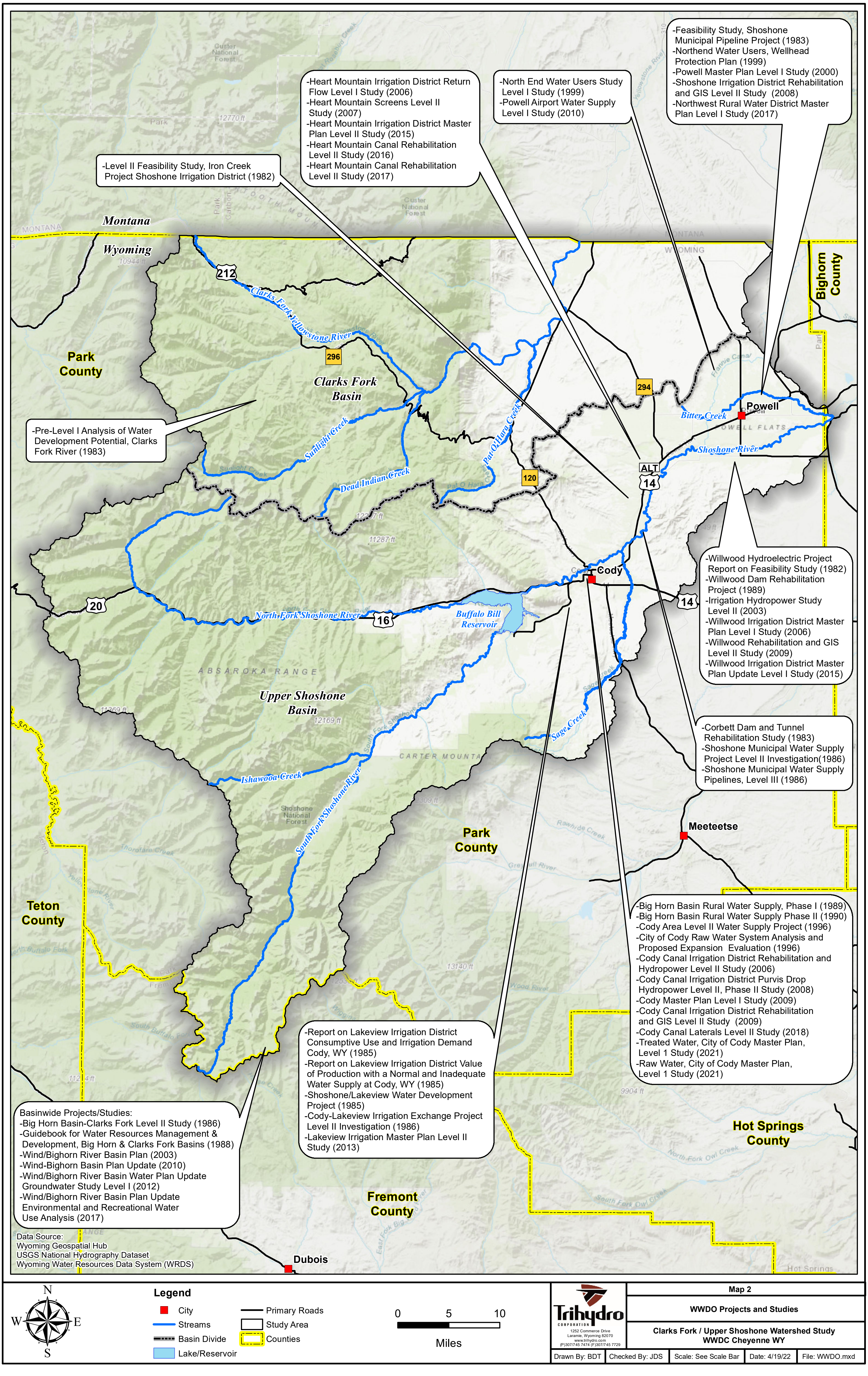
Map 1

Location Map

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 5/13/22	File: Location.mxd



-Feasibility Study, Shoshone Municipal Pipeline Project (1983)
-Northend Water Users, Wellhead Protection Plan (1999)
-Powell Master Plan Level I Study (2000)
-Shoshone Irrigation District Rehabilitation and GIS Level II Study (2008)
-Northwest Rural Water District Master Plan Level I Study (2017)
-Heart Mountain Irrigation District Return Flow Level I Study (2006)
-Heart Mountain Screens Level II Study (2007)
-Heart Mountain Irrigation District Master Plan Level II Study (2015)
-Heart Mountain Canal Rehabilitation Level II Study (2016)
-Heart Mountain Canal Rehabilitation Level II Study (2017)
-North End Water Users Study Level I Study (1999)
-Powell Airport Water Supply Level I Study (2010)
-Level II Feasibility Study, Iron Creek Project Shoshone Irrigation District (1982)
-Pre-Level I Analysis of Water Development Potential, Clarks Fork River (1983)
-Willwood Hydroelectric Project Report on Feasibility Study (1982)
-Willwood Dam Rehabilitation Project (1989)
-Irrigation Hydropower Study Level II (2003)
-Willwood Irrigation District Master Plan Level I Study (2006)
-Willwood Rehabilitation and GIS Level II Study (2009)
-Willwood Irrigation District Master Plan Update Level I Study (2015)
-Corbett Dam and Tunnel Rehabilitation Study (1983)
-Shoshone Municipal Water Supply Project Level II Investigation(1986)
-Shoshone Municipal Water Supply Pipelines, Level III (1986)
-Big Horn Basin Rural Water Supply, Phase I (1989)
-Big Horn Basin Rural Water Supply Phase II (1990)
-Cody Area Level II Water Supply Project (1996)
-City of Cody Raw Water System Analysis and Proposed Expansion Evaluation (1996)
-Cody Canal Irrigation District Rehabilitation and Hydropower Level II Study (2006)
-Cody Canal Irrigation District Purvis Drop Hydropower Level II, Phase II Study (2008)
-Cody Master Plan Level I Study (2009)
-Cody Canal Irrigation District Rehabilitation and GIS Level II Study (2009)
-Cody Canal Laterals Level II Study (2018)
-Treated Water, City of Cody Master Plan, Level 1 Study (2021)
-Raw Water, City of Cody Master Plan, Level 1 Study (2021)
-Report on Lakeview Irrigation District Consumptive Use and Irrigation Demand Cody, WY (1985)
-Report on Lakeview Irrigation District Value of Production with a Normal and Inadequate Water Supply at Cody, WY (1985)
-Shoshone/Lakeview Water Development Project (1985)
-Cody-Lakeview Irrigation Exchange Project Level II Investigation (1986)
-Lakeview Irrigation Master Plan Level II Study (2013)
Basinwide Projects/Studies:
-Big Horn Basin-Clarks Fork Level II Study (1986)
-Guidebook for Water Resources Management & Development, Big Horn & Clarks Fork Basins (1988)
-Wind/Bighorn River Basin Plan (2003)
-Wind-Bighorn Basin Plan Update (2010)
-Wind/Bighorn River Basin Water Plan Update Groundwater Study Level I (2012)
-Wind/Bighorn River Basin Plan Update Environmental and Recreational Water Use Analysis (2017)
Montana
Wyoming
Park County
Clarks Fork Basin
Upper Shoshone Basin
Bighorn County
Teton County
Fremont County
Hot Springs County
Powell
Cody
Meeteetse
Dubois
Clarks Fork Yellowstone River
Sunlight Creek
Dead Indian Creek
Pat O'Hara Creek
Bitter Creek
Shoshone River
North Fork Shoshone River
Buffalo Bill Reservoir
Sage Creek
Ishawooa Creek
South Fork Shoshone River
ABSAROKA RANGE
CARTER MOUNTAIN
POWELL FLATS
212
296
294
120
ALT 14
14
20
16
Data Source:
Wyoming Geospatial Hub
USGS National Hydrography Dataset
Wyoming Water Resources Data System (WRDS)
Legend
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N S E W
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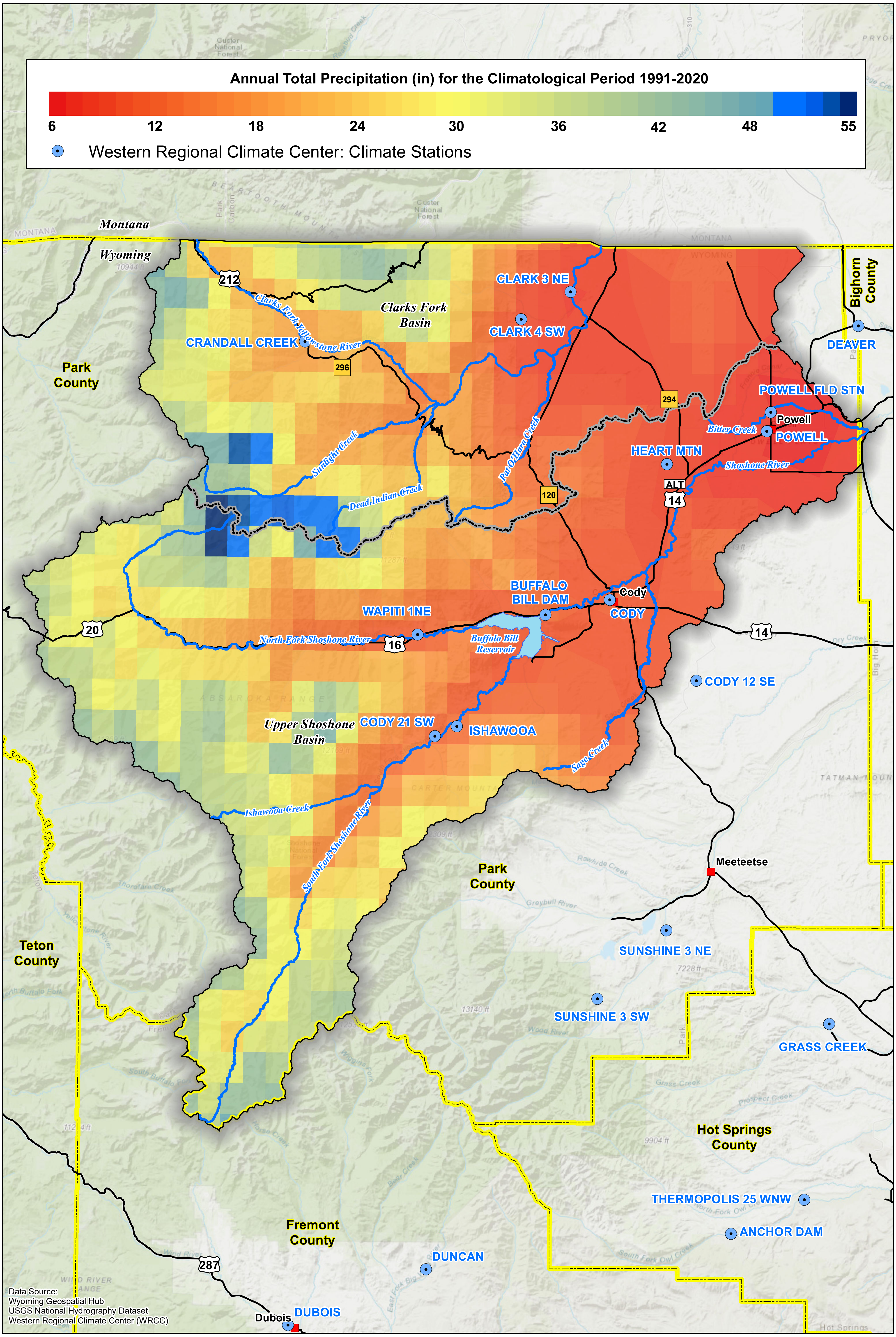
Map 2
WWDO Projects and Studies
Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY
Drawn By: BDT
Checked By: JDS
Scale: See Scale Bar
Date: 4/19/22
File: WWDO.mxd



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Miles

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Map 3

Mean Annual Precipitation

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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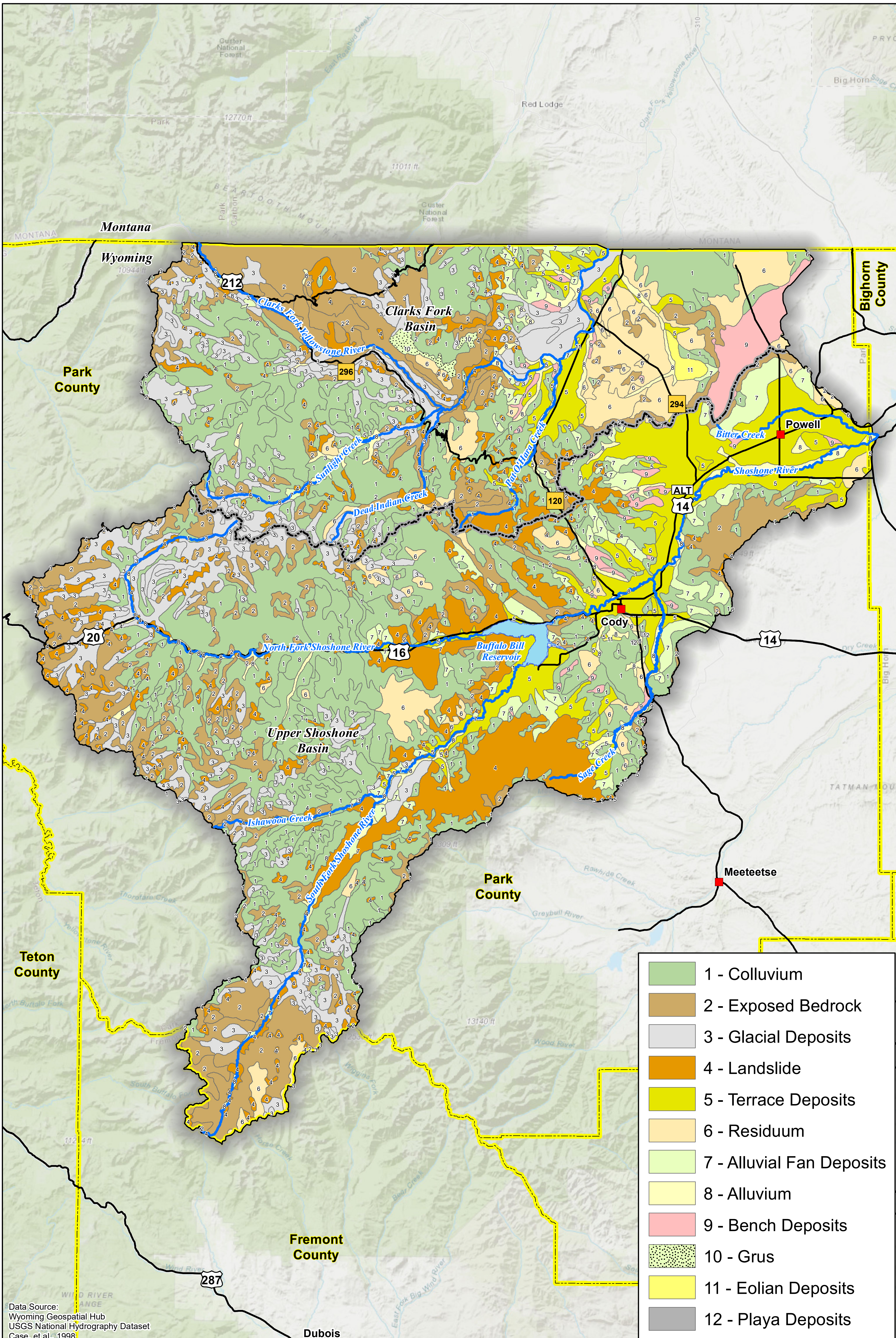

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Miles

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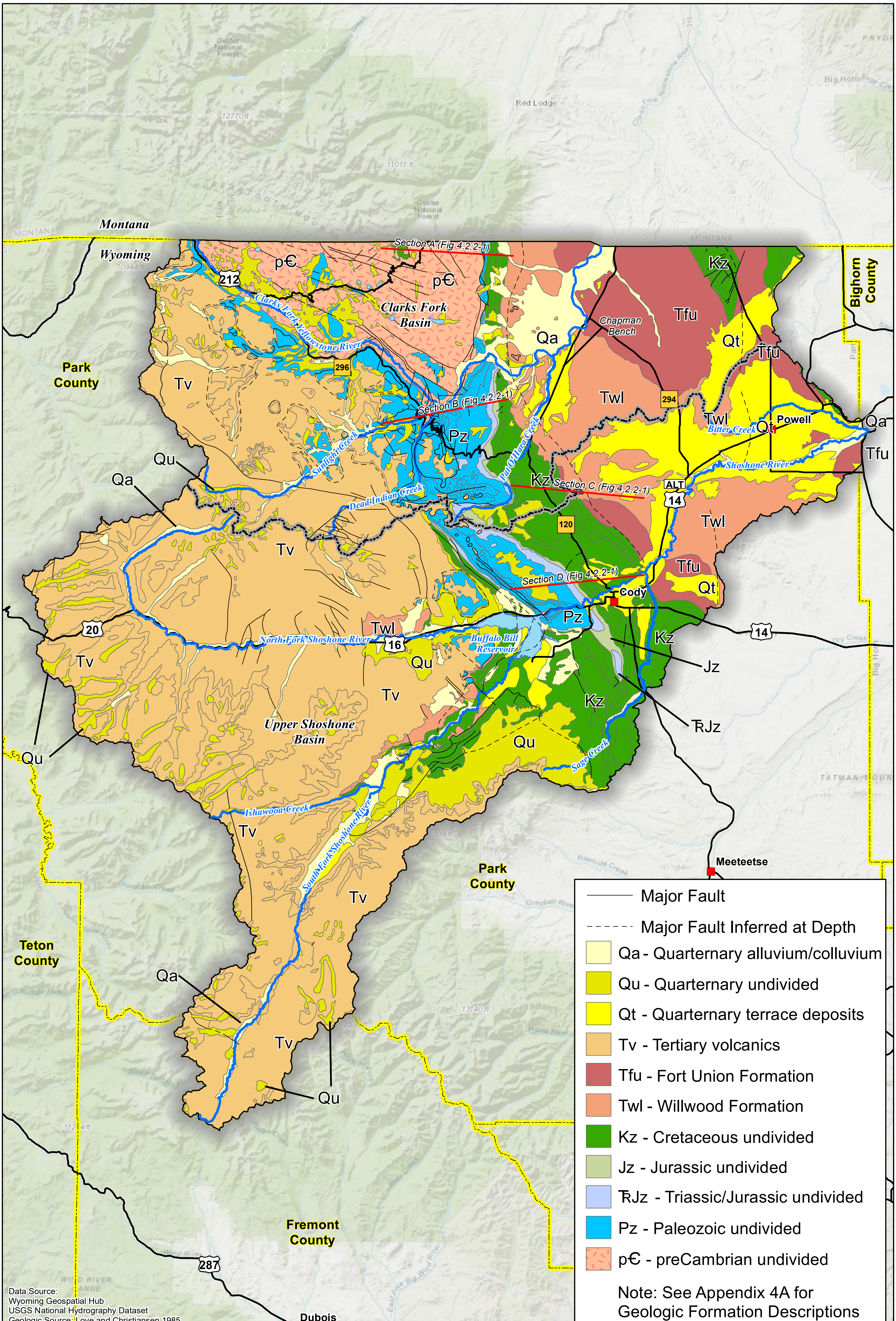
Map 4

Surficial Geology

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File:Surficial.mxd



Legend

City
Streams
Basin Divide
Lake/Reservoir
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Miles

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Map 5

Bedrock Geology

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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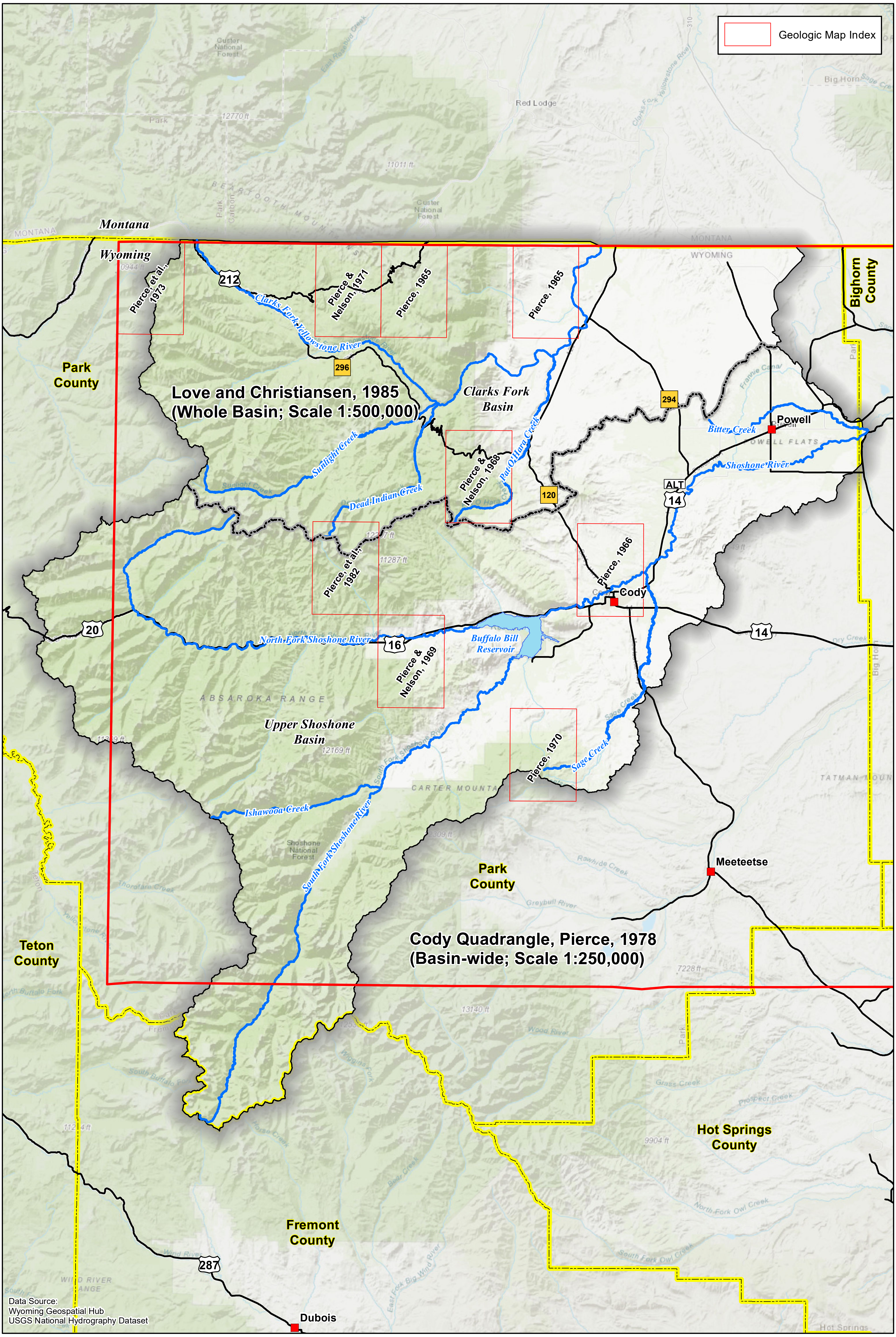

Legend

- City
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Miles

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Map 6

Index to Available Geologic Maps

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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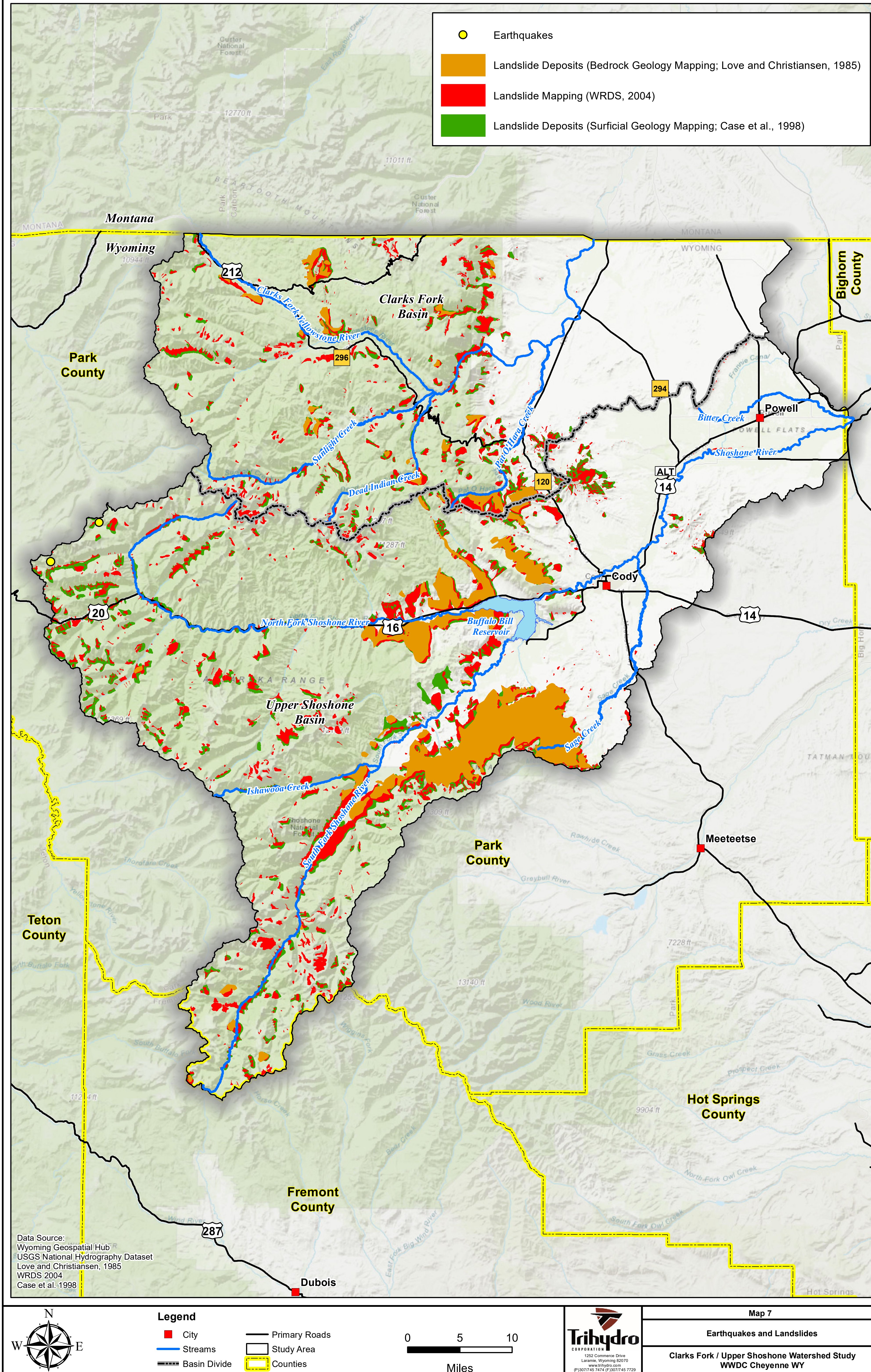

Map 7

Earthquakes and Landslides

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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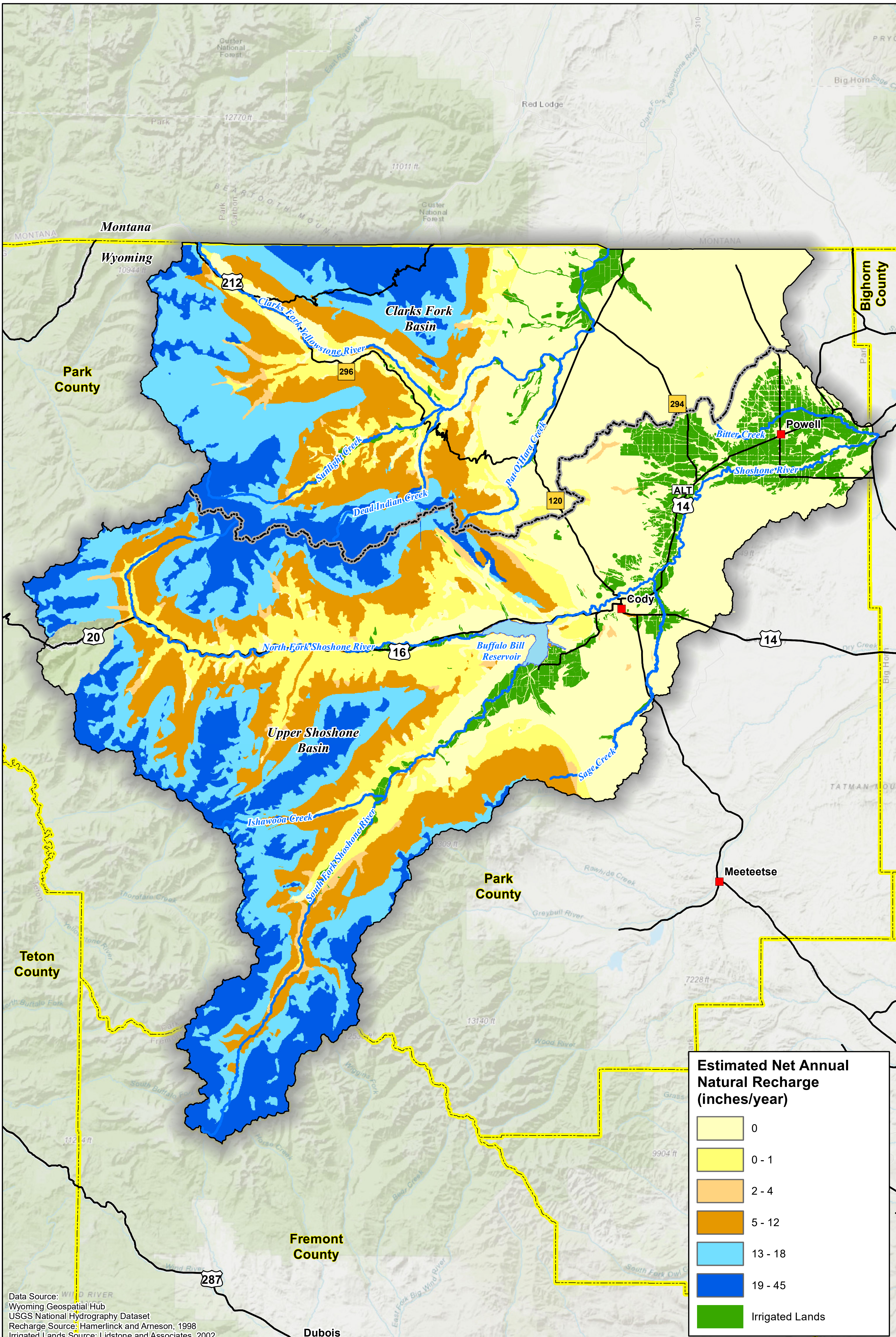
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/22	File: EarthQL.mxd



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Miles

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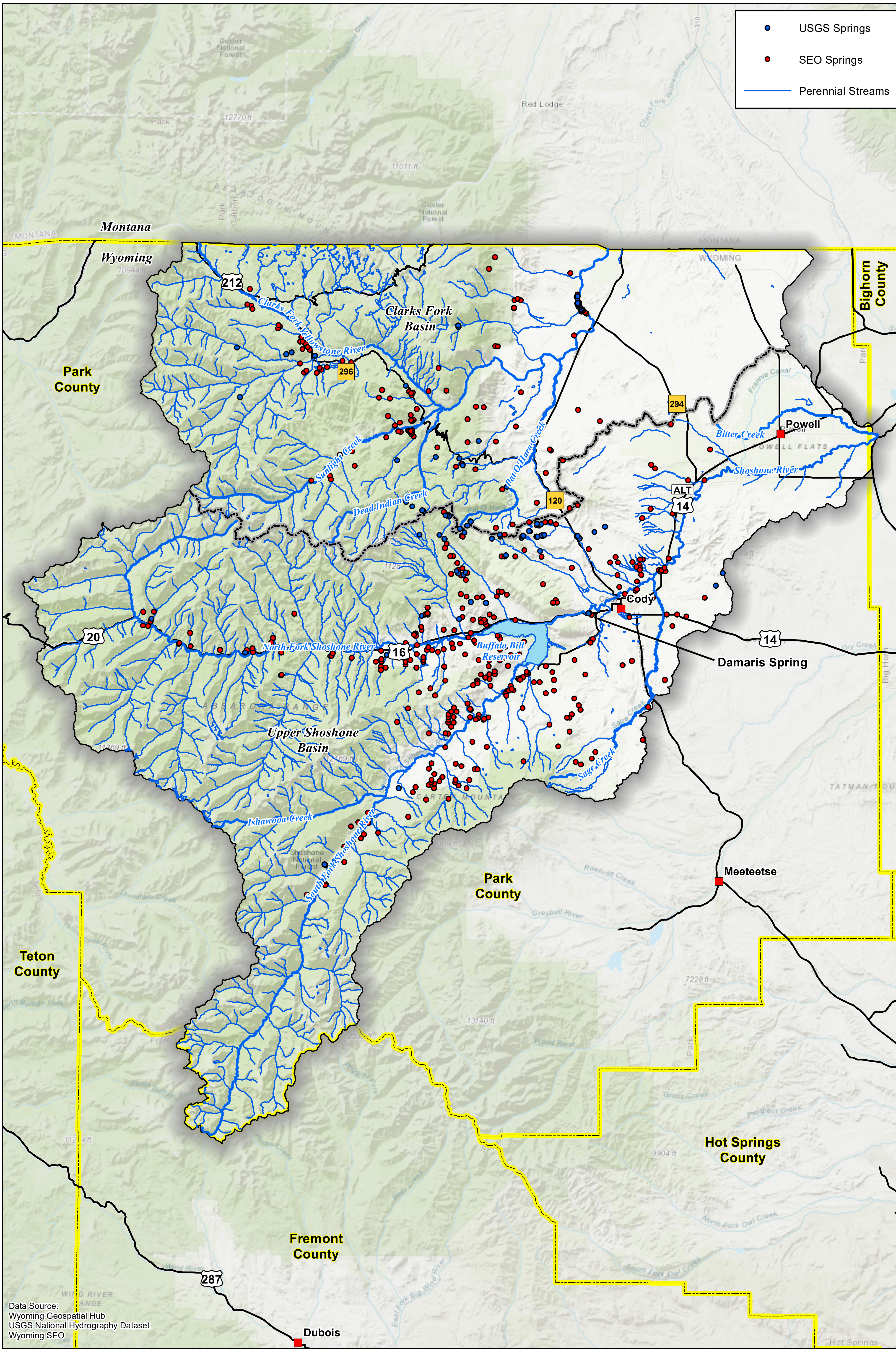
Map 8

Groundwater Recharge

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: Aqua_Rec.mxd



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Miles

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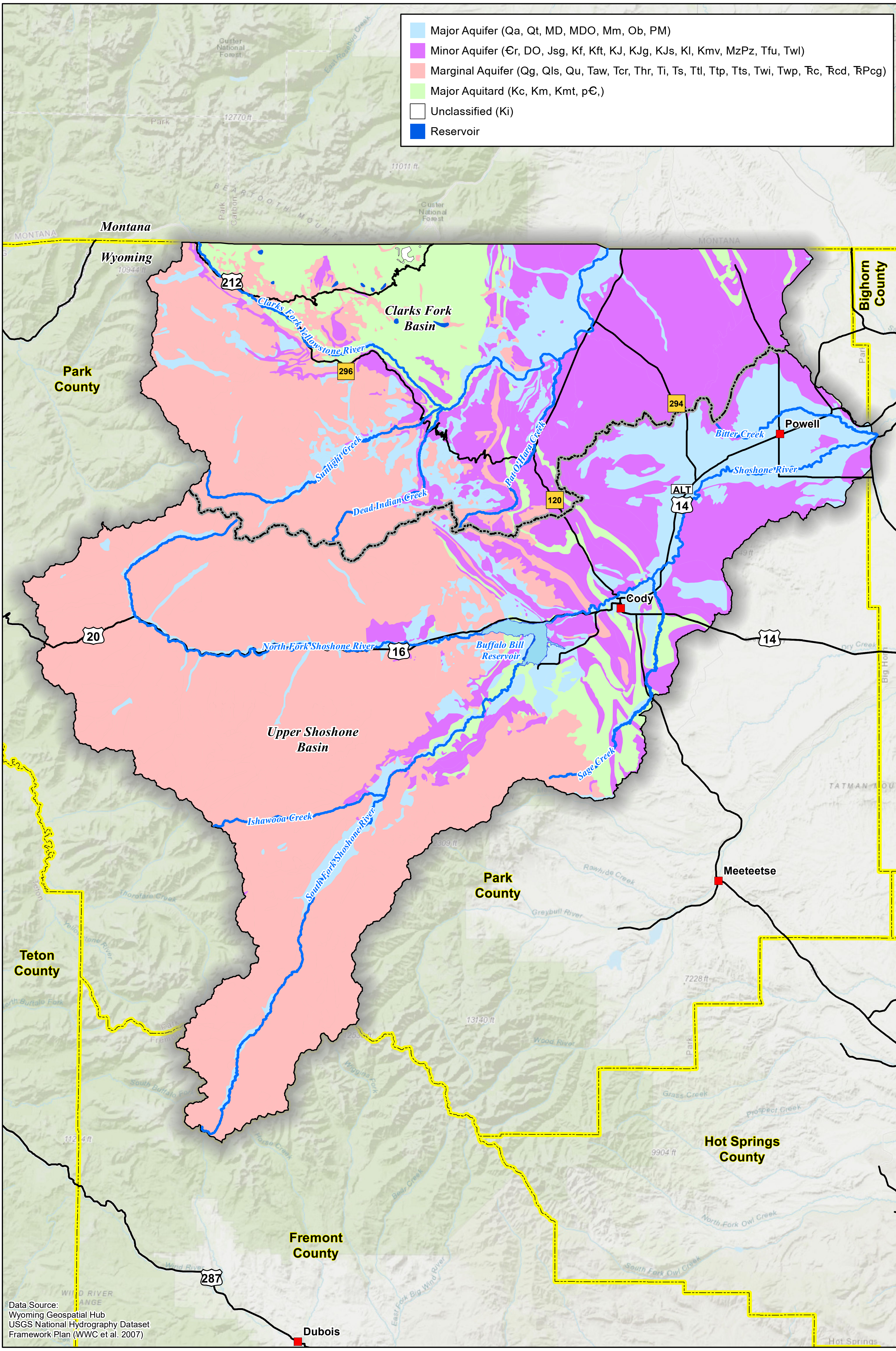
Map 9

Groundwater Discharge

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: Springs.mxd



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Miles

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Map 10

Aquifer Classification

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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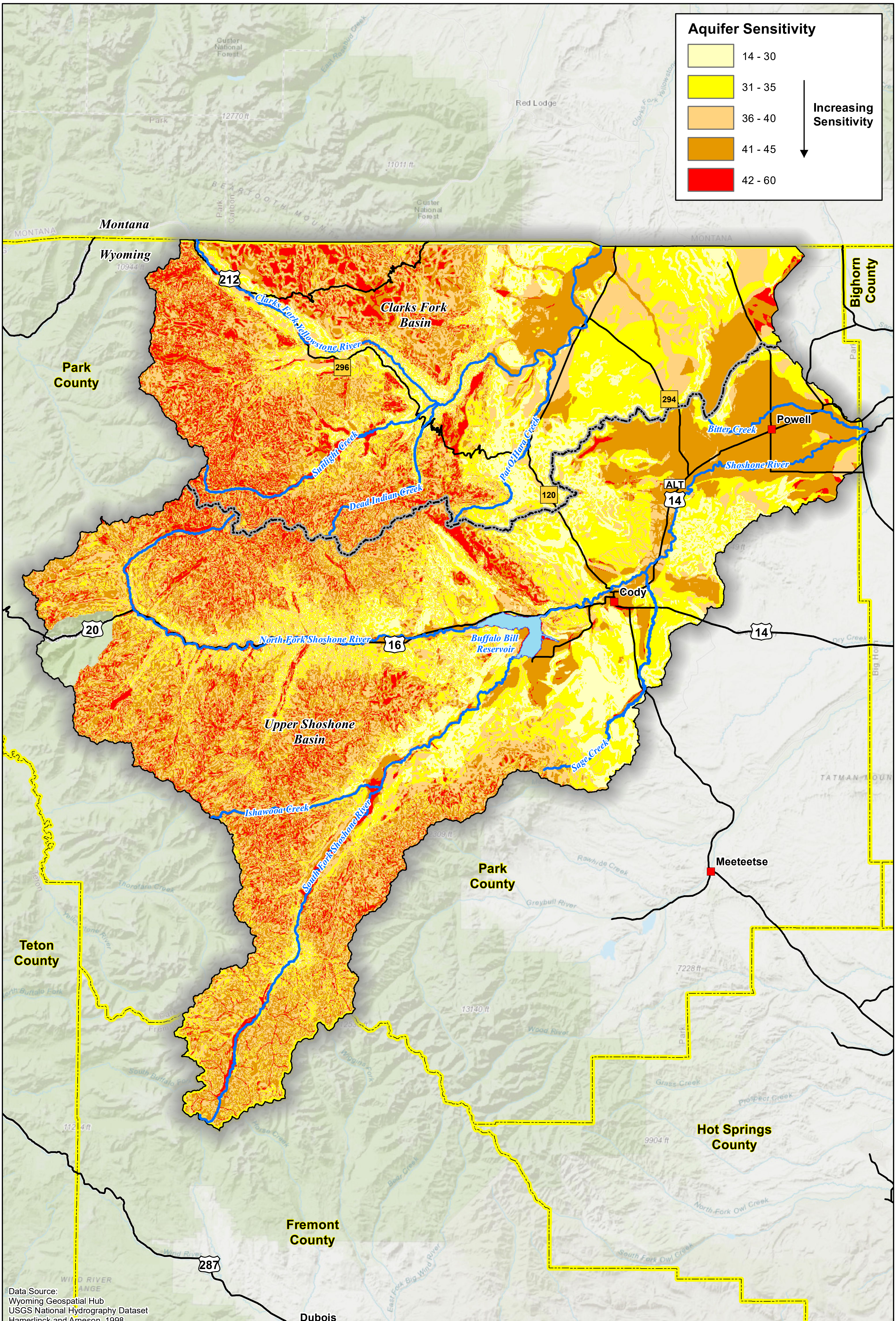

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Counties

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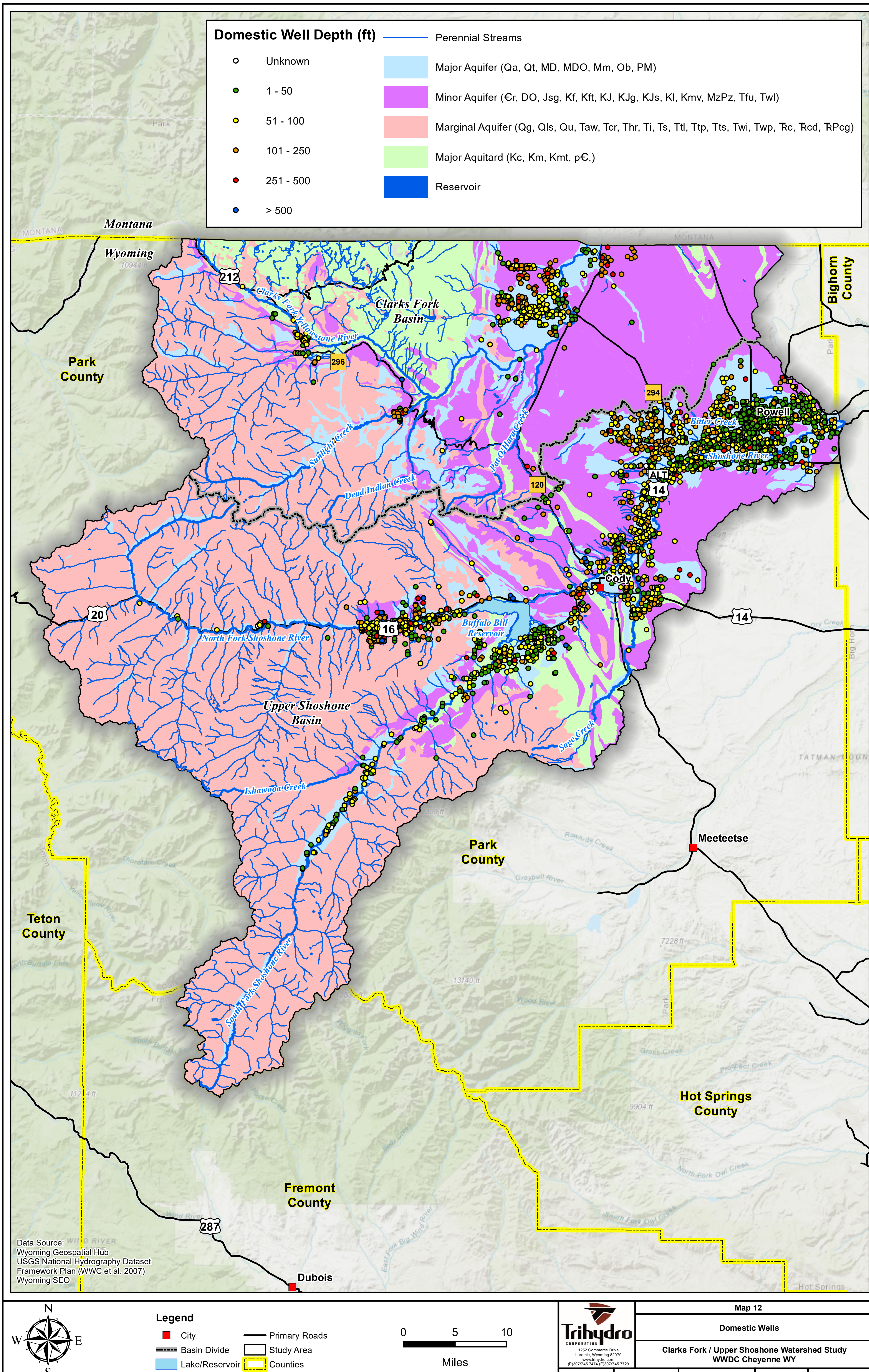
Map 11

Aquifer Sensitivity

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: Aq_sense.mxd



Domestic Well Depth (ft)
Unknown
1 - 50
51 - 100
101 - 250
251 - 500
> 500
Perennial Streams
Major Aquifer (Qa, Qt, MD, MDO, Mm, Ob, PM)
Minor Aquifer (Ꞓr, DO, Jsg, Kf, Kft, KJ, KJg, KJs, Kl, Kmv, MzPz, Tfu, Twl)
Marginal Aquifer (Qg, Qls, Qu, Taw, Tcr, Thr, Ti, Ts, Ttl, Ttp, Tts, Twi, Twp, Ꞇc, Ꞇcd, ꞆPcg)
Major Aquitard (Kc, Km, Kmt, pꞒ,)
Reservoir
Montana
Wyoming
Park County
Clarks Fork Basin
Clarks Fork Yellowstone River
Sunlight Creek
Dead Indian Creek
Pat O'Hara Creek
Bitter Creek
Shoshone River
Powell
Bighorn County
Cody
North Fork Shoshone River
Buffalo Bill Reservoir
Upper Shoshone Basin
Ishawooa Creek
Sage Creek
South Fork Shoshone River
Meeteetse
Teton County
Hot Springs County
Fremont County
Dubois
212
296
294
120
ALT 14
20
16
14
287
Data Source:
Wyoming Geospatial Hub
USGS National Hydrography Dataset
Framework Plan (WWC et al. 2007)
Wyoming SEO
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Legend
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0
5
10
Miles
Trihydro
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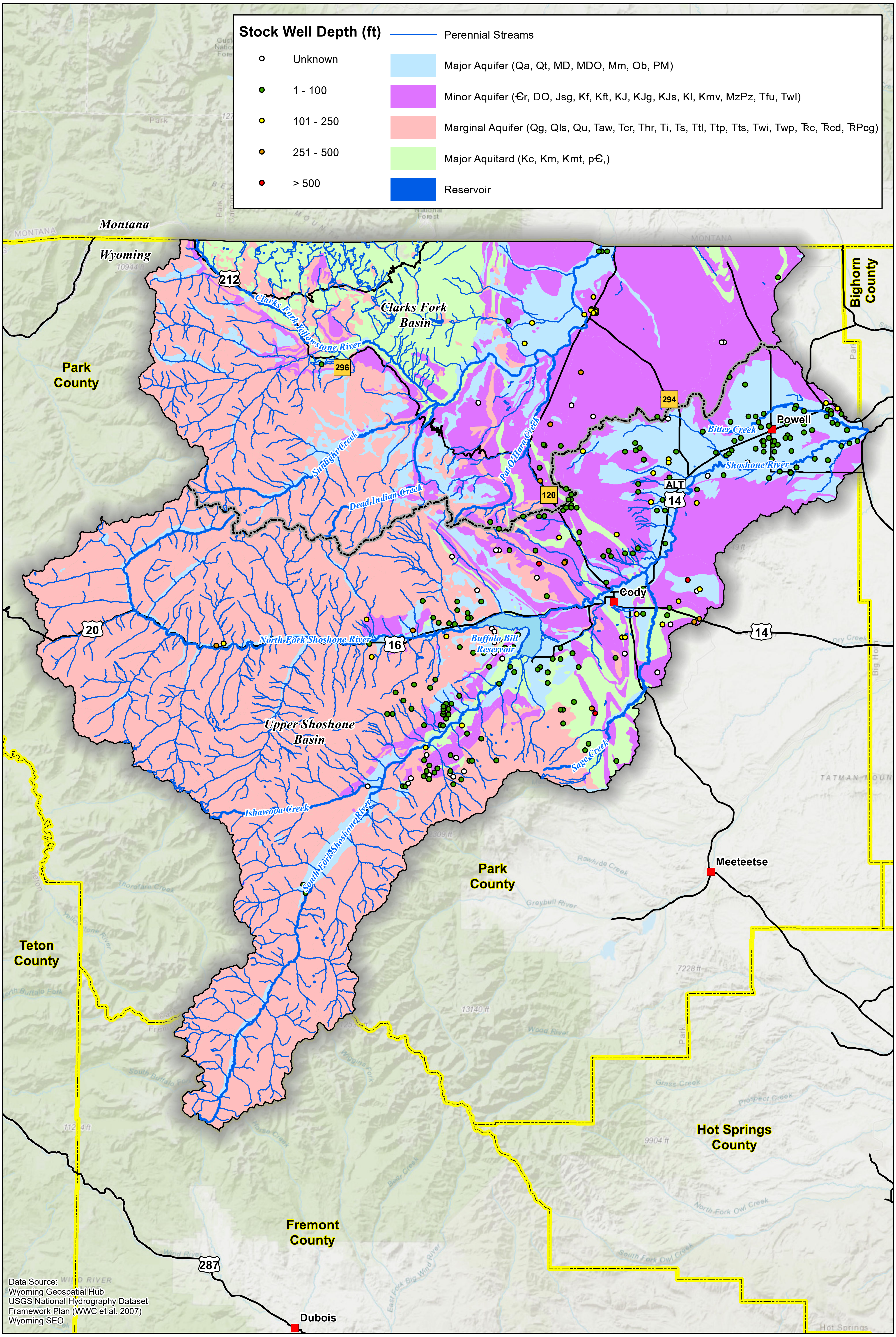
Map 12
Domestic Wells
Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY
Drawn By: BDT
Checked By: JDS
Scale: See Scale Bar
Date: 9/18/23
File: DomPerm.mxd



Legend

- City
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0 5 10 Miles

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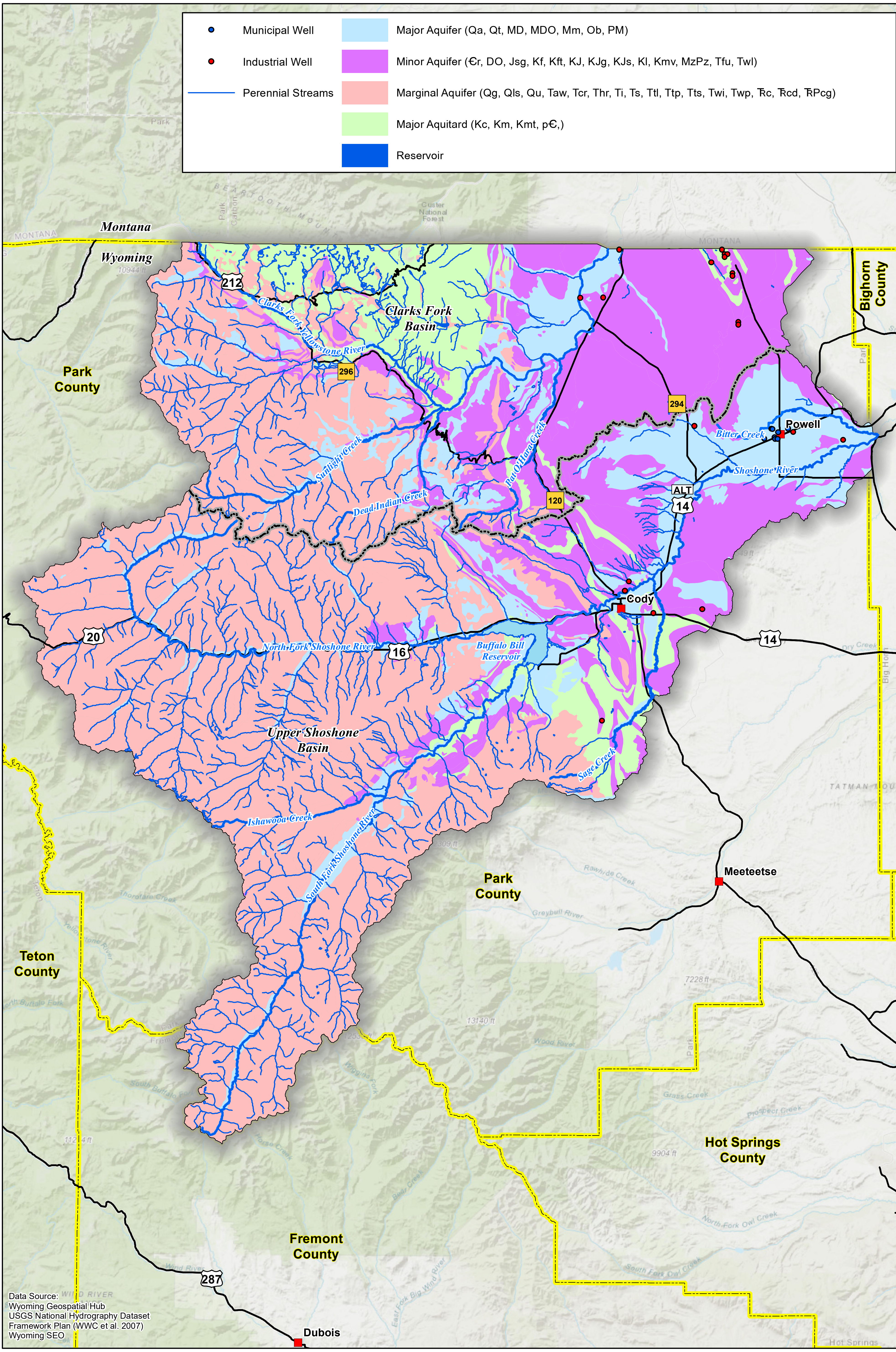
Map 13

Stock Wells

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: Stock_per.mxd



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Legend

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0 5 10
Miles

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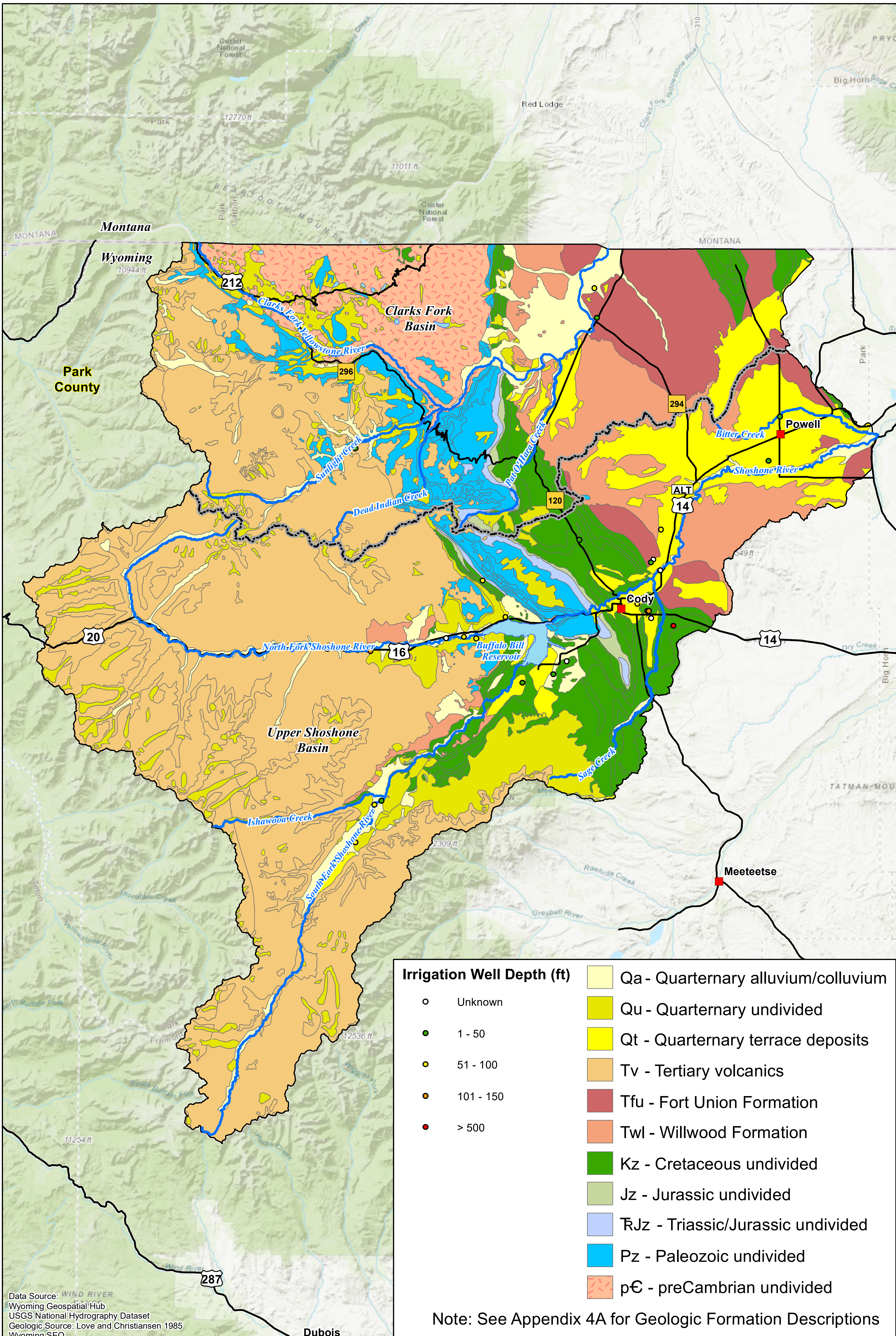
Map 14				
Municipal and Industrial Wells				
Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY				
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: Muni_Ind.mxd



N S W E

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Miles

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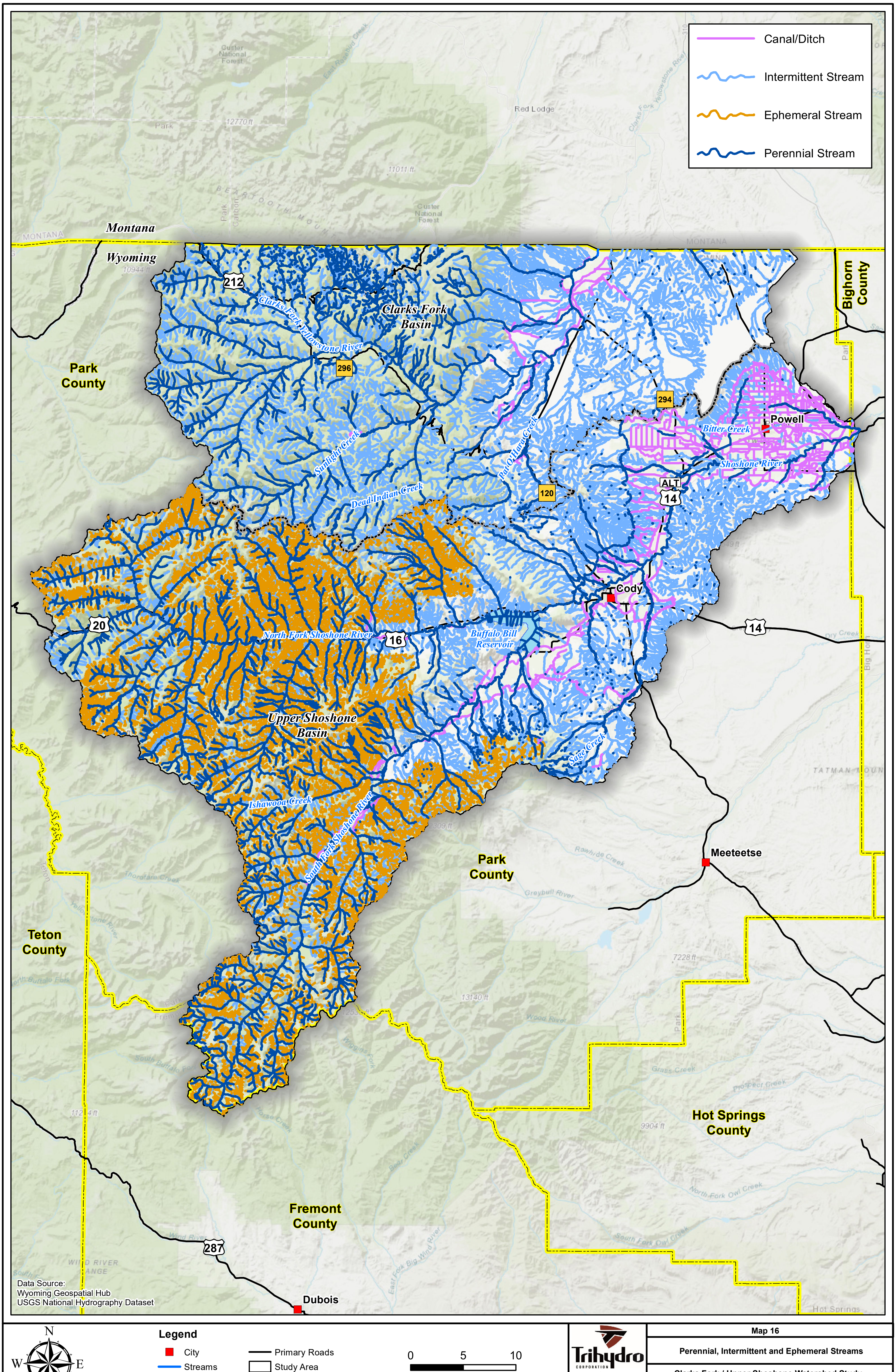
Map 15

Irrigation Wells

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: IrrPer.mxd



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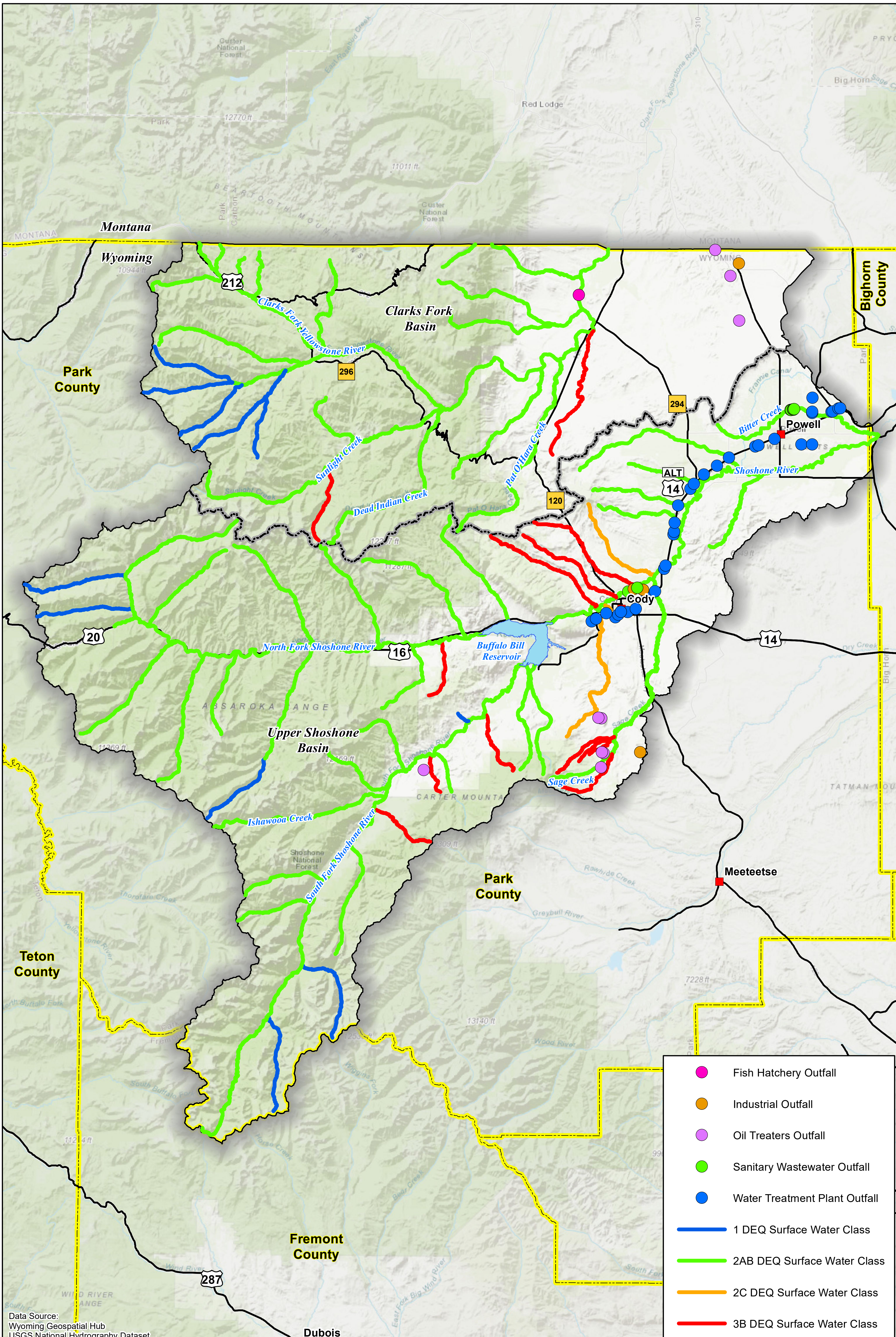
Map 16

Perennial, Intermittent and Ephemeral Streams

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/25/22	File: Perennial.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
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- Counties

0 5 10
Miles

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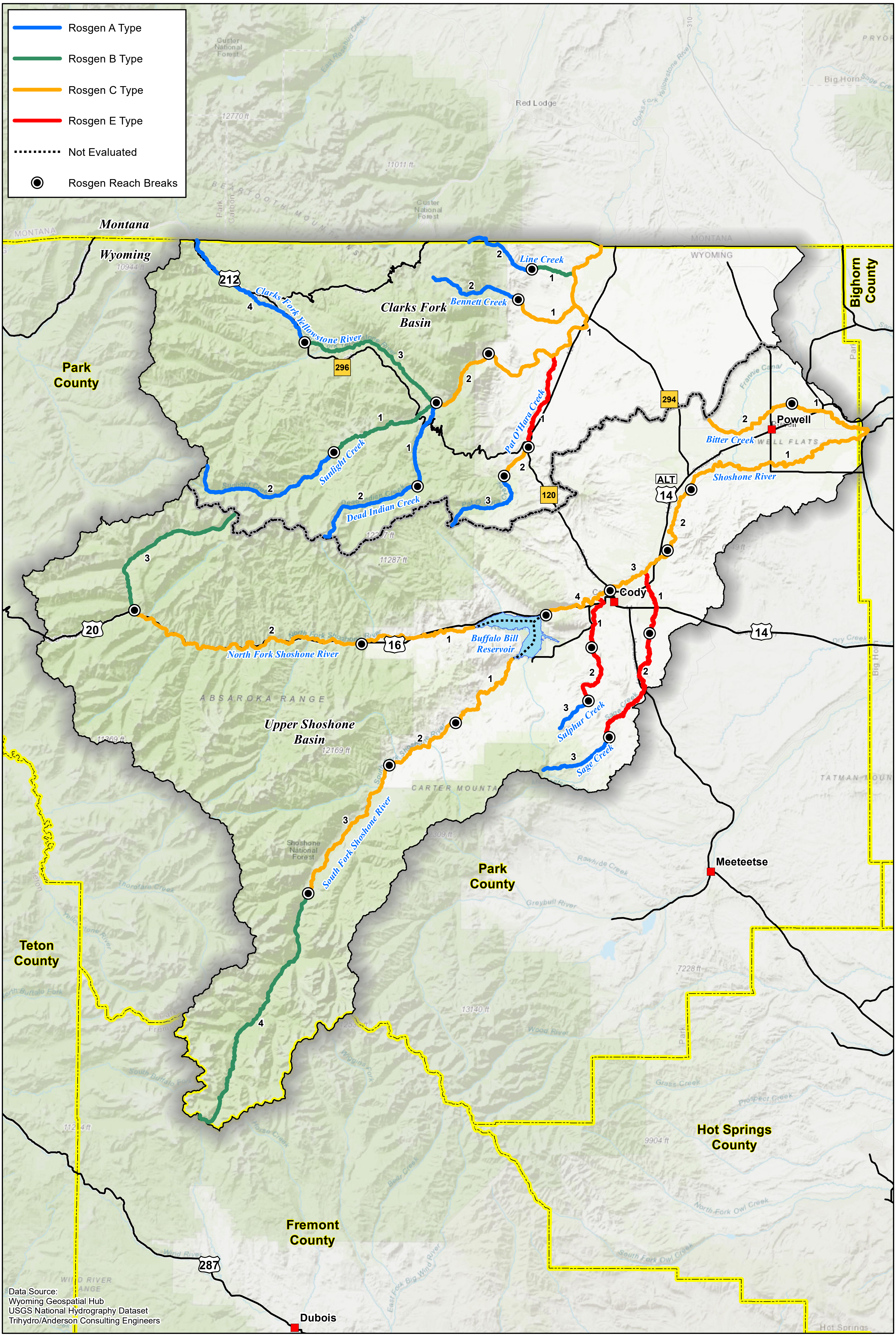
Map 17

WDEQ Surface Water Classes and WYPDES Outfalls (8/4/22)

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 8/4/22	File: DEQ_Cl.mxd



Legend

City | Primary Roads | Basin Divide | Study Area | Lake/Reservoir | Counties

0 5 10 Miles

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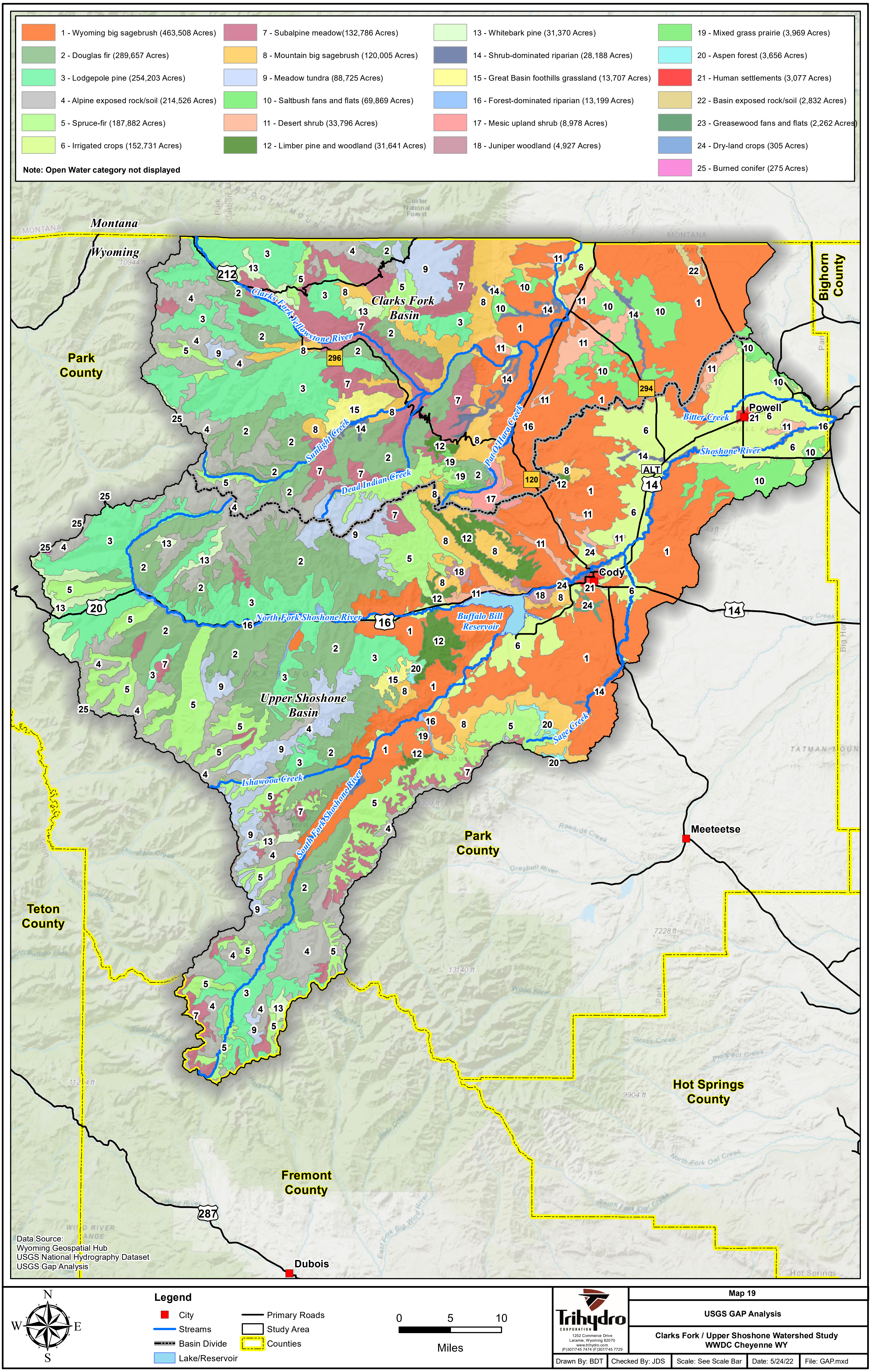
Map 18

Rosgen Level I Classification

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 5/1/23 | File: Rosgen.mxd



1 - Wyoming big sagebrush (463,508 Acres)
2 - Douglas fir (289,657 Acres)
3 - Lodgepole pine (254,203 Acres)
4 - Alpine exposed rock/soil (214,526 Acres)
5 - Spruce-fir (187,882 Acres)
6 - Irrigated crops (152,731 Acres)
7 - Subalpine meadow(132,786 Acres)
8 - Mountain big sagebrush (120,005 Acres)
9 - Meadow tundra (88,725 Acres)
10 - Saltbush fans and flats (69,869 Acres)
11 - Desert shrub (33,796 Acres)
12 - Limber pine and woodland (31,641 Acres)
13 - Whitebark pine (31,370 Acres)
14 - Shrub-dominated riparian (28,188 Acres)
15 - Great Basin foothills grassland (13,707 Acres)
16 - Forest-dominated riparian (13,199 Acres)
17 - Mesic upland shrub (8,978 Acres)
18 - Juniper woodland (4,927 Acres)
19 - Mixed grass prairie (3,969 Acres)
20 - Aspen forest (3,656 Acres)
21 - Human settlements (3,077 Acres)
22 - Basin exposed rock/soil (2,832 Acres)
23 - Greasewood fans and flats (2,262 Acres)
24 - Dry-land crops (305 Acres)
25 - Burned conifer (275 Acres)
Note: Open Water category not displayed
Montana
Wyoming
Park County
Bighorn County
Teton County
Fremont County
Hot Springs County
Clarks Fork Basin
Upper Shoshone Basin
Clarks Fork Yellowstone River
Sunlight Creek
Dead Indian Creek
Pat O'Hara Creek
Bitter Creek
Shoshone River
North Fork Shoshone River
Buffalo Bill Reservoir
Sage Creek
Ishawooa Creek
South Fork Shoshone River
Powell
Cody
Meeteetse
Dubois
Data Source:
Wyoming Geospatial Hub
USGS National Hydrography Dataset
USGS Gap Analysis
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Lake/Reservoir
Primary Roads
Study Area
Counties
0 5 10
Miles
Trihydro
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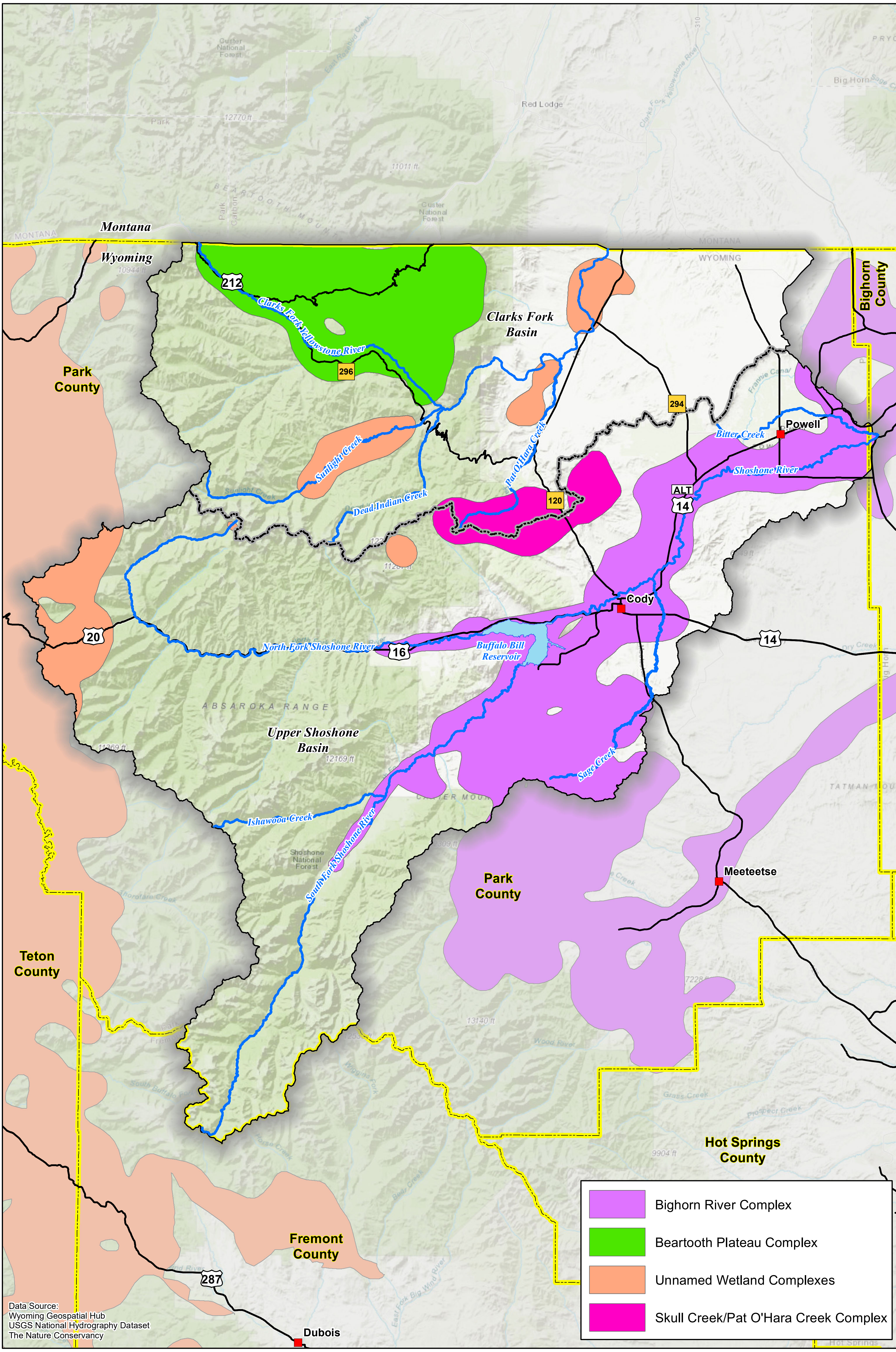
Map 19
USGS GAP Analysis
Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY
Drawn By: BDT
Checked By: JDS
Scale: See Scale Bar
Date: 5/24/22
File: GAP.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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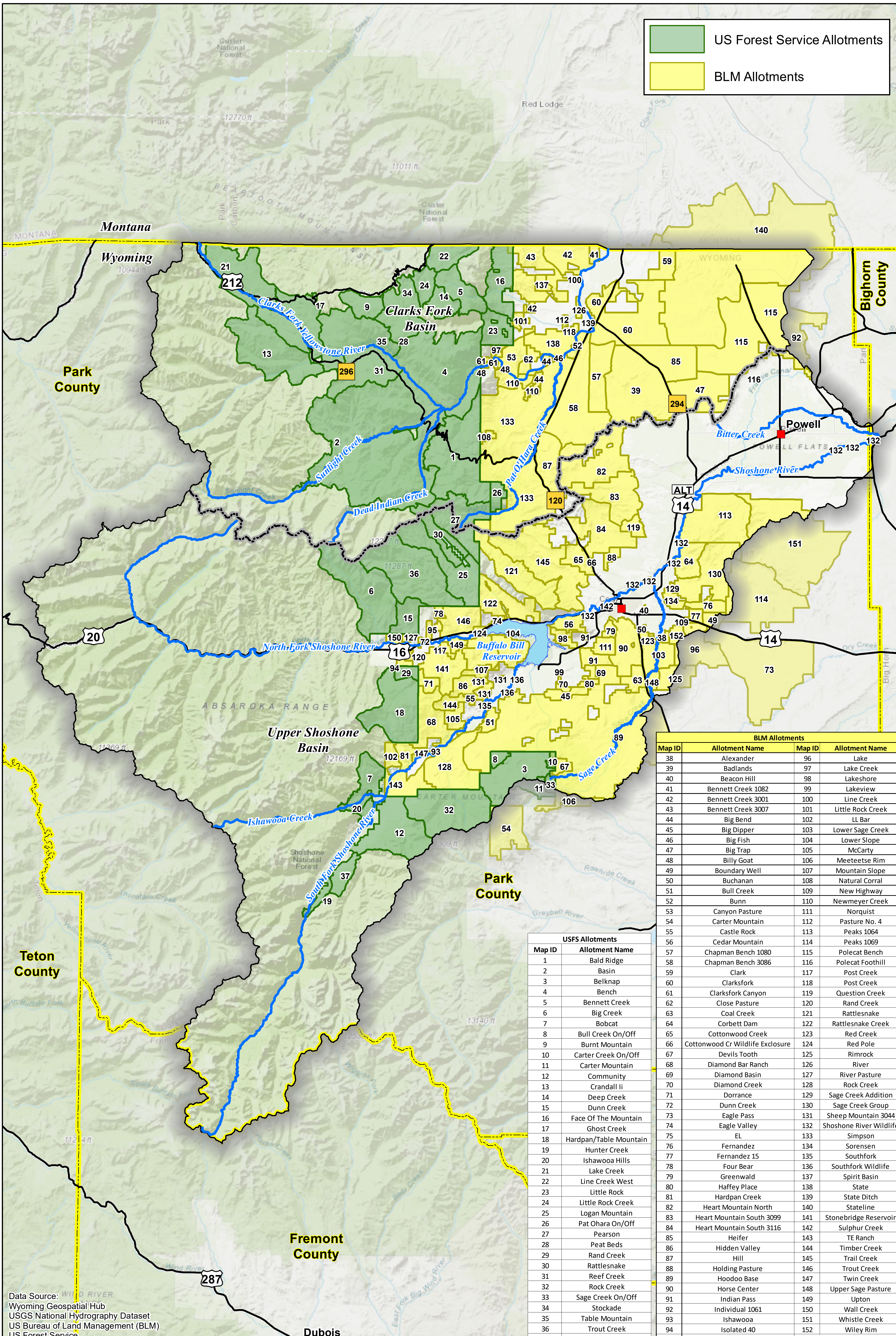
Map 20

Wetland Complexes

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 5/26/22	File: WetComp.mxd



BLM Allotments			
Map ID	Allotment Name	Map ID	Allotment Name
38	Alexander	96	Lake
39	Badlands	97	Lake Creek
40	Beacon Hill	98	Lakeshore
41	Bennett Creek 1082	99	Lakeview
42	Bennett Creek 3001	100	Line Creek
43	Bennett Creek 3007	101	Little Rock Creek
44	Big Bend	102	LL Bar
45	Big Dipper	103	Lower Sage Creek
46	Big Fish	104	Lower Slope
47	Big Trap	105	McCarty
48	Billy Goat	106	Meeteetse Rim
49	Boundary Well	107	Mountain Slope
50	Buchanan	108	Natural Corral
51	Bull Creek	109	New Highway
52	Bunn	110	Newmeyer Creek
53	Canyon Pasture	111	Norquist
54	Carter Mountain	112	Pasture No. 4
55	Castle Rock	113	Peaks 1064
56	Cedar Mountain	114	Peaks 1069
57	Chapman Bench 1080	115	Polecat Bench
58	Chapman Bench 3086	116	Polecat Foothill
59	Clark	117	Post Creek
60	Clarksfork	118	Post Creek
61	Clarksfork Canyon	119	Question Creek
62	Close Pasture	120	Rand Creek
63	Coal Creek	121	Rattlesnake
64	Corbett Dam	122	Rattlesnake Creek
65	Cottonwood Creek	123	Red Creek
66	Cottonwood Cr Wildlife Exclosure	124	Red Pole
67	Devils Tooth	125	Rimrock
68	Diamond Bar Ranch	126	River
69	Diamond Basin	127	River Pasture
70	Diamond Creek	128	Rock Creek
71	Dorrance	129	Sage Creek Addition
72	Dunn Creek	130	Sage Creek Group
73	Eagle Pass	131	Sheep Mountain 3044
74	Eagle Valley	132	Shoshone River Wildlife
75	EL	133	Simpson
76	Fernandez	134	Sorensen
77	Fernandez 15	135	Southfork
78	Four Bear	136	Southfork Wildlife
79	Greenwald	137	Spirit Basin
80	Haffey Place	138	State
81	Hardpan Creek	139	State Ditch
82	Heart Mountain North	140	Stateline
83	Heart Mountain South 3099	141	Stonebridge Reservoir
84	Heart Mountain South 3116	142	Sulphur Creek
85	Heifer	143	TE Ranch
86	Hidden Valley	144	Timber Creek
87	Hill	145	Trail Creek
88	Holding Pasture	146	Trout Creek
89	Hoodoo Base	147	Twin Creek
90	Horse Center	148	Upper Sage Pasture
91	Indian Pass	149	Upton
92	Individual 1061	150	Wall Creek
93	Ishawooa	151	Whistle Creek
94	Isolated 40	152	Wiley Rim
95	Jim Creek		

USFS Allotments	
Map ID	Allotment Name
1	Bald Ridge
2	Basin
3	Belknap
4	Bench
5	Bennett Creek
6	Big Creek
7	Bobcat
8	Bull Creek On/Off
9	Burnt Mountain
10	Carter Creek On/Off
11	Carter Mountain
12	Community
13	Crandall Ii
14	Deep Creek
15	Dunn Creek
16	Face Of The Mountain
17	Ghost Creek
18	Hardpan/Table Mountain
19	Hunter Creek
20	Ishawooa Hills
21	Lake Creek
22	Line Creek West
23	Little Rock
24	Little Rock Creek
25	Logan Mountain
26	Pat Ohara On/Off
27	Pearson
28	Peat Beds
29	Rand Creek
30	Rattlesnake
31	Reef Creek
32	Rock Creek
33	Sage Creek On/Off
34	Stockade
35	Table Mountain
36	Trout Creek
37	Valley/Boulder

Legend
- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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Map 21

BLM and US Forest Service Grazing Allotments

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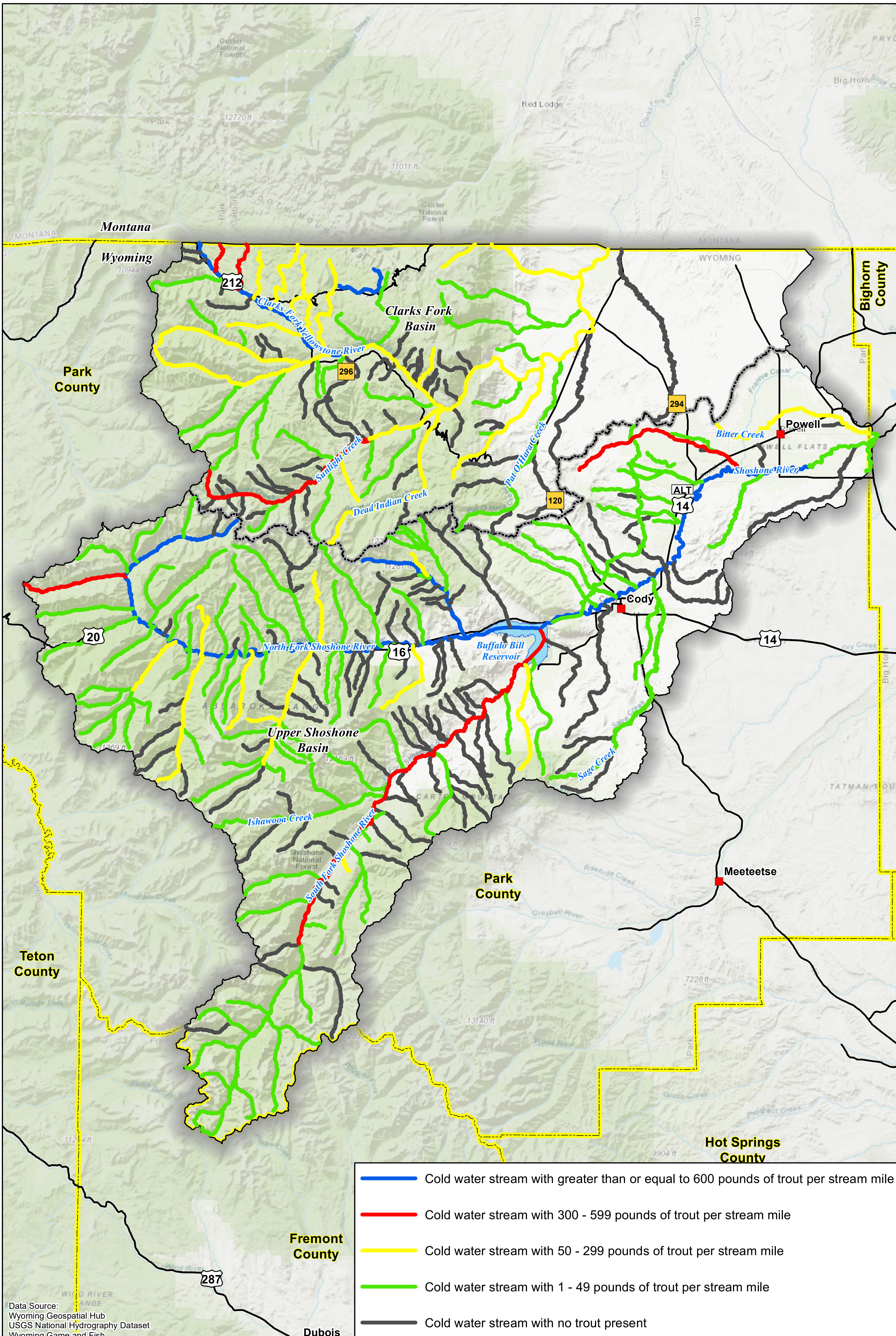
WWDC Cheyenne WY

Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 5/26/22 | File: Allot.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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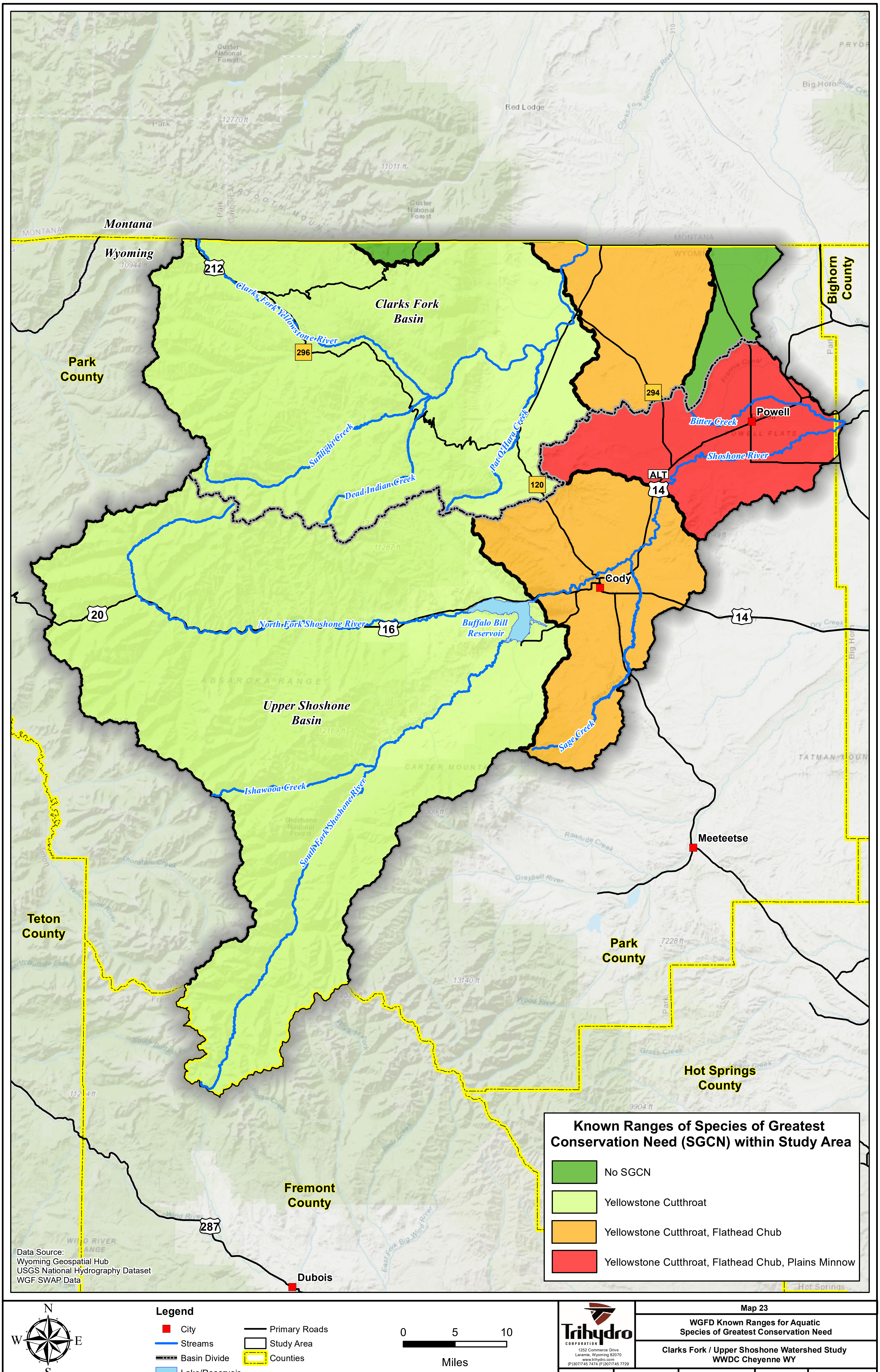
Map 22

WGFD Trout Stream Classifications

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/6/22	File: Trout.mxd

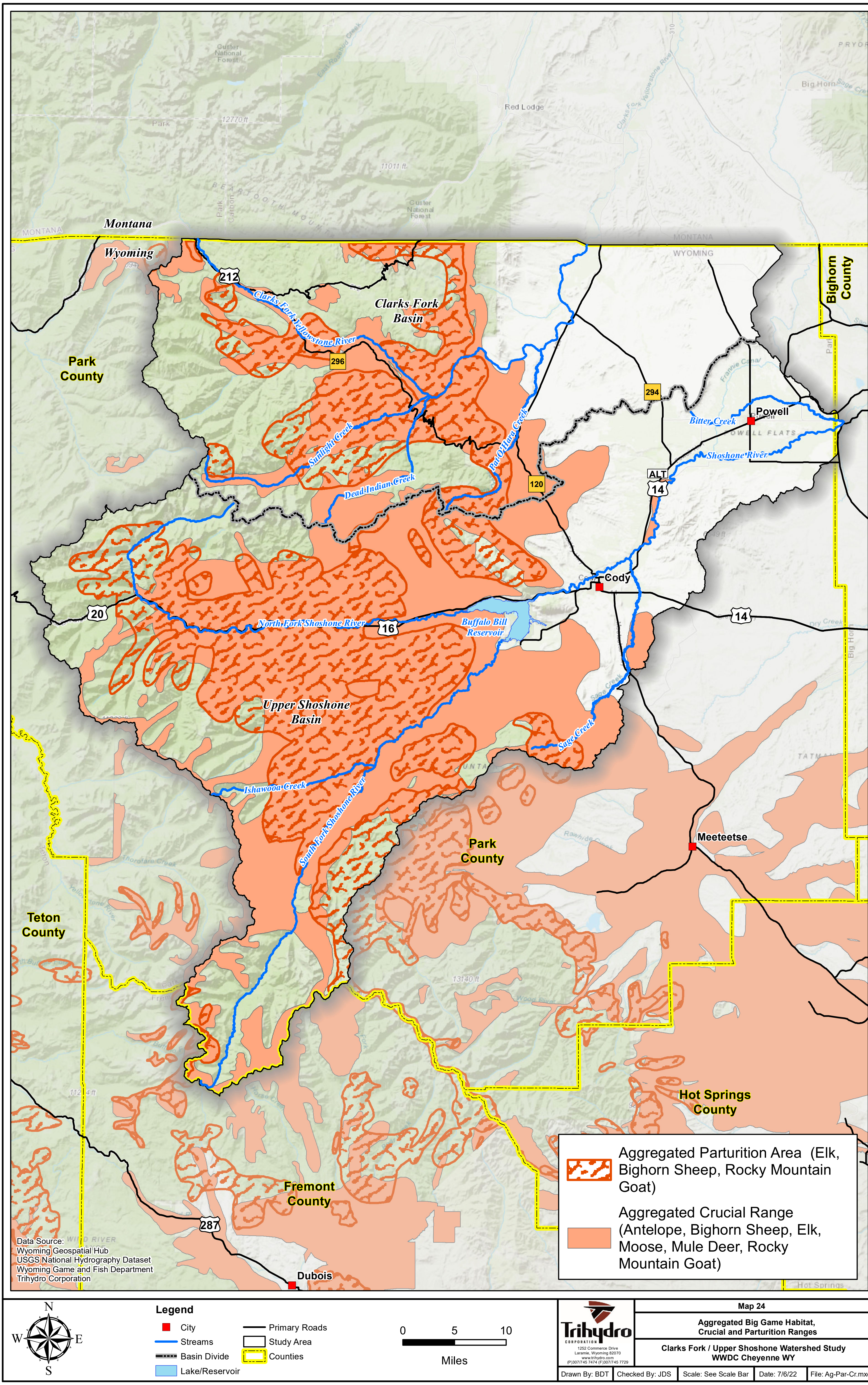


Map 23

WGFD Known Ranges for Aquatic Species of Greatest Conservation Need

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 7/6/22 | File: SGCN.mxd



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Map 24

Aggregated Big Game Habitat, Crucial and Parturition Ranges

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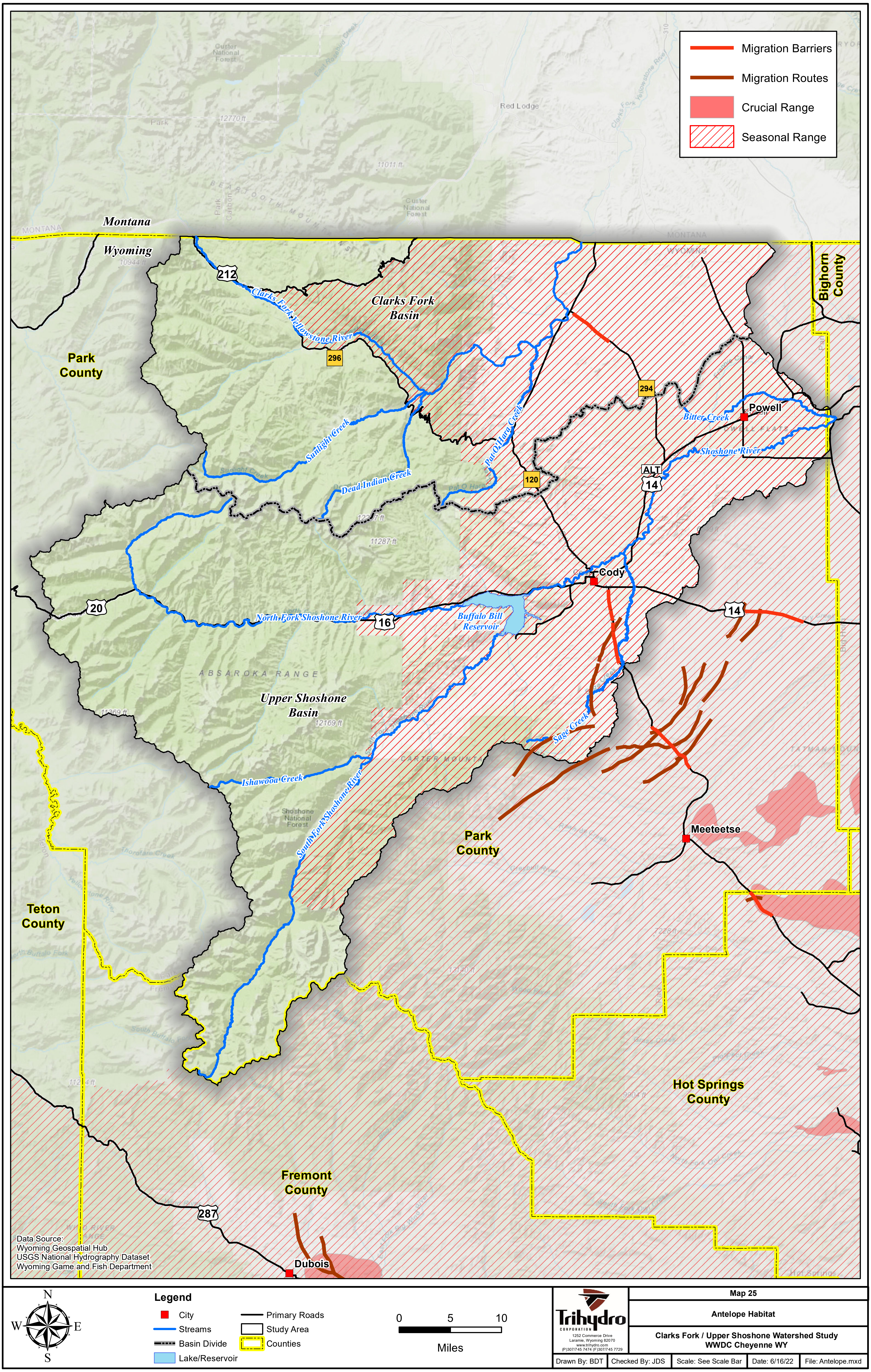
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/6/22	File: Ag-Par-Cr.mxd



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Map 25

Antelope Habitat

Clarks Fork / Upper Shoshone Watershed Study
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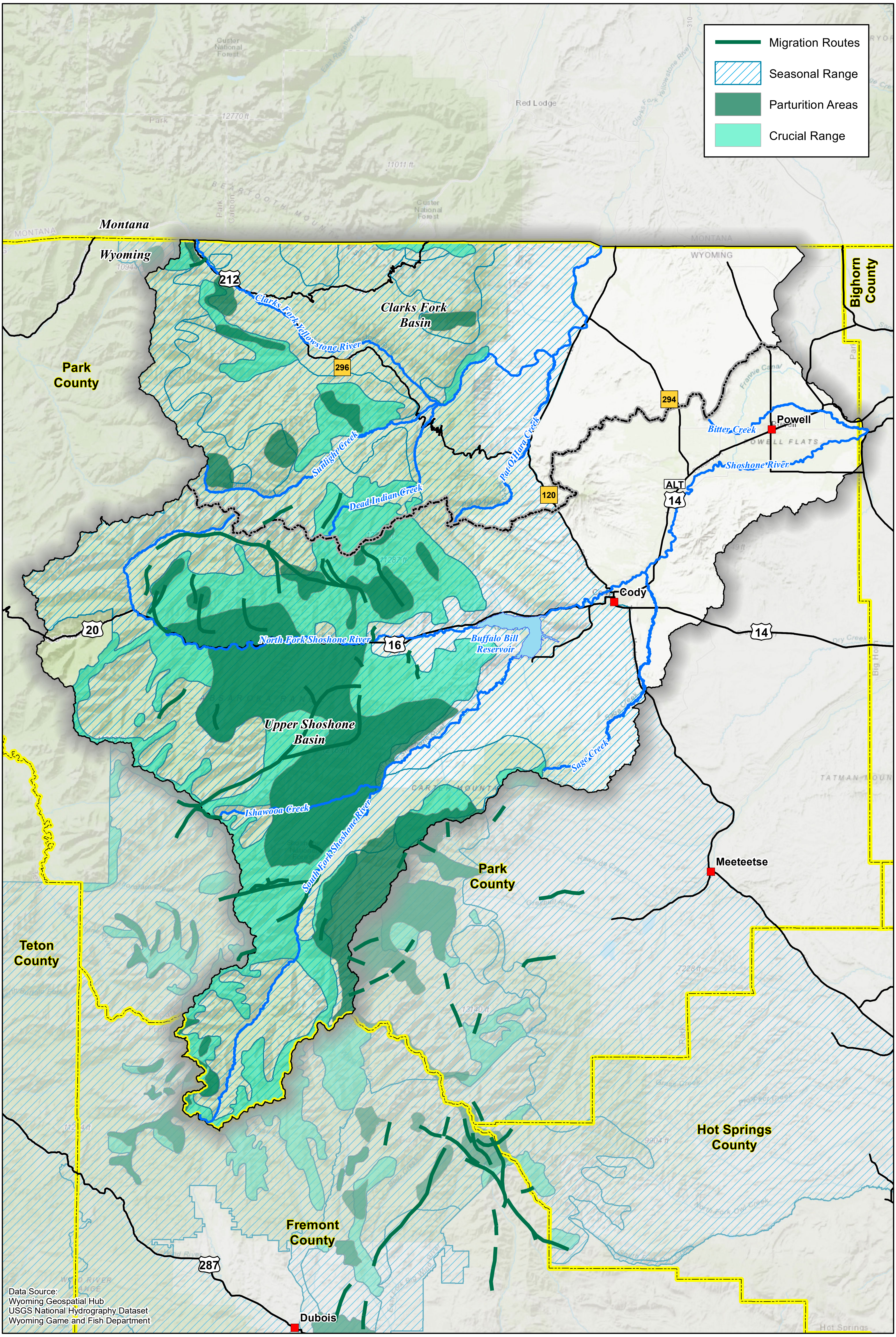
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/16/22	File: Antelope.mxd



Legend

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- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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Map 26

Bighorn Sheep Habitat

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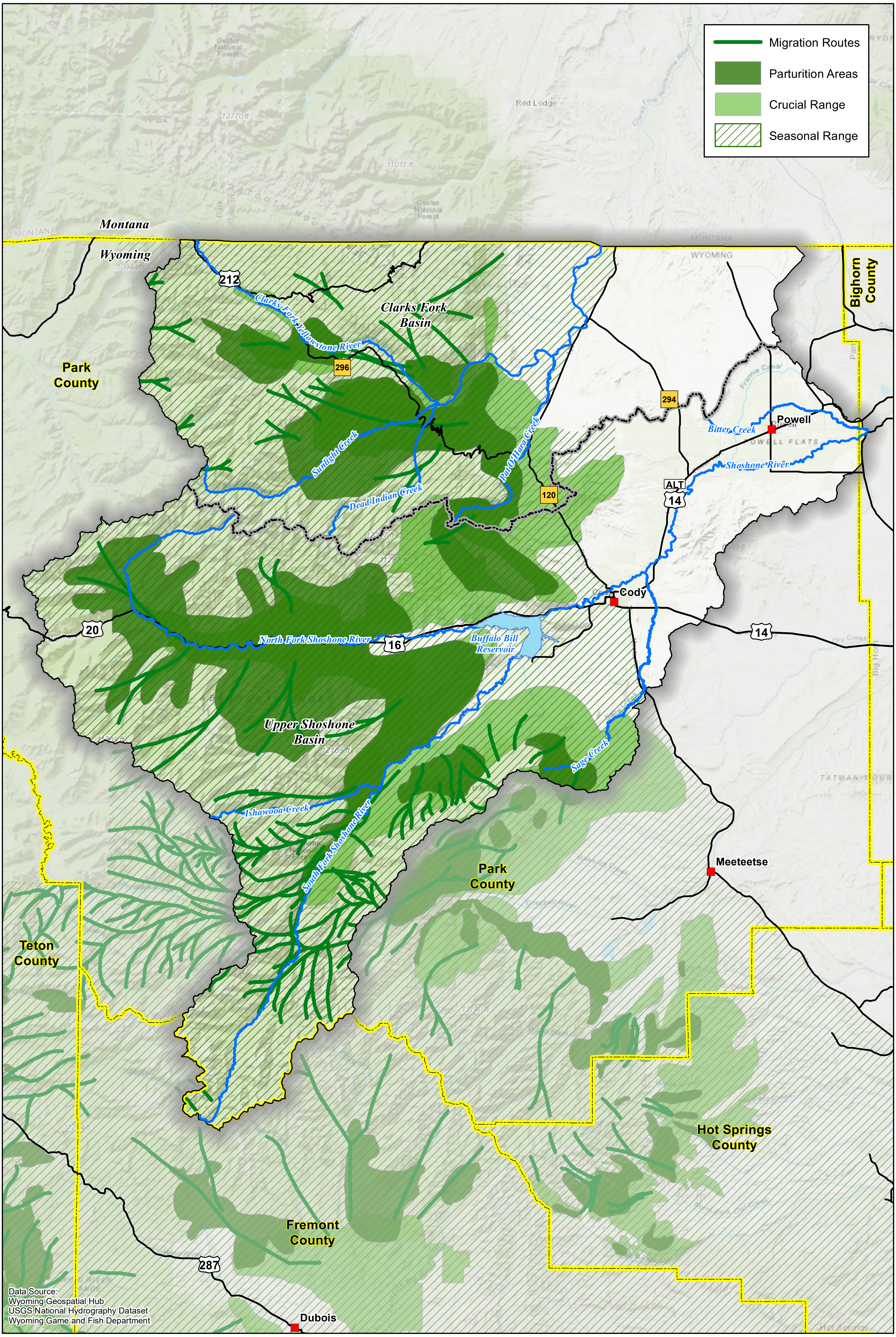
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/16/22	File: BHSheep.mxd



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Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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Map 27

Elk Habitat

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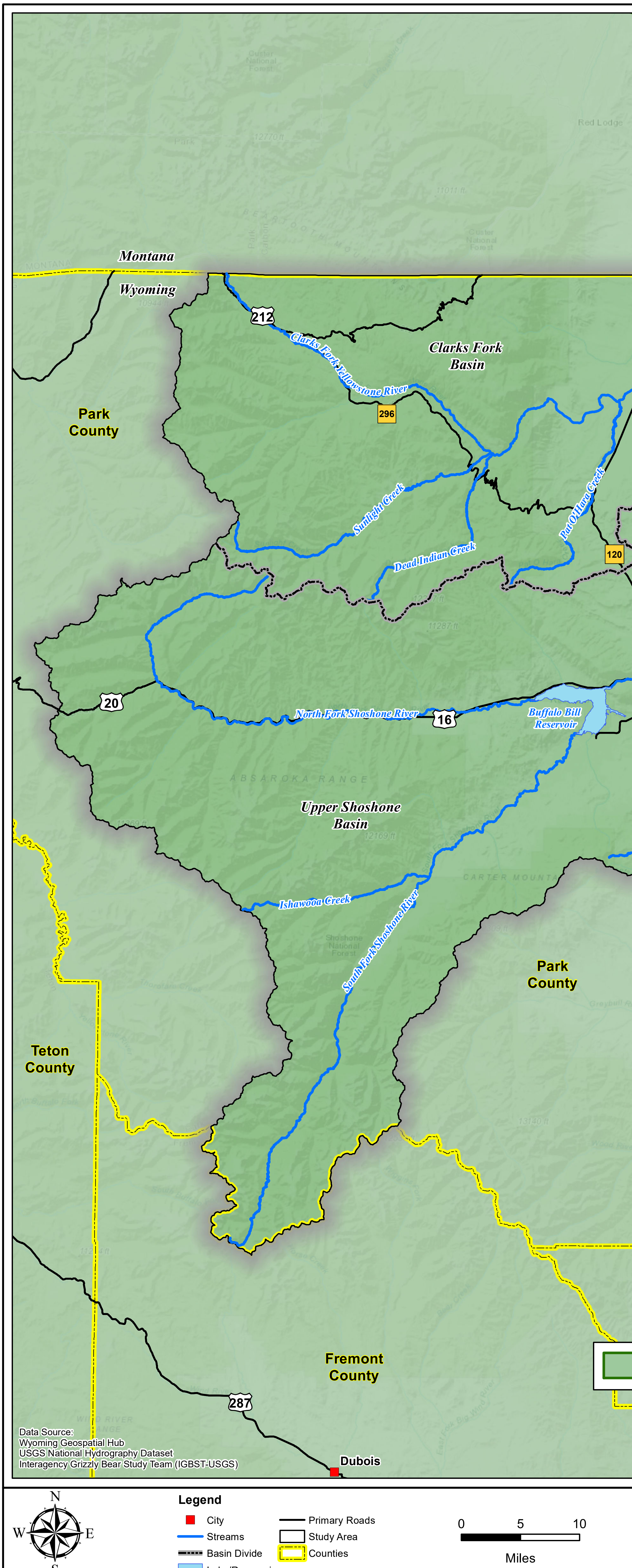
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/16/22	File: Elk.mxd

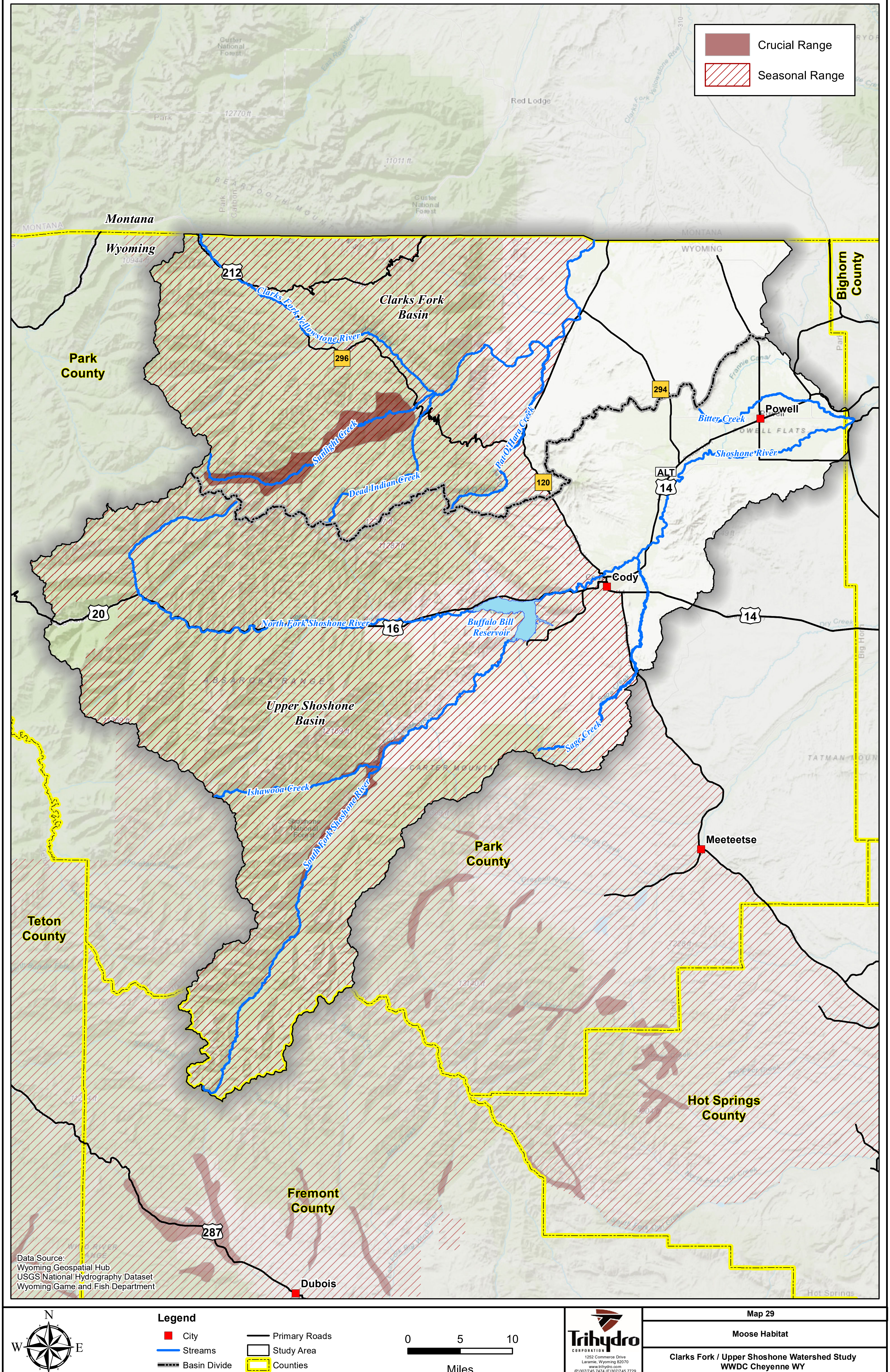


Map 28

Grizzly Bear Habitat

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/27/22	File: Grizzly.mxd



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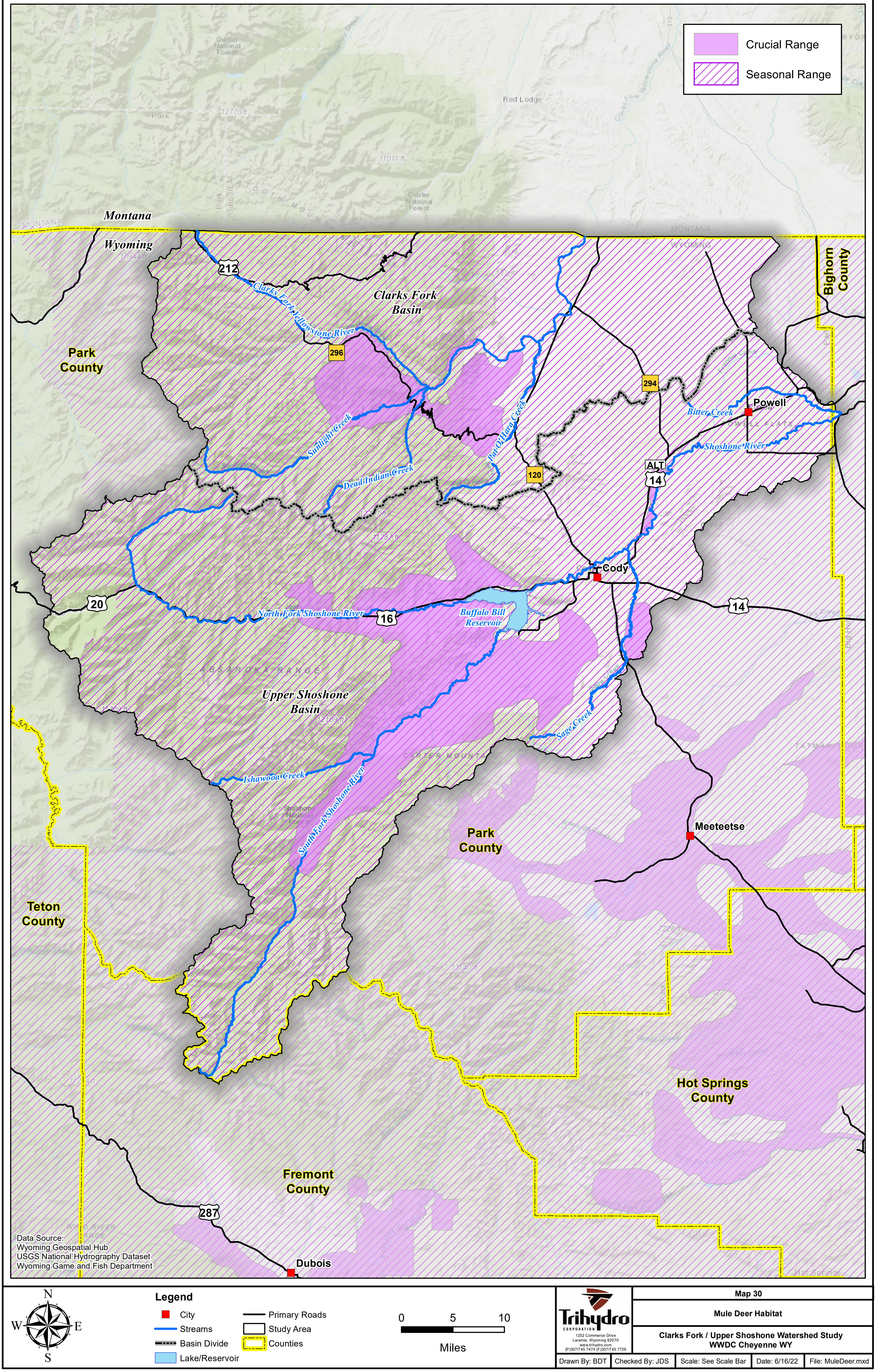
Map 29

Moose Habitat

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/16/22	File: Moose.mxd



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Map 30

Mule Deer Habitat

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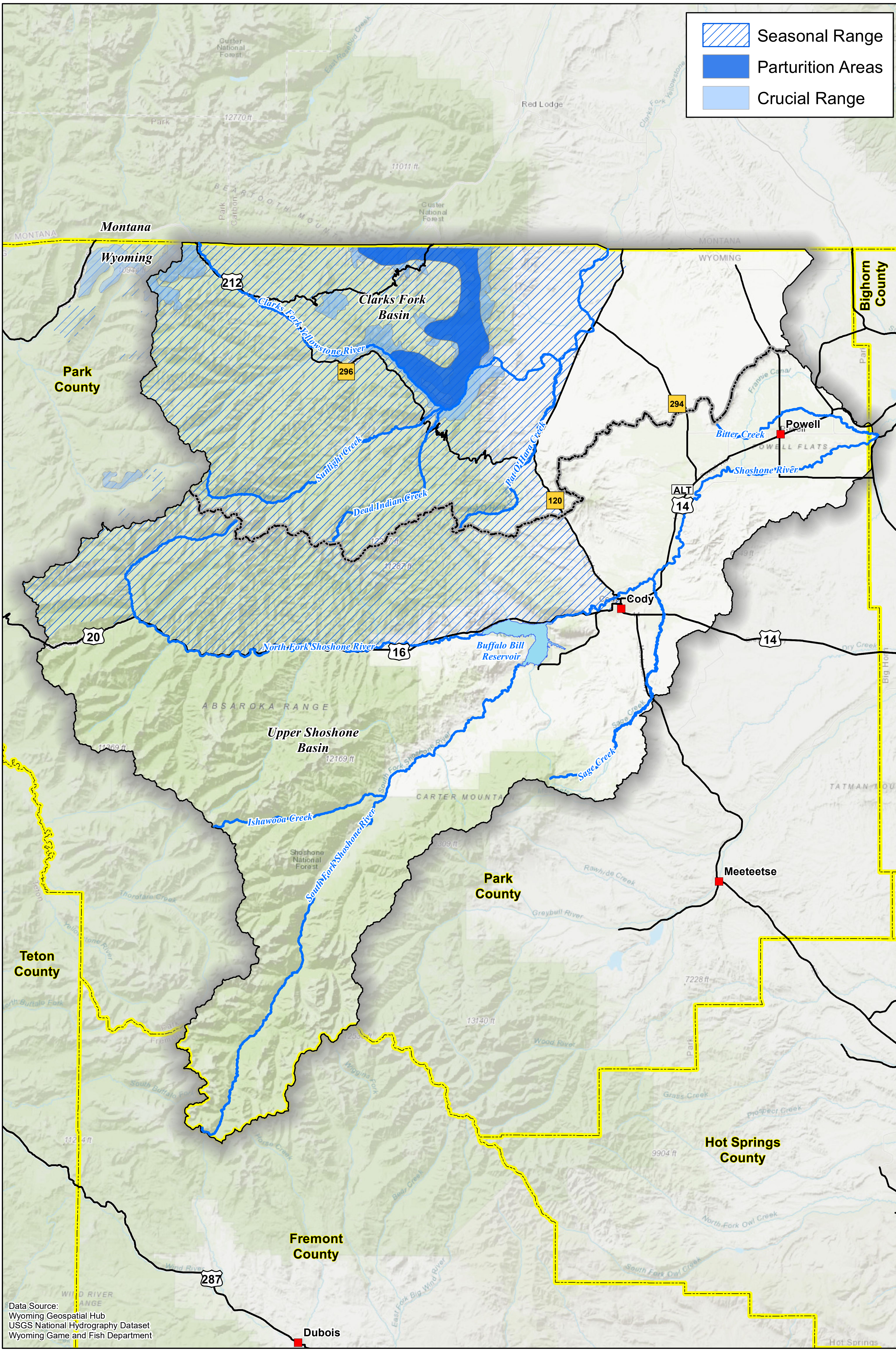
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/16/22	File: MuleDeer.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

N S E W

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Map 31

Rocky Mountain Goat Habitat

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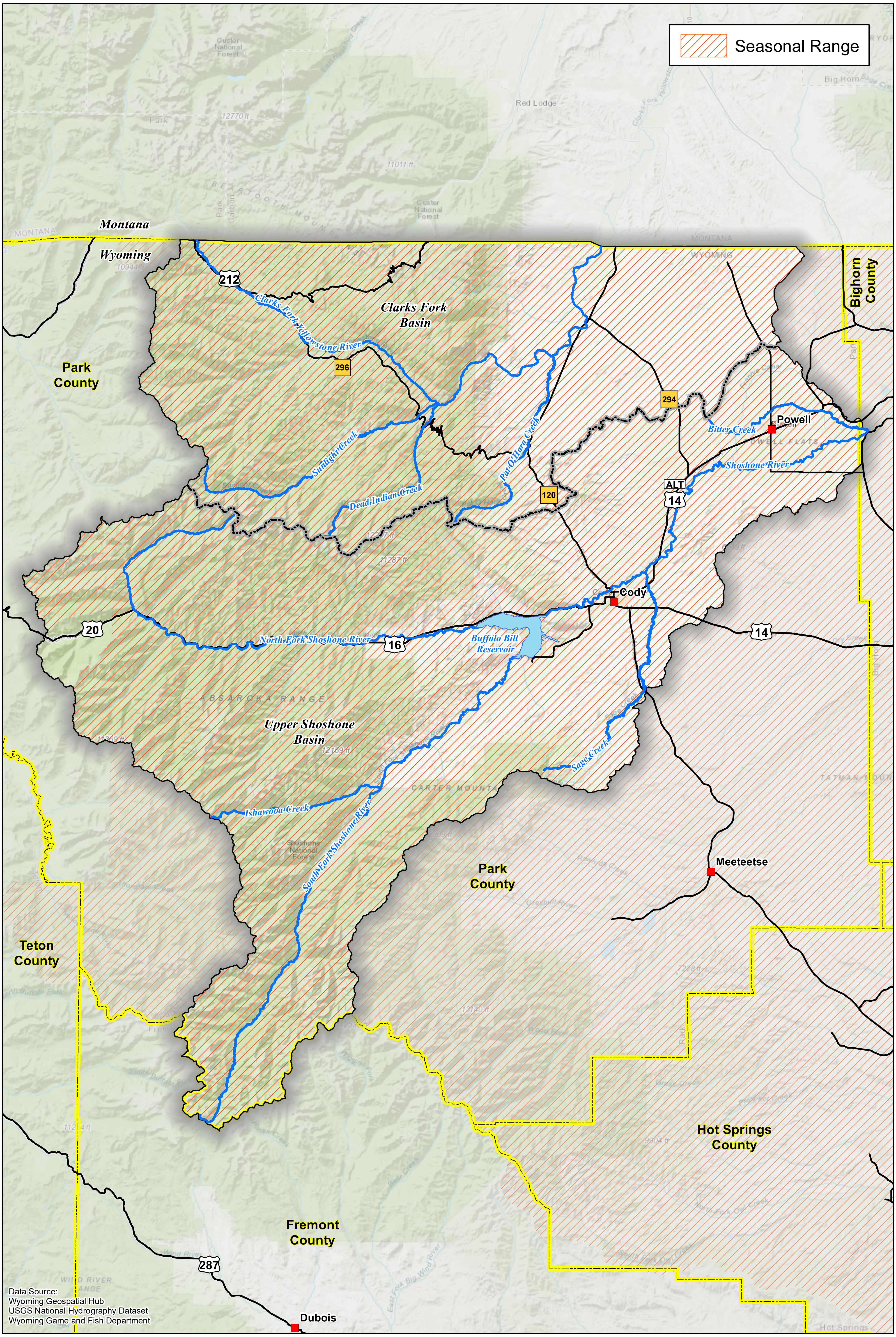
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/28/23	File: RMGoat.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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Map 32

White Tail Deer Habitat

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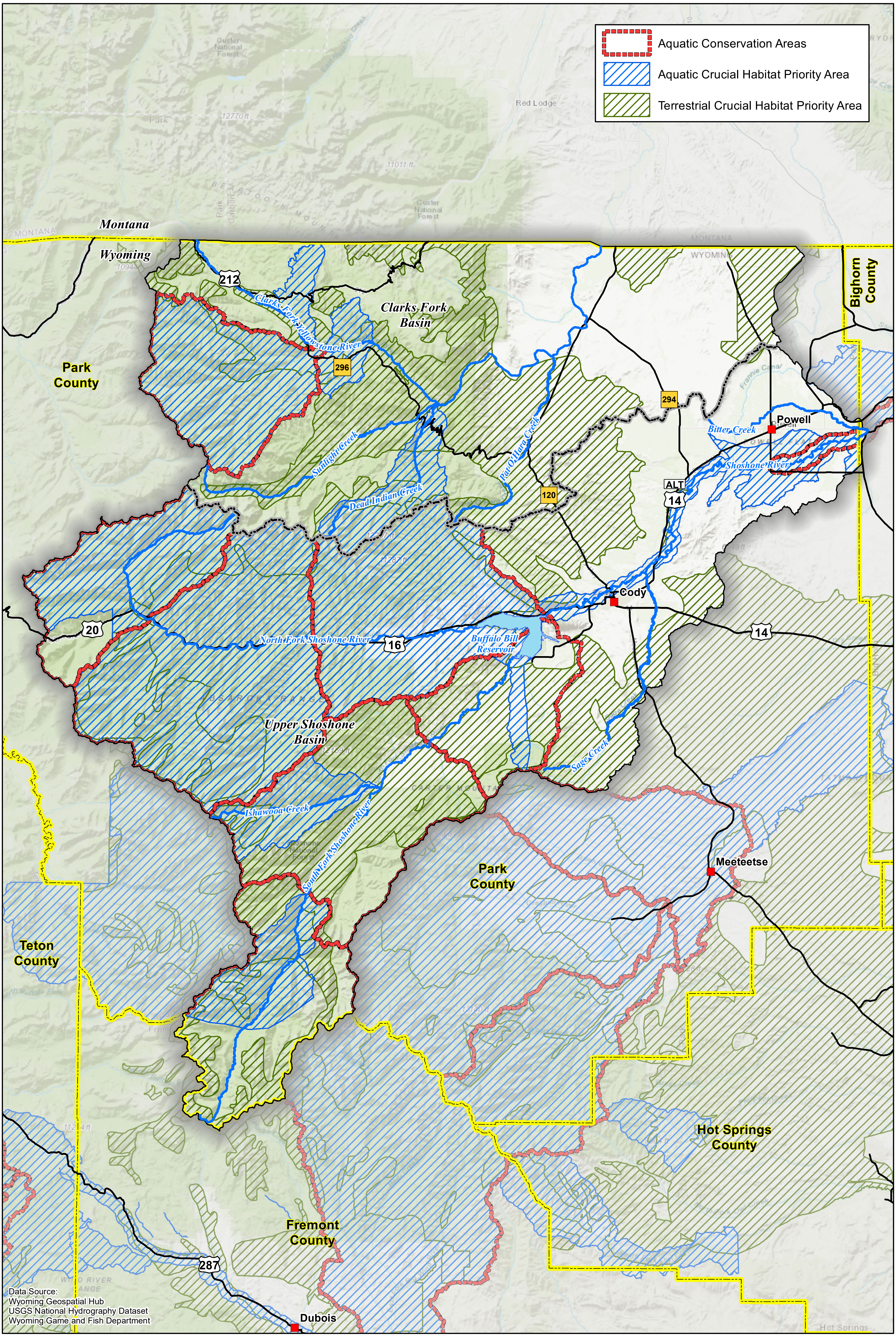
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/12/22	File: WhiteTail.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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Map 33

Crucial Habitats and Conservation Areas

Clarks Fork / Upper Shoshone Watershed Study
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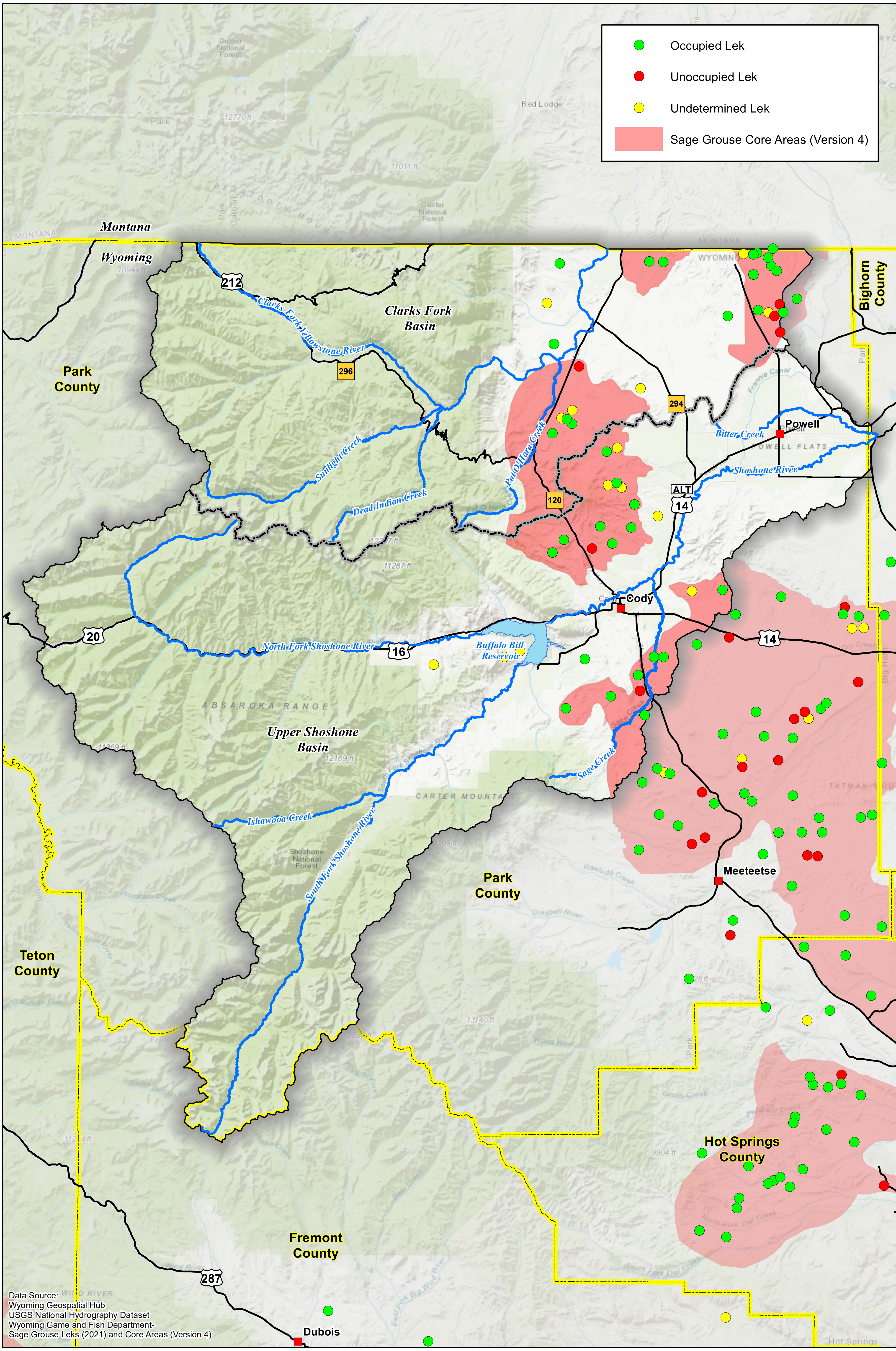
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/17/22	File: Habitat.mxd



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Map 34

Sage Grouse Habitat and Breeding Grounds

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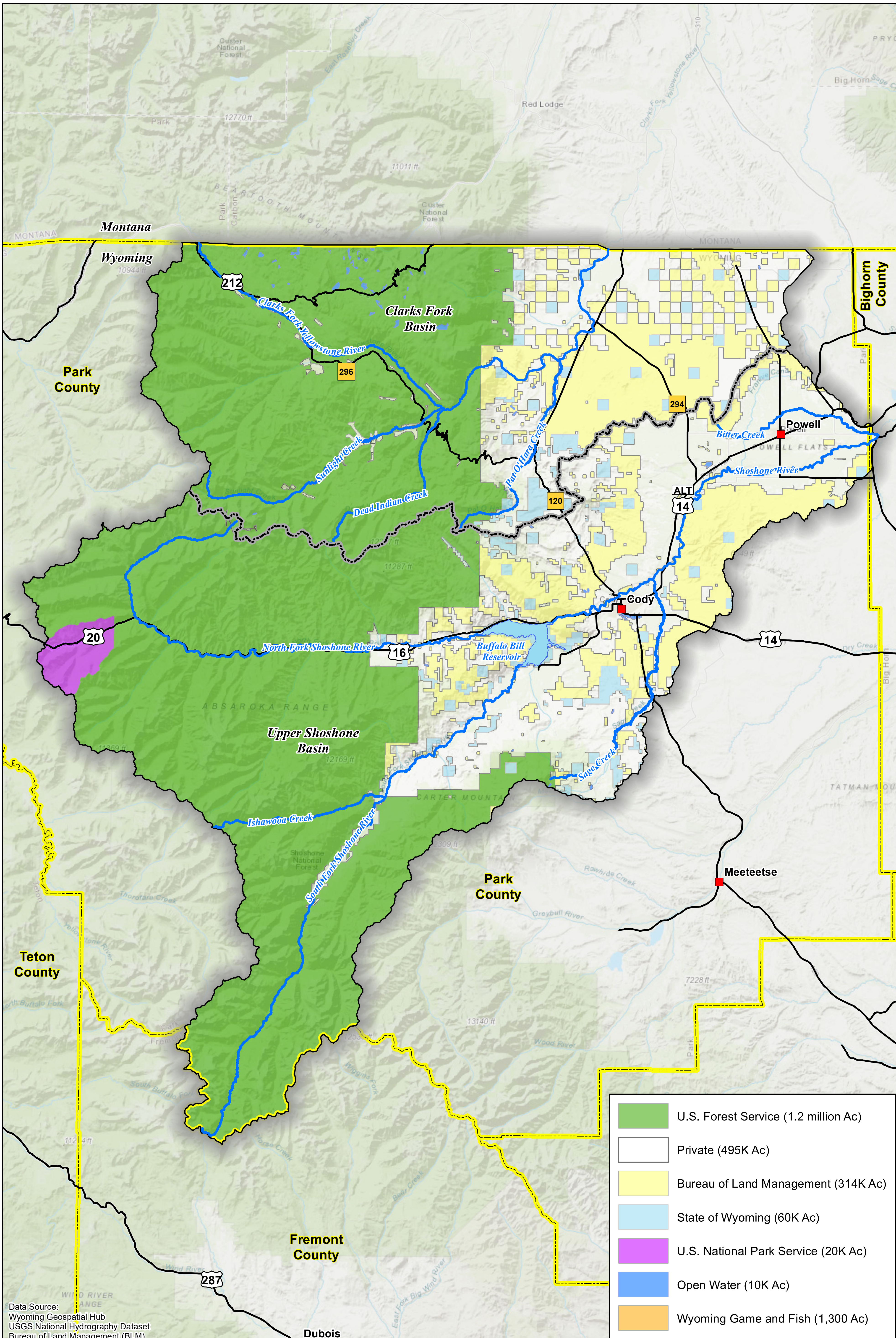
Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 6/17/22 | File: Habitat.mxd



Legend

City
Streams
Basin Divide
Lake/Reservoir
Primary Roads
Study Area
Counties

0 5 10
Miles

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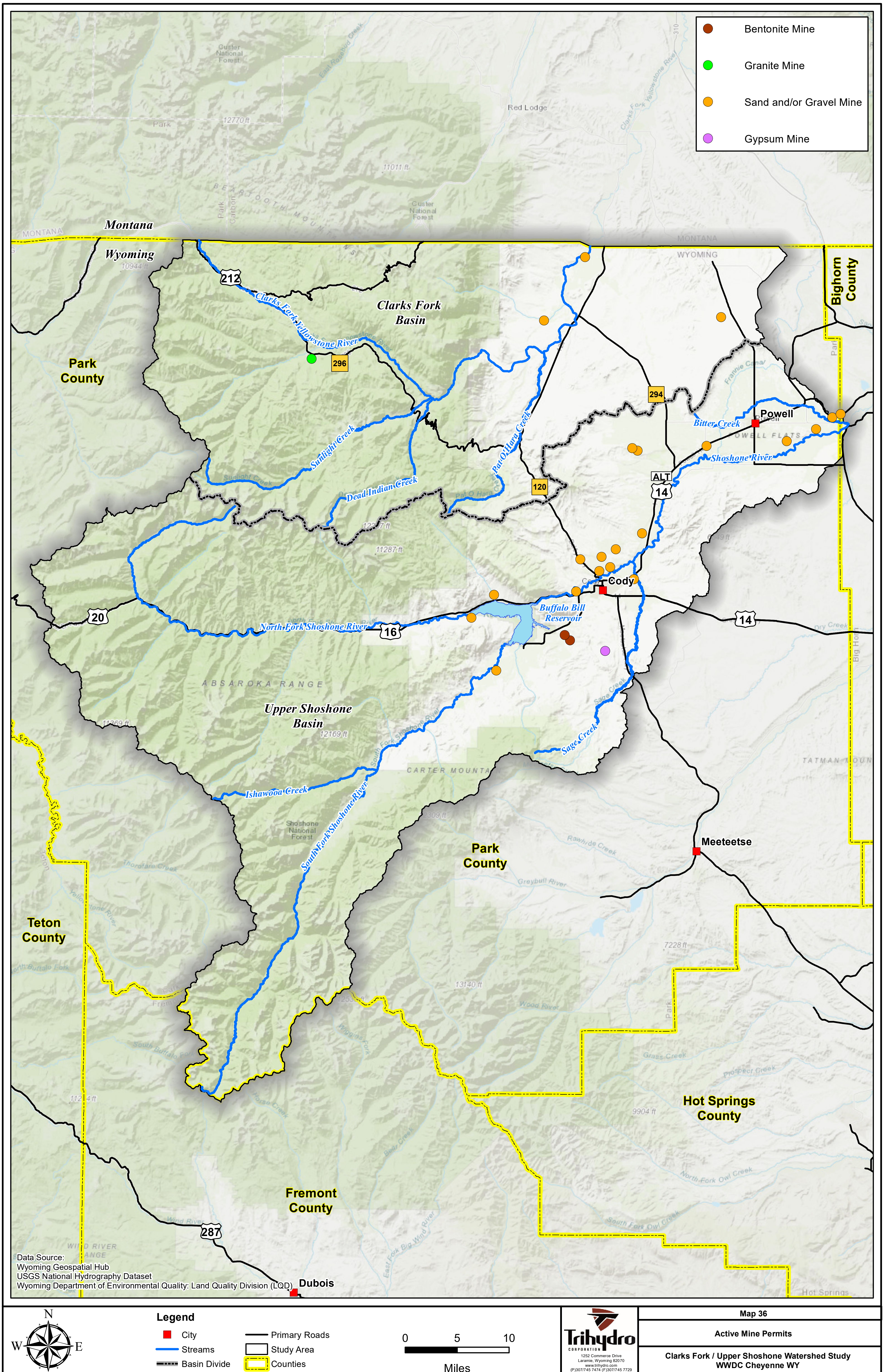
Map 35

Land Ownership

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 5/13/22	File: Ownership.mxd



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Map 36

Active Mine Permits

Clarks Fork / Upper Shoshone Watershed Study
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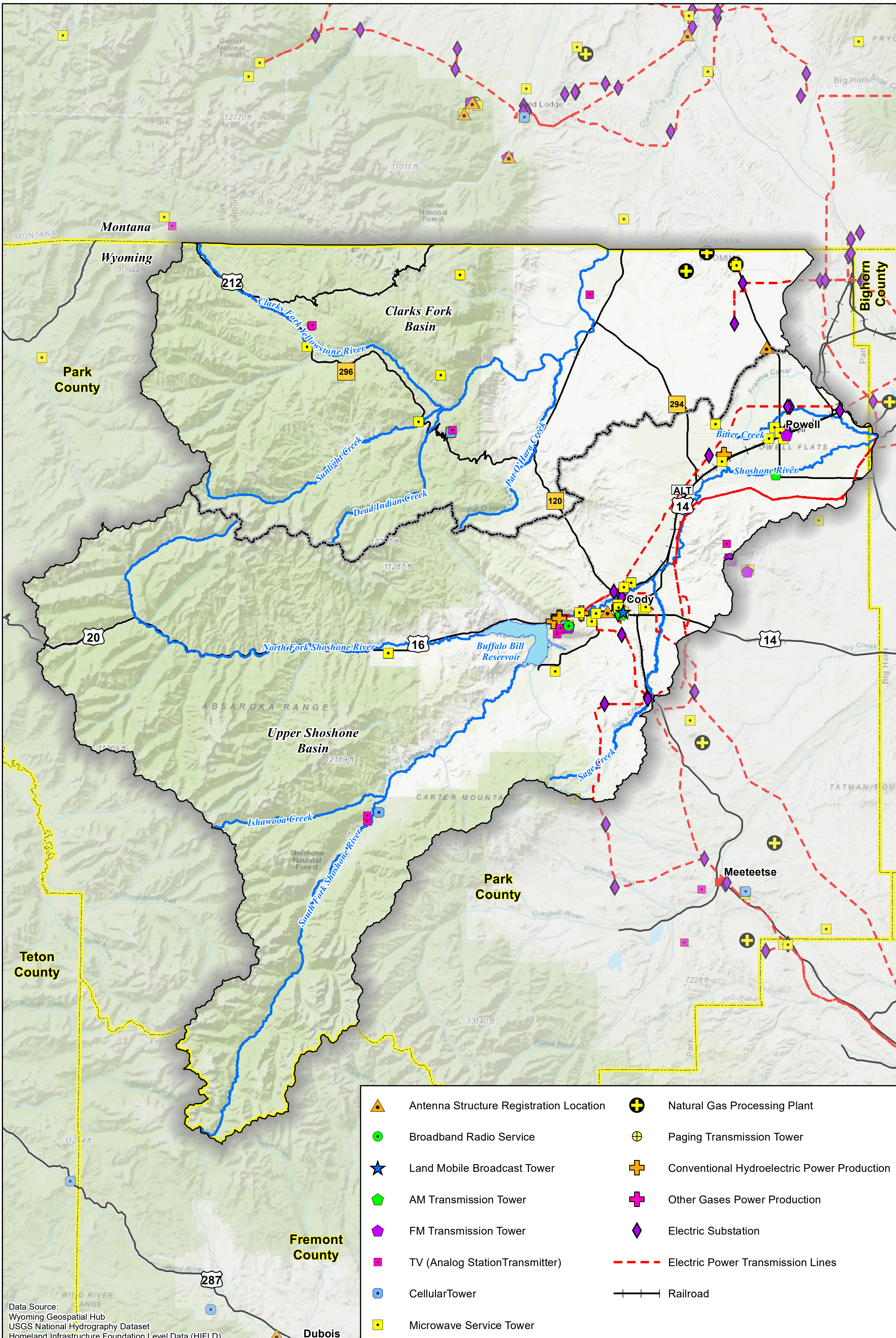
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 6/15/23	File: mines.mxd



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Legend

City
Streams
Basin Divide
Lake/Reservoir
Primary Roads
Study Area
Counties

0 5 10
Miles

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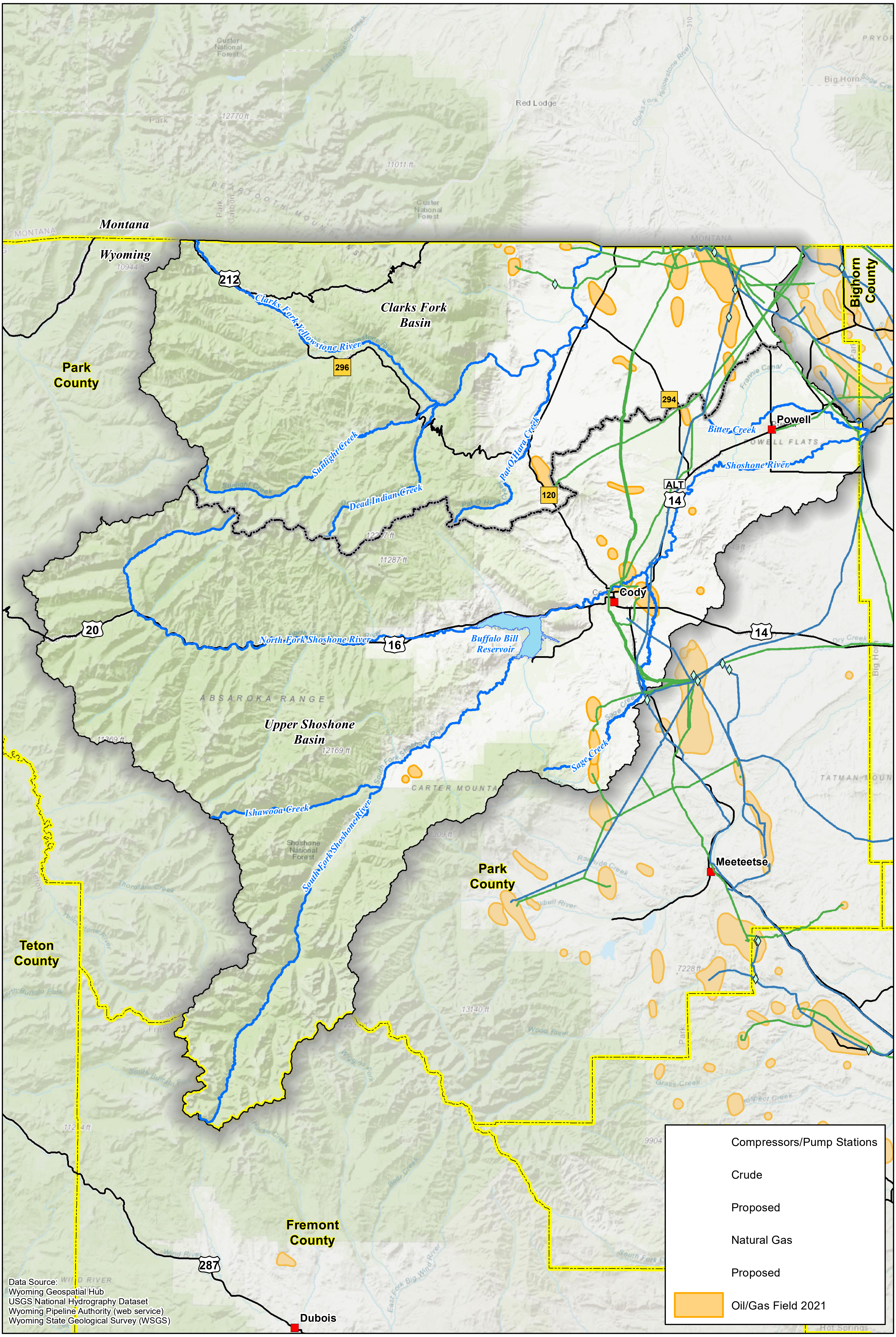
Map 37

Transportation, Energy and Communications Infrastructure

Upper Shoshone River - Clarks Fork Watershed Study
WWDC Cheyenne WY

Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 8/23/22 | File: Infra.mxd



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Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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Map 38

Pipeline and Oil/Gas Field Locations

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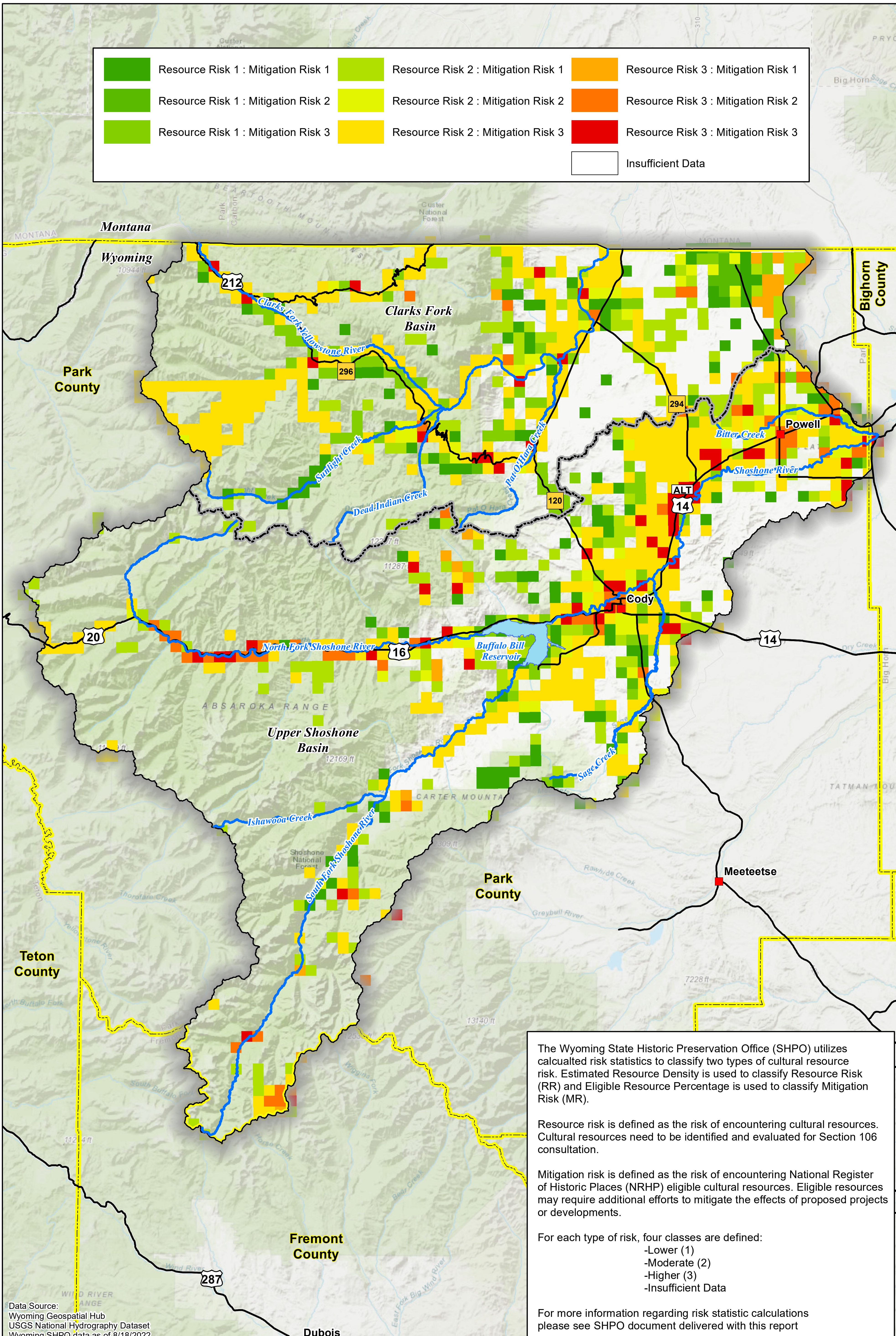
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 8/20/22	File: Oil_Gas.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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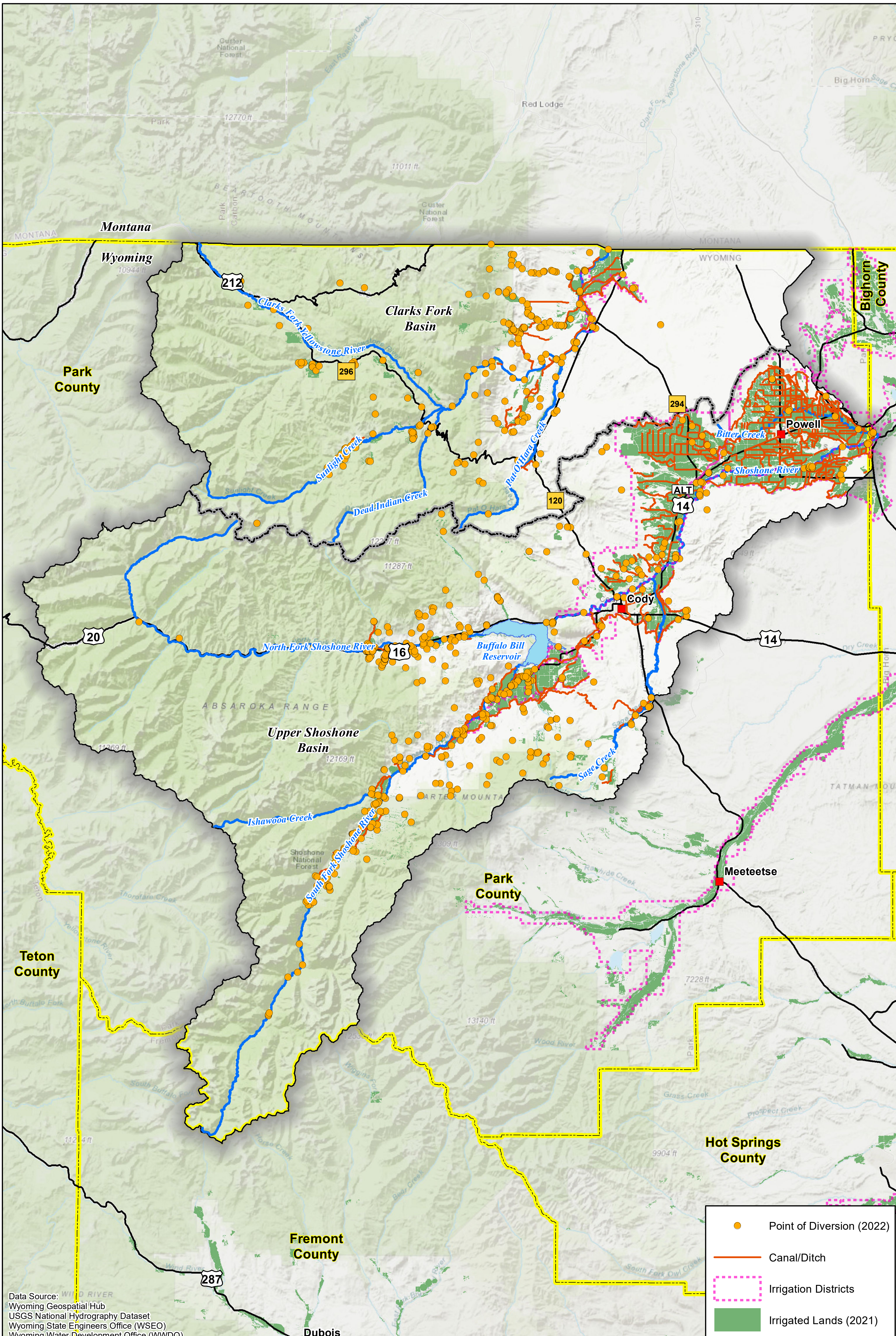
Map 39

Cultural Features

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 8/22/22	File: Cultural.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

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Map 40

Irrigated Lands

Clarks Fork / Upper Shoshone Watershed Study
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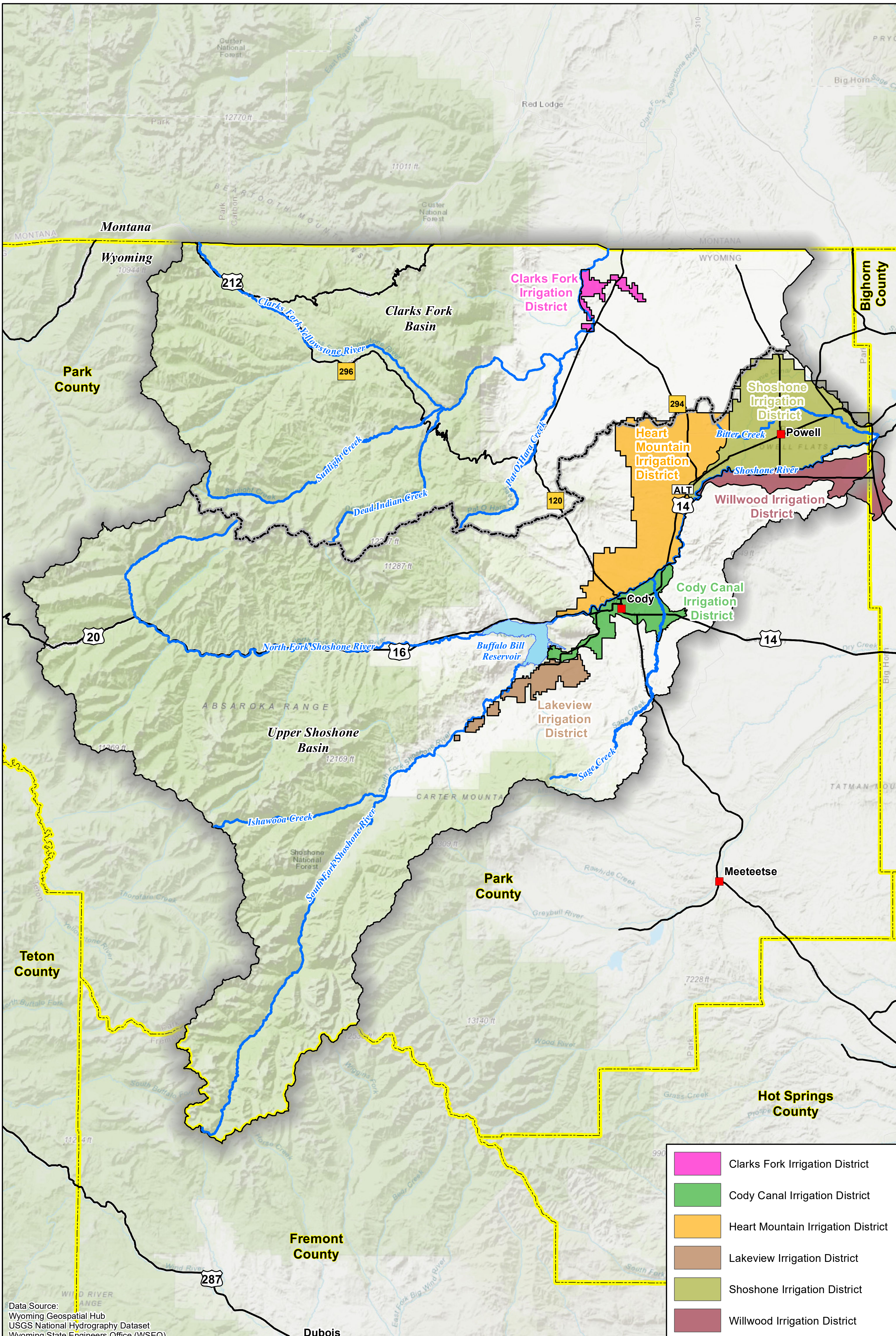
Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 10/12/22	File: Irr_Lands.mxd



Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10 Miles

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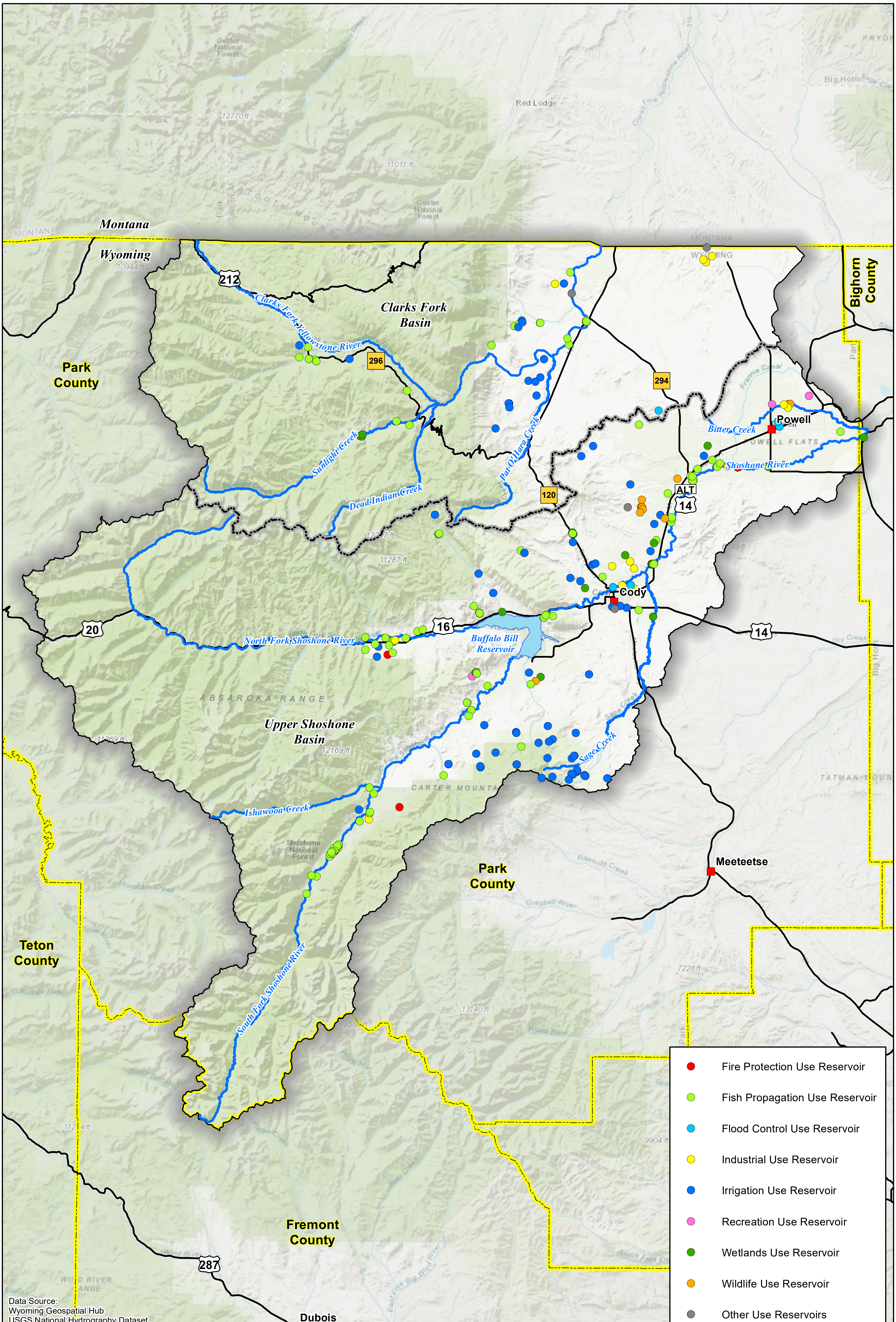
Map 41

Irrigation Districts

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/22/22	File: Template.mxd



Legend

City
Streams
Basin Divide
Lake/Reservoir
Primary Roads
Study Area
Counties

0 5 10
Miles

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Map 42

Non-Stock Reservoirs

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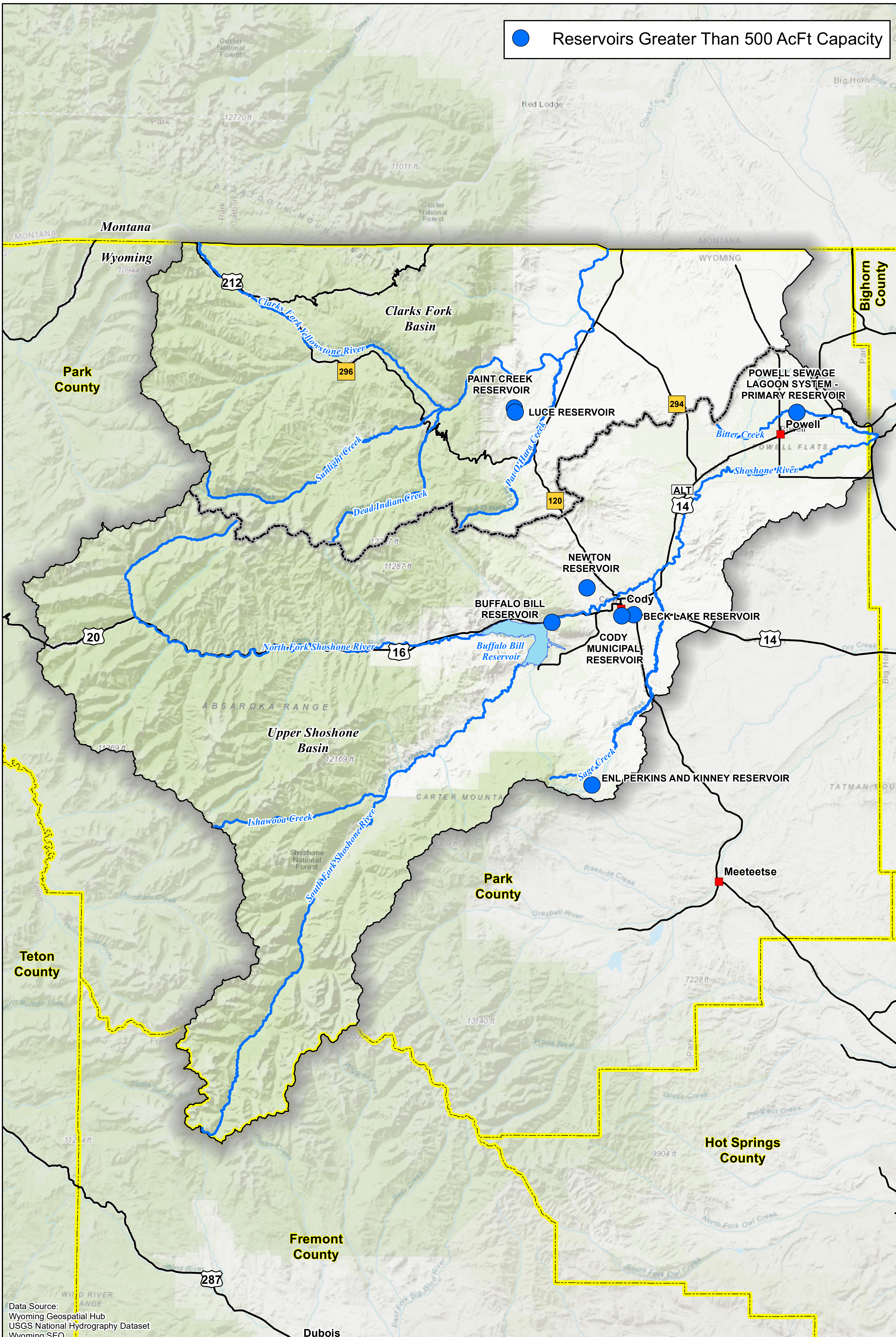
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 8/23/22	File: NSRes.mxd



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Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10

Miles

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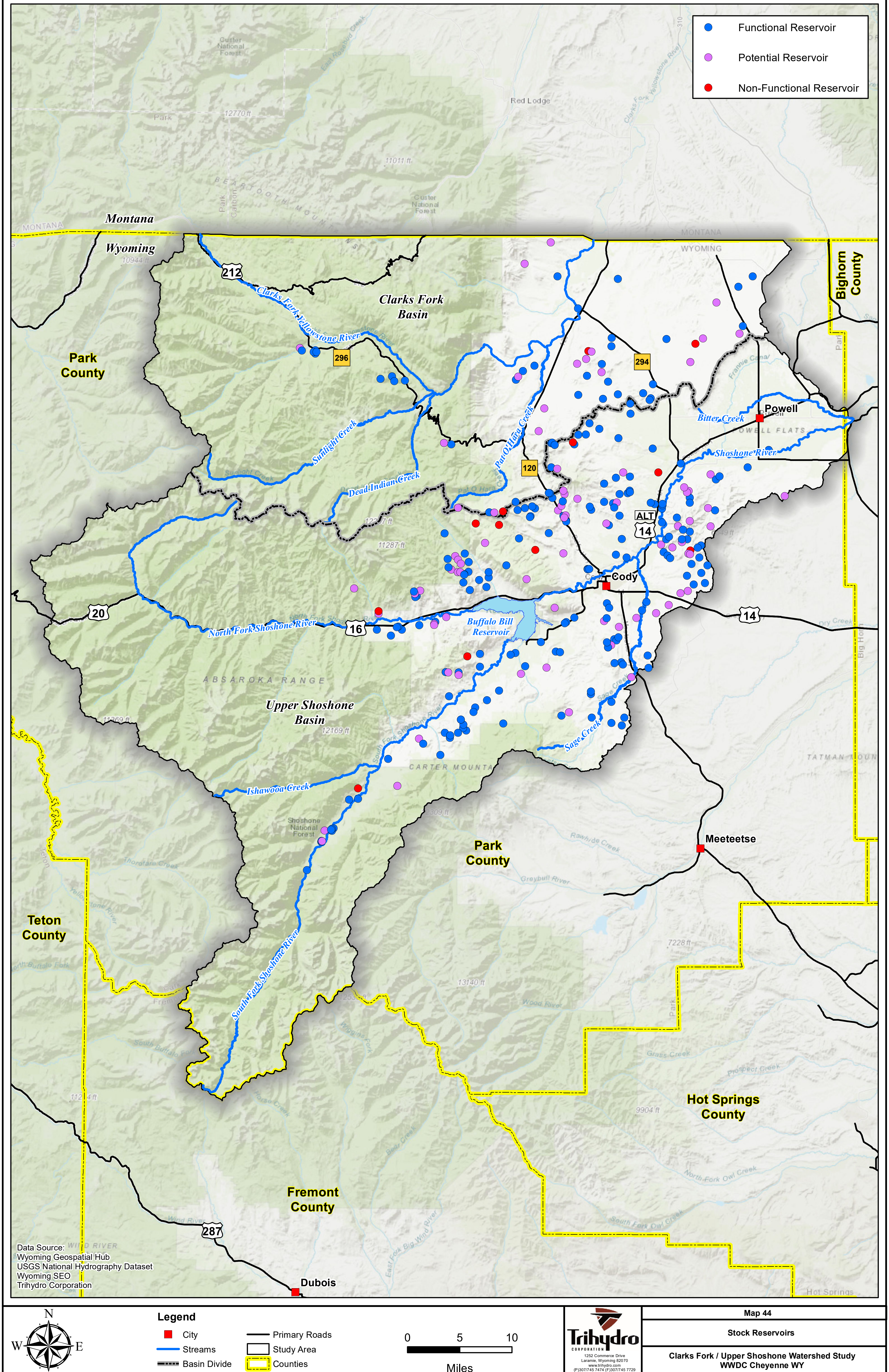
Map 43

Major Reservoirs (Capacity > 500 AF)

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/25/23	File: Res500.mxd



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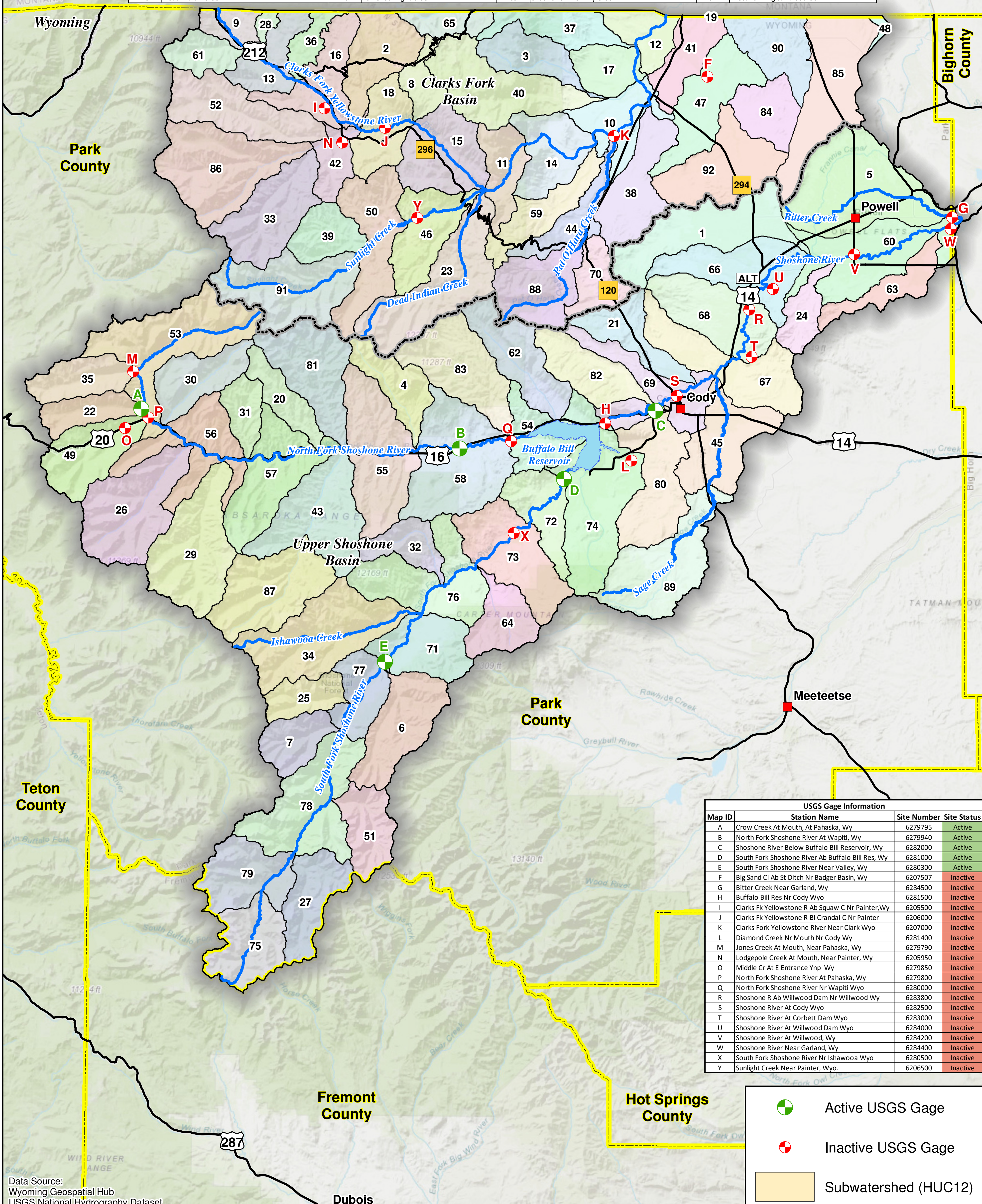
Map 44

Stock Reservoirs

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT | Checked By: JDS | Scale: See Scale Bar | Date: 9/26/22 | File: StockRes.mxd

Map ID	Subwatershed Name (HUC12)	Map ID	Subwatershed Name (HUC12)	Map ID	Subwatershed Name (HUC12)	Map ID	Subwatershed Name (HUC12)
1	Alkali Creek Patch	24	Deer Creek-Shoshone River	47	Middle Big Sand Coulee	70	Skull Creek
2	Beartooth Creek	25	Deer Creek-South Fork Shoshone River	48	Middle Cottonwood Creek	71	South Fork Shoshone River-Aldrich Creek
3	Bennett Creek	26	Eagle Creek	49	Middle Creek	72	South Fork Shoshone River-Bear Creek
4	Big Creek	27	East Fork Creek	50	Middle Sunlight Creek	73	South Fork Shoshone River-Belknap Creek
5	Bitter Creek	28	Farley Creek	51	Needle Creek	74	South Fork Shoshone River-Carter Creek
6	Boulder Creek	29	Fishhawk Creek	52	North Fork Crandall Creek	75	South Fork Shoshone River-Clark Creek
7	Cabin Creek	30	Grinnell Creek	53	North Fork Shoshone River-Bear Creek	76	South Fork Shoshone River-Houlihan Creek
8	Canyon Creek	31	Gunbarrel Creek	54	North Fork Shoshone River-Buffalo Bill Reservoir	77	South Fork Shoshone River-Legg Creek
9	Clarks Fork Yellowstone River-Broadwater Creek	32	Hardpan Creek	55	North Fork Shoshone River-Grizzly Creek	78	South Fork Shoshone River-Saddle Creek
10	Clarks Fork Yellowstone River-Chapman Bench	33	Hoodoo Creek	56	North Fork Shoshone River-Libby Creek	79	South Fork Shoshone River-Younts Creek
11	Clarks Fork Yellowstone River-Cyclone Bar Creek	34	Ishawooa Creek	57	North Fork Shoshone River-Sheep Creek	80	Sulphur Creek
12	Clarks Fork Yellowstone River-Dilworth Creek	35	Jones Creek-North Fork Shoshone River	58	North Fork Shoshone River-Whit Creek	81	Sweetwater Creek
13	Clarks Fork Yellowstone River-Gilbert Creek	36	Lake Creek-Yellowstone River	59	Paint Creek	82	Trail Creek-Shoshone River
14	Clarks Fork Yellowstone River-Newmeyer Creek	37	Line Creek	60	Peerless Coulee	83	Trout Creek-North Fork Shoshone River
15	Clarks Fork Yellowstone River-Russell Creek	38	Little Sand Coulee	61	Pilot Creek	84	Upper Big Sand Coulee
16	Clarks Fork Yellowstone River-Squaw Creek	39	Little Sunlight Creek	62	Rattlesnake Creek	85	Upper Cottonwood Creek
17	Clarks Fork Yellowstone River-Sugarloaf Butte	40	Littlerock Creek	63	Roan Wash	86	Upper Crandall Creek
18	Clarks Fork Yellowstone River-Table Creek	41	Lower Big Sand Coulee	64	Rock Creek-South Fork Shoshone River	87	Upper Elk Creek
19	Clarks Fork Yellowstone River-Wolf Creek	42	Lower Crandall Creek	65	Rock Creek-Wyoming Creek	88	Upper Pat O'Hara Creek
20	Clearwater Creek	43	Lower Elk Creek	66	Shoshone River-Eaglenest Creek	89	Upper Sage Creek-Trail Creek
21	Cottonwood Creek-Shoshone River	44	Lower Pat O'Hara Creek	67	Shoshone River-Idaho Creek	90	Upper Silver Tip Creek
22	Crow Creek	45	Lower Sage Creek	68	Shoshone River-Iron Creek	91	Upper Sunlight Creek
23	Dead Indian Creek	46	Lower Sunlight Creek	69	Shoshone River-Dry Creek	92	West Fork Big Sand Coulee



USGS Gage Information

Map ID	Station Name	Site Number	Site Status
A	Crow Creek At Mouth, At Pahaska, Wy	6279795	Active
B	North Fork Shoshone River At Wapiti, Wy	6279940	Active
C	Shoshone River Below Buffalo Bill Reservoir, Wy	6282000	Active
D	South Fork Shoshone River Ab Buffalo Bill Res, Wy	6281000	Active
E	South Fork Shoshone River Near Valley, Wy	6280300	Active
F	Big Sand Cl Ab St Ditch Nr Badger Basin, Wy	6207507	Inactive
G	Bitter Creek Near Garland, Wy	6284500	Inactive
H	Buffalo Bill Res Nr Cody Wyo	6281500	Inactive
I	Clarks Fk Yellowstone R Ab Squaw C Nr Painter,Wy	6205500	Inactive
J	Clarks Fk Yellowstone R Bl Crandal C Nr Painter	6206000	Inactive
K	Clarks Fork Yellowstone River Near Clark Wyo	6207000	Inactive
L	Diamond Creek Nr Mouth Nr Cody Wy	6281400	Inactive
M	Jones Creek At Mouth, Near Pahaska, Wy	6279790	Inactive
N	Lodgepole Creek At Mouth, Near Painter, Wy	6205950	Inactive
O	Middle Cr At E Entrance Ynp Wy	6279850	Inactive
P	North Fork Shoshone River At Pahaska, Wy	6279800	Inactive
Q	North Fork Shoshone River Nr Wapiti Wyo	6280000	Inactive
R	Shoshone R Ab Willwood Dam Nr Willwood Wy	6283800	Inactive
S	Shoshone River At Cody Wyo	6282500	Inactive
T	Shoshone River At Corbett Dam Wyo	6283000	Inactive
U	Shoshone River At Willwood Dam Wyo	6284000	Inactive
V	Shoshone River At Willwood, Wy	6284200	Inactive
W	Shoshone River Near Garland, Wy	6284400	Inactive
X	South Fork Shoshone River Nr Ishawooa Wyo	6280500	Inactive
Y	Sunlight Creek Near Painter, Wyo.	6206500	Inactive

Active USGS Gage
Inactive USGS Gage
Subwatershed (HUC12)

Legend

- City
- Streams
- Basin Divide
- Lake/Reservoir
- Primary Roads
- Study Area
- Counties

0 5 10
Miles

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
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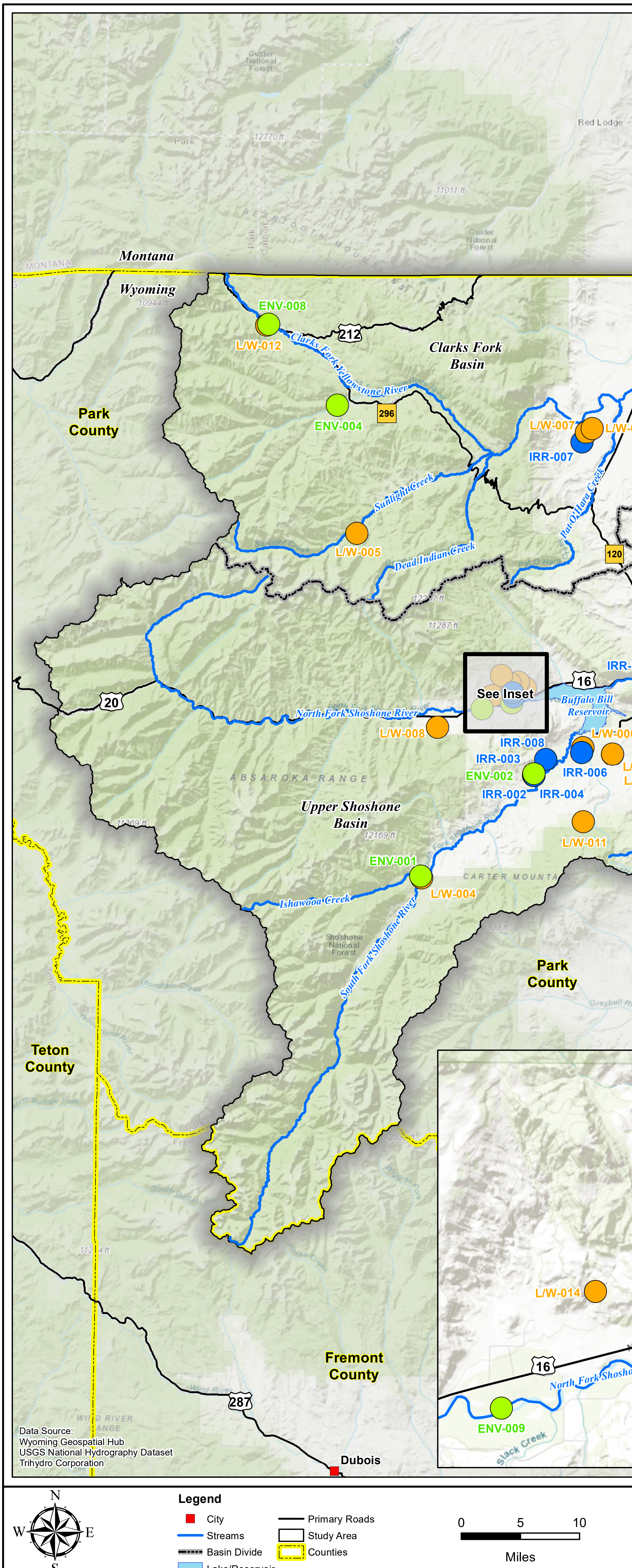
Map 45

Hydrologic Units and USGS Stream Gages

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 10/18/23	File: HUC12_USGS



Trihydro Corporation
1252 Commerce Drive
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Map 46

Watershed Management Plan Components

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 10/19/23	File: WMP.mxd

APPENDIX 2A

PUBLIC OUTREACH AND MEETING DOCUMENTS

CLARKS FORK/UPPER SHOSHONE RIVER WATERSHED STUDY
ATTEND AN UPCOMING PROJECT SCOPING MEETING

Project Background:
- Being completed on behalf of the Cody and Powell/Clarks Fork Conservation Districts
- Fully funded by the Wyoming Water Development Commission
- Trihydro Corporation has been selected to complete the study

Project Details:
The project involves a comprehensive evaluation of the study area and will include the opportunity for individual landowners/stakeholders to have Trihydro staff evaluate their specific water resources-related issues and help develop solutions at no charge.

Learn More at an Upcoming Scoping Meeting

June 1, 2022 6:00-8:00 PM *Park County Library* *Grizzly Hall* *1500 Heart Mountain Street* *Cody, WY 82414*	June 2, 2022 6:00-8:00 PM *Northwest College* *Fagerberg Building, Room 70* *231 West 6th Street* *Powell, WY 82435*

Questions? Connect with Us!

Carmen McIntyre Powell Clarks Fork Conservation District pcfcd1@gmail.com	Brittany Swope Cody Conservation District conservecody@gmail.com

SCOPING MEETING ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Date / Time of Meeting	June 1, 2022, 6 p.m. – 8 p.m.
Meeting Location	Cody, Wyoming – Park County Library, Grizzly Hall
Project Title	Clarks Fork / Upper Shoshone Watershed, Level I Study
Project Sponsors	Cody Conservation District and Powell Clarks Fork Conservation District
Funding Agency	Wyoming Water Development Commission
Consulting Firm	Trihydro Corporation
Consultant Project No.	06N-006-001

Name	Telephone	Email	Onsite Visit? (Yes / No)
David Rawlings	899-5519		–
Laura Burckhardt	250-1213	laura.burckhardt@wyo.gov	No
Brittany Swope	250-1065	bconservecody@gmail.com	NO
Fi Brewer strong	899-0454		
Renn Strong	(805) 698-9626	RennFiEnterprises@protonmail.com	
Ann Trosper	307 527 6381	anne.trosper48@gmail.com	
LARRY TIMCHAK	406-250-7473	ltimchak1@gmail.com	✓
Tom Brown	978-886-3371	tombrown5@comcast.net	✓
Michael Roell	573-487-4548	roellm34@gmail.com	
BOB CAPRON	587-2456	robert.capron@gmail	

SCOPING MEETING ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Name	Telephone	Email	Onsite Visit? (Yes / No)
Karri Cary	307-250-5170	karri.cary@usda.gov	yes
Erin Leonetti	250-8585	erin.sobel@wyo.gov	
Russ Dwyer	307-254-3018	RUSS@ODUBBHER.NET	
CARMEN HORNE-MCINTYRE	307 578-8335	chmcintyre.cmrd@gmail.com	
Scott Lee	307-335-3169	slee@trihydro.com	
Jay Schug	970-692-4735	jschug@trihydro.com	
Mike Robertson	307-777-3342	mike.robertson1@wyo.gov	

SCOPING MEETING ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Date / Time of Meeting	June 2, 2022, 6 p.m. – 8 p.m.
Meeting Location	Powell, Wyoming – Northwest College, Fagerberg Building, Room 70
Project Title	Clarks Fork / Upper Shoshone Watershed, Level I Study
Project Sponsors	Cody Conservation District and Powell Clarks Fork Conservation District
Funding Agency	Wyoming Water Development Commission
Consulting Firm	Trihydro Corporation
Consultant Project No.	06N-006-001

Name	Telephone	Email	Onsite Visit? (Yes / No)
Lloyd Thiel	307 645-3072	Lloyd.Thiel@ParkCounty.Gov	
Neil Christofferson	405-227-8018	neil_susan78@yahoo.com	yes
Abby Shuler	307-254-0367	justabs@hotmail.com	
Colby Schaefer	307-202-1360	wyoturf@gmail.com	
Anthony Spiering	254-2645		
Lee Craig	254-5115	leecraig@tctwest.net	
Rory Karhu	462-1748	rory.karhu@usda.gov	
Trent Reed	307-202-0884	Shoshoneid@Hotmail.c	
Kevin Killough	~~307~~ 701-641-6603	KevinK@PowellTribune.com	
Tye H. Whitlock	307 254 0584	twhitlock33@gmail.com	

SCOPING MEETING ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Name	Telephone	Email	Onsite Visit? (Yes / No)
Ann Trosper	527 6381	anntrosper tt@gmail	
CARMEN Horner McIntyre	578-8335	chmcintyre.conrd@gmail.com	
Scott Lee	307-335-3169	slee@trihydro.com	
Jay Schug	970-692-4735	jschug@trihydro.com	
Mike Robertson	307-777-3342	mike.robertson1@wyo.gov	

Project Scoping Meetings

Cody June 1, 2022

Powell June 2, 2022

Wyoming Water Development Commission

Trihydro

The Project is....

- A collection of available information
- A comprehensive inventory of the study area
- Identification of water resources related local issues

Trihydro

Clarks Fork/Upper Shoshone Watershed Study, Level I

Why are we here?

- Wyoming Water Development Commission Study
  - WWDC has fully funded the project
  - Participation is encouraged and strictly voluntary
- 25 Watershed Studies have been completed to date.
- Cody and Powell / Clarks Fork Conservation Districts requested the study.
- Trihydro Corporation was selected to complete it.

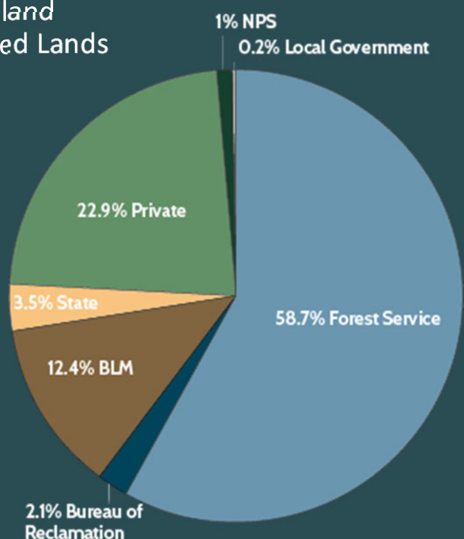
Project Study Area

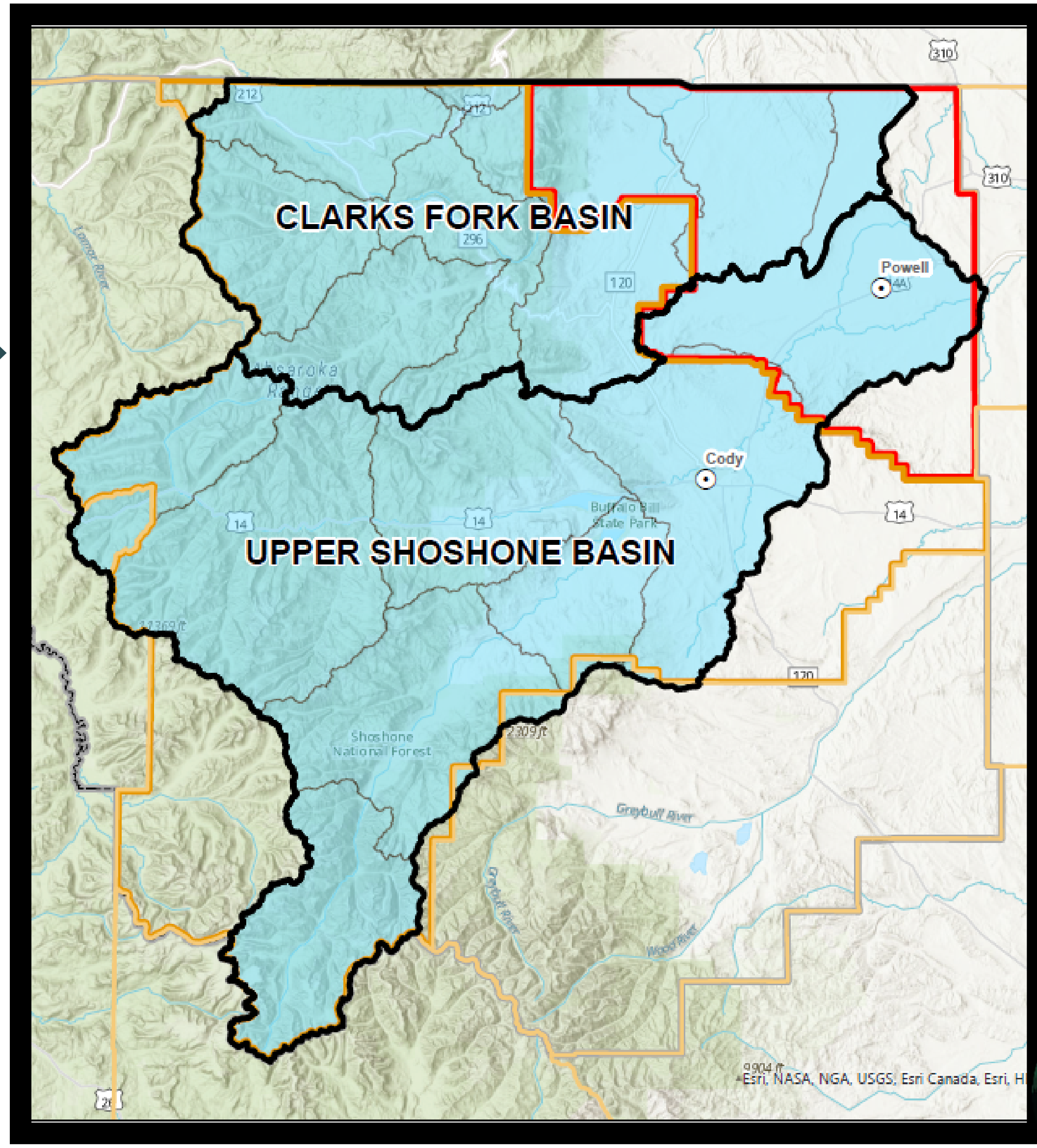
Study Area Characteristics

- 2.3 million acres (3,500 sq. mi.)

- Clarks Fork watershed 37.3%
- Upper Shoshone River watershed 62.7%

The Study area includes:
- Cody and Powell and smaller towns along the mainstem of the Shoshone River.
- Relatively undeveloped:
  - -National Forest
  - -Rangeland
  - -Irrigated Lands

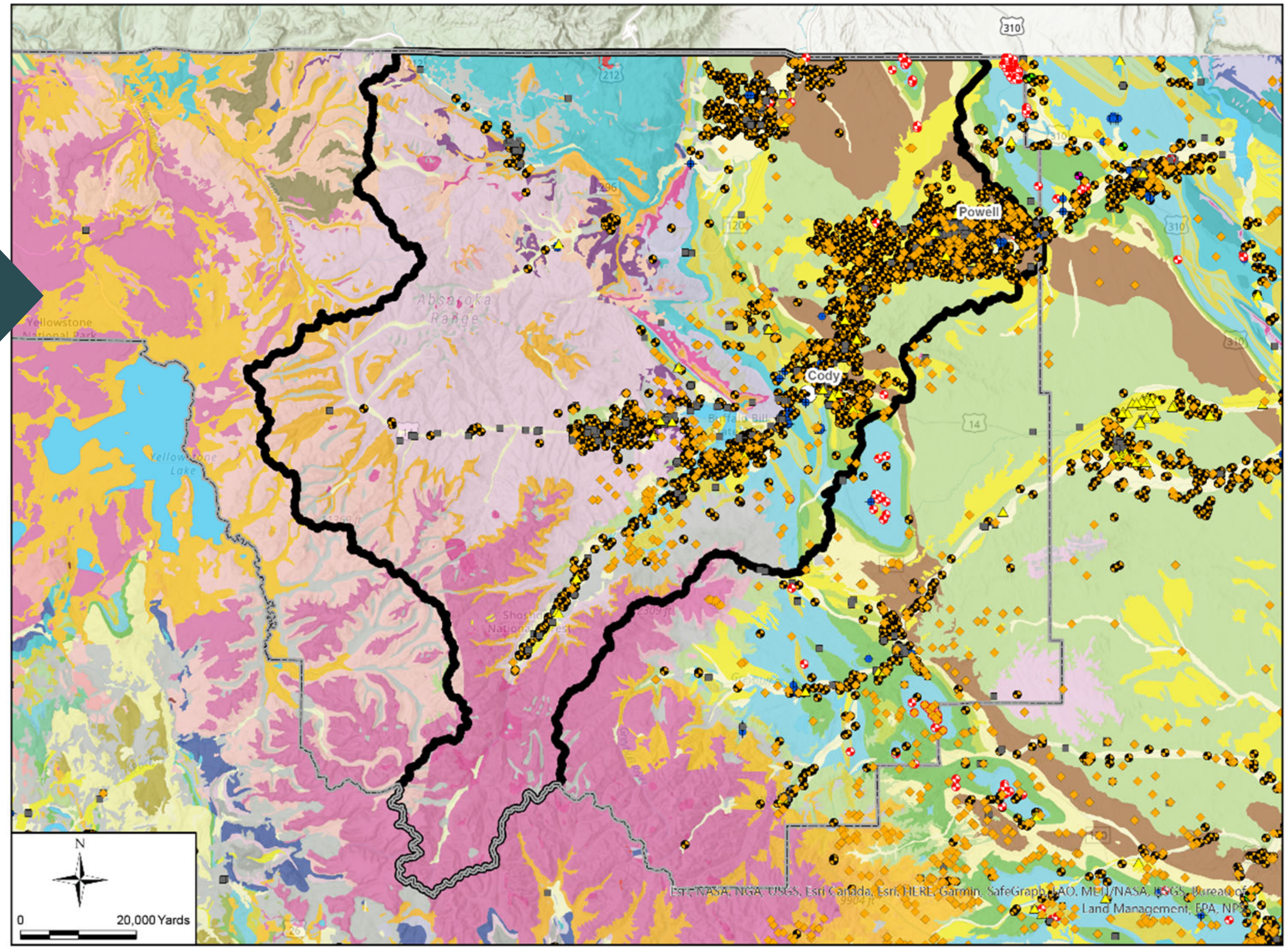




Project Study Area

Study Area Issues

- Significant Growth
- Subdivision of Lands
- Agricultural Water Use
- Water Quality Impacts
- Sediment Delivery
- Groundwater Demands
- Septic Systems
- Willwood Dam



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Project Study Area

Willwood Dam

- Willwood Dam Operations
- Sediment Delivery
- Sediment Source Identification
- WDEQ Working Groups (3)
- Established Inertia

Trihydro

Our Approach

- Task 1: Scoping and Project Meetings
- Task 2: Review of Background Information
- Task 3: Watershed Inventory & Description
- Task 4: Streamflow Hydrology
- Task 5: Management & Rehabilitation Plan
- Task 6: Cost Estimates
- Task 7: Economic Analysis
- Task 8: Permits
- Task 9: Discretionary Task
- Task 10: Draft Report
- Task 11: Report Presentations
- Task 12: Final Report & Deliverables

Task 1

Project Meetings & Public Participation

Public input is critical. Initiate with:

1. Scoping Meeting Proposed Agenda:
2. Project Workshops
3. Tailgate Talks
4. Webpage
5. Social media

Task 2

Review Existing Information

There is a LOT of information out there:

- Contact all local, state, and federal agencies
- Validate the current datasets and update digital library and geodatabase
- Review mapped data with sponsors, landowners, and participants

Task 3

Watershed Inventory

Task 3A: Physical Systems

- Task 3A-I: Surface Water
- Task 3A-II: Geomorphology
- Task 3A-III: Groundwater
- Task 3A-IV: Geology
- Task 3A-V: Climate

Task 3B: Biological Systems

- Task 3B-I: Fish and Wildlife
- Task 3B-II: Land Cover

Task 3C Anthropogenic Systems

- Task 3C-I: Agricultural Water Use
- Task 3C-II: Domestic Water use
- Task 3C-III: Water Storage
- Task 3C-IV: Land

Technical Proposal Contains Detailed Descriptions of These Efforts

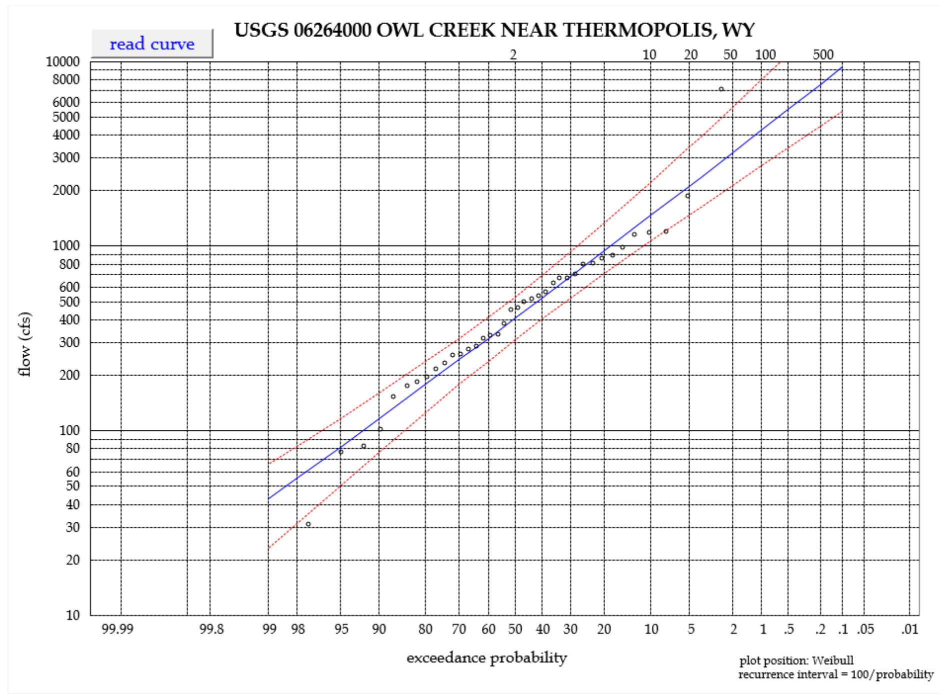
Trihydro

Task 4

Streamflow Hydrology

Task 4: Streamflow Hydrology

- Update pertinent water budget estimates in the Wind/Bighorn Basin plan (2010)
- Use same methods as in the Wind/Bighorn plan for consistency
- Peak flow analysis



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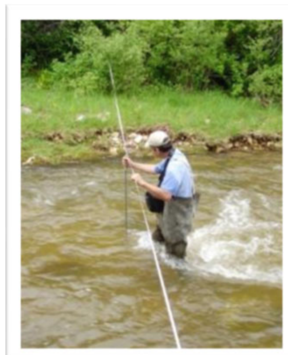
Task 4

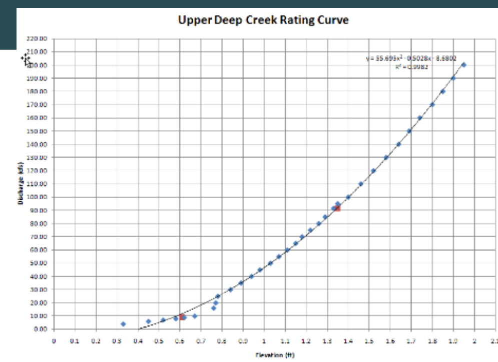
Streamflow Hydrology

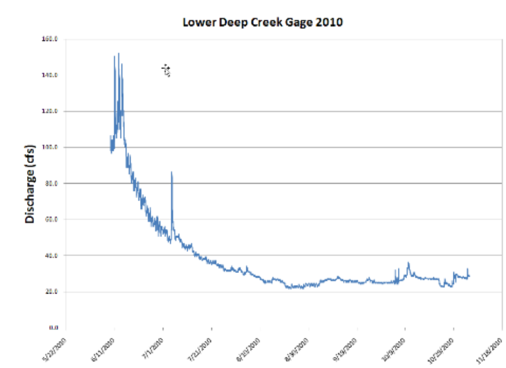
Subtask I: Temporary Stream Gages

Site Selection:

- Coordinate with WWDO and CD's
- Landowner consent
- Access
- Historic gage locations
- Ability to develop rating curves
- Consider data needs to support
- Potential projects in the plan
- *Suitability of site to meet the*
- *Objectives of the study*







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Task 5

Watershed Management & Rehabilitation Plan

GOAL: Develop and Evaluate Practical and Economical Alternatives

Components of the Plan:

A. Water Storage and Conservation
B. Upland Livestock/Wildlife Management
C. Stream Channel Stability
D. Irrigation Rehabilitation
E. Water Quality Management
F. Wetland Development & Enhancement
G. Grazing Management Alternatives
H. Groundwater Recharge

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

Trihydro

Small Water Development Program

To provide grant funding for Small Water Development Projects that improve watershed condition and function and provide benefits for…

- Livestock
- Wildlife
- Irrigation
- Environmental
- Recreational

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 Development Program

Eligible projects include

- Small Reservoirs
- Wells
- Solar Platforms
- Pipelines and Conveyance Facilities
- Springs
- Wetland Development
- Environmental
- Irrigation
- Windmills
- Rural Community Fire Suppression
- Recreational

Small Water Development Program

Criteria…

Small Water projects <u>must adequately demonstrate a public benefit</u>. Public Benefits may be demonstrated for projects included in WWDC Watershed Studies. Eligible projects may be located on Federal, State, public, or private land.

- Livestock
- Wildlife
- Irrigation
- Environmental
- Recreational

* This is a Constitutional Requirement

Small Water Development Program

Sponsors are asked to…

- Specifically address the resource benefits of their project
- Explain how distribution of livestock will improve the health of the watershed.
- Address how watershed health is improved and why public dollars are justified for every project in every application.
- Not use the following "…improved economics for the county…" as a benefit. Water Development is not in the economic improvement business.

Examples

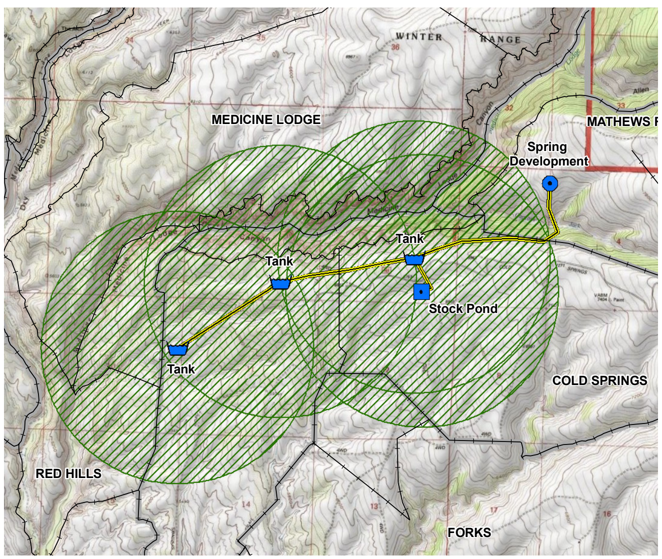
- Wildlife Habitat Improvements
- Sage Grouse
- Improved Riparian Condition
- Fish Passage
- Water Quality Improvements
- ETC…

This is not an exhaustive list.

Task 6

Cost Estimates

“Application Ready” project descriptions and cost estimates



Project Name		Brokenback No. 2 Pipeline Project
Project Component	**Allotment Directly Benefitted**	**Brokenback**
Well Construction / Spring Development	Mobilization	$3,000
	Well / Spring	Spring Development
	Units (each)	1
	Depth Each	NA
	Unit Cost ($/LF wells ror $/EA springs	$5,000
	Well Screen (LF each well)	
	Well Screen ($/LF)	
	Component Subtotal	$8,000
Pipeline	Units (LF)	11,600
	Unit Cost (EA)	$1.34
	Component Subtotal	$15,544
Additional Storage Tanks / Fencing / Etc	Units (EA)	NA
	Size (gal)	
	Unit Cost ($/gal)	
	Component Subtotal	
Water Tanks	Units (EA)	2
	Size (gal)	1,200
	Unit Cost	$3,000
	Component	$6,000
Construction Subtotal		$29,544
Engineering (10%)		$2,954
Constuction and Engineering Subtotal		$32,498
Contingency (15%)		$4,875
Total Construction Cost		$37,373
Final Plans and Specs		$2,000
Additional		$0
Permitting / Legal Fees / Access and Rights of Way		$1,000
Total Project Cost		**$40,373**

Task 7

Economic Analysis

FUNDING ALTERNATIVES

State Sources

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 Water Development Commission

- Wyoming Water Development Program
- *Small Water Project Program*

Wyoming Wildlife and Natural Resources Trust

CLARKS FORK UPPER SHOSHONE WATERSHED STUDY PARK COUNTY, WYOMING

- ➢ Find Partnering Opportunities
- ➢ Offset Project Costs

Federal Sources

Bureau of Land Management

- Riparian 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)

Task 8

Permitting

PERMIT REQUIREMENTS DETERMINED FOR ALL PLAN COMPONENTS, will include:

- NEPA Compliance (EIS)
- U.S. Army Corps of Engineers Section 404 permits
- Wyoming Department of Environmental Quality/Water Quality Division NPDES Stormwater Discharge Permits for Construction Activities and Section 401 Certification
- Endangered Species Act (Section 7 Consultation)
- Fish and Wildlife Coordination Act
- Wyoming Board of Land Commissioners
- Wyoming State Historic Preservation Office archaeological clearances
- Wyoming State Engineer's Office Surface Water Storage Permit
- Wyoming State Engineer's Office Permit to Construct/Dam Safety Review

HOW CAN YOU PARTICIPATE?

- Attend Project Meetings and Workshops
- Provide Input
  - Water Issues
  - Stream Channel Conditions
  - Irrigation Infrastructure
  - Local Issues
- On-Site Visits / Small Water Project Program

Clarks Fork Upper Shoshone Watershed Study Park County, Wyoming

CONTACT US

- Carmen McIntyre: pcfcd1@gmail.com
- Brittany Swope: conservecody@gmail.com

Clarks Fork Upper Shoshone Watershed Study
Park County, Wyoming

Clarks Fork/Upper Shoshone Watershed Study
Summary of Scoping Meetings

Project: Clarks Fork/Upper Shoshone Watershed, Level I Study (Study)
Client: Wyoming Water Development Commission (WWDC)
Sponsors: Cody and Powell Clarks Fork Conservation Districts (CDs)
Consultant: Trihydro Corporation (Trihydro)

Cody Scoping Meeting

Date: June 1, 2022
Time: 6:00 pm – 8:00 pm
Location: Cody, WY – Park County Library, Grizzly Hall

1. The meeting was called to order at 6:00 pm.
2. An attendance roster was provided to record attendees' names, their contact information, and whether they would like to be contacted for an onsite visit or further discussion of specific watershed problems/issues.
   a. Total attendance was 17 (per roster)
   b. 4 attendees requested to be contacted
3. Comment cards were provided to allow attendees to share information about known watershed issues/problems.
   a. 1 comment card was received from WGFD regarding fish passage and points of diversion data.
4. A Study area map was also provided.
5. Trihydro began the meeting with a PowerPoint presentation, which included the following information:
   a. Study area, purpose, and known watershed issues
   b. Approach to the Study (specific tasks involved)
   c. Watershed Management and Rehabilitation Plan development
   d. Small Water Project Program (SWPP) funding opportunities through the WWDC for landowners/stakeholders

e. The need for public (landowner/stakeholder) participation and input, how to participate, and CDs contact info.

6. This was an informal meeting, so questions and discussion were allowed during and after the presentation.

7. The following were topics of discussion and observations from the meeting:

   a. Attendees seemed very interested in the Study and overall goals

   b. Project ideas provided by attendees were quite limited

   c. WGFD may be a good source for quite a few project ideas in the Study area, and they had questions on what types of projects would qualify for SWPP funding.

   d. WGFD indicated that there are fish barriers in the watersheds and will be able to provide data on barriers, such as points of diversion.

   e. WGFD stated that there are also fish barriers that they wish to remain in place for species health.

   f. A hydrologist with the Shoshone National Forest requested that she be contacted for information on issues and potential project ideas.

   g. A lot of discussion on how the watershed study could benefit the community as a whole

   h. Lengthy discussion regarding higher level sources of watershed degradation, level of effort for restoration, and contaminant sources such as chemtrails and weather modification efforts/cloud seeding.

   i. Attendees promoted a holistic approach to watershed management as restoration projects are identified

   j. Small acreage restoration/permaculture

   k. Extending scoping by incorporating additional regular public meetings (monthly) to talk through issues in a roundtable format, which is not really the goal or intent of WWDC watershed studies. CDs will discuss the possibility of hosting meetings every 2-3 months to provide Study updates.

   l. It was suggested by an attendee that maybe it would be best to have the Study identify issues first and then focus on how to address those issues through identification of individual projects, but the WWDO Project Manager had to clarify that the timeframe of the project required that both components move forward simultaneously. Trihydro would need to work with individual landowners to identify projects that could contribute to watershed health while simultaneously completing an inventory of the many resources and calling out those areas with issues and prepare recommendations on how to solve them.

m. SWPP guidance that is available for determining project eligibility as well as information on the prioritization of projects

n. Other funding sources for consideration to combine with SWPP funding or in lieu of if the project is ineligible for SWPP funding

8. The meeting ended at approximately 8:20 pm.

Powell Scoping Meeting

Date: June 2, 2022

Time: 6:00 pm – 8:00 pm

Location: Powell, WY – Northwest College, Fagerberg Building, Room 70

1. The meeting was called to order around 6:10 pm.
2. An attendance roster was provided to record attendees' names, their contact information, and whether they would like to be contacted for an onsite visit or further discussion of specific watershed problems/issues
   a. Total attendance was 15 (per roster)
   b. 1 attendee requested to be contacted
3. Comment cards were provided to allow attendees to share information about known watershed issues/problems
   a. No comment cards were received
4. A Study area map was also provided.
5. Trihydro began the meeting with a PowerPoint presentation, which included the following information:
   a. Study area, purpose, and known watershed issues
   b. Approach to the Study (specific tasks involved)
   c. Watershed Management and Rehabilitation Plan development
   d. SWPP funding opportunities through the WWDC for landowners/stakeholders
   e. The need for public (landowner/stakeholder) participation and input, how to participate, and CDs contact info
6. This was an informal meeting, so questions and discussion were allowed during and after the presentation.

7. The following were topics of discussion and observations from the meeting:
   a. Again, project ideas provided by attendees were quite limited.
   b. Most of this meeting involved discussion of the SWPP, which projects are eligible, the funding amount seems low, are these projects intended to benefit individuals (with some confusion regarding on-farm disqualification), and whether irrigation districts could be project sponsors
   c. SWPP guidance that is available for determining project eligibility as well as information on the prioritization of projects
   d. Other funding sources for consideration to combine with SWPP funding or in lieu of if the project is ineligible for SWPP funding
   e. NRCS indicated knowledge of several potential projects but stated most involve flood-to-pivot (sprinkler) irrigation conversions and were disappointed to learn that those do not qualify for SWPP funding. However, some components could still be eligible.
   f. WWDC policy changes to consider on-farm projects because of the public benefit they provide, and what constitutes a public benefit
   g. Adding more meetings to gain more participation and input, but this is not how watershed studies are designed to proceed. The intent is to have a scoping meeting that identifies some specific issues that have not already been identified by the Sponsors and to allow individuals with project ideas to come forward to identify locations and begin the process of evaluation.
   h. Suggestion that the Study address small acreage and overuse of water
   i. Questions and discussion pertaining to a specific project within the Shoshone Irrigation District which would collect irrigation return via buried tile drains and pipe it to another location for reuse
   j. Shoshone Irrigation District may have other project ideas as well.
   k. Shoshone Irrigation District also offered to help with additional landowner/stakeholder outreach in their annual billing in the fall, but this may be too late in the game.
   l. Recommendation to look at WSEO permit applications for well deepening to gain insight to where pivots may be affecting groundwater recharge
   m. Concerns with subdivision development and coordination with Park County on recommendations for watershed health on that front
   n. Consideration of an additional temporary stream gage on Deer Creek
   o. Fire-damaged culvert on a USFS road
   p. Commissioner Lloyd Thiel mentioned that he had several potential project ideas for the Clarks Fork drainage.

8. The meeting ended at approximately 8:30 pm.

We were hoping for a larger turnout at both meetings and more information on specific issues and potential projects that have not already been identified. Trihydro will work with the CDs and the landowners and stakeholders that have expressed interest and offered to provide information on potential issues and projects. In the meantime, Trihydro will also explore additional options for outreach, such as the Farm Service. Furthermore, we expect that word-of-mouth by the CDs, landowners, and stakeholders that attended the meetings will generate additional interest and participation. Trihydro will touch base with Jodie Pavlica (WWDC) and review the SWPP guidance document to get better versed on eligible and non-eligible projects so that we can paint a clear picture to landowners and stakeholders and encourage participation.

Clarks Fork Upper Shoshone Watershed Study Park County, Wyoming

CLARKS FORK / UPPER SHOSHONE RIVER WATERSHED STUDY PROVIDES OPPORTUNITIES FOR PARK COUNTY LANDOWNERS, RANCHERS, AND FARMERS

The Cody and Powell Clarks Fork Conservation Districts announce the initiation of the Clarks Fork / Upper Shoshone River Watershed Study (Study). The Study area consists of the Shoshone River watershed beginning at its headwaters in Yellowstone National Park and extending downstream to the vicinity of Powell. In addition, the portion of the Clarks Fork of the Yellowstone River watershed that lies within the State of Wyoming is included.

One key component of the Study is the development of a Watershed Management and Rehabilitation Plan (Plan), which will be a prioritized list of projects that will improve the health of the watersheds. THIS IS WHERE THE OPPORTUNITIES LIE FOR LANDOWNERS AND STAKEHOLDERS. A large focus will be to identify water-related issues on private property and develop projects to resolve those issues. If a project is selected for the Plan, a preliminary design, cost estimate, funding alternatives, and permitting requirements will be provided at no cost to the owner. Furthermore, match funding up to $35,000 may be available through the WWDC's Small Water Project Program (SWPP). Samples of SWPP-eligible projects may include irrigation infrastructure (diversions, headgates, etc.), upland water sources (stock reservoirs, pipelines/stock tanks, etc.), wells, solar platforms, and stream channel restoration efforts, to name a few.

We are relying on local knowledge and participation to make this Study a success. If there are known water issues on your property, please reach out and share this information with us. We would welcome very much the opportunity to meet with you and discuss and evaluate the issues. Again, there is no cost to participate. Many landowners and stakeholders have reaped the benefits of other watershed studies and management plans that have performed and developed throughout the State of Wyoming.

To share information, gain information, or simply ask questions, please contact:

Carmen McIntyre
Powell Clarks Fork Conservation District
(307) 754-9301
pcfcd1@gmail.com

Brittany Swope
Cody Conservation District
(307) 578-8335
conservecody@gmail.com

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CLARKS FORK/UPPER SHOSHONE RIVER WATERSHED STUDY

OPPORTUNITIES FOR PARK COUNTY LANDOWNERS, RANCHERS, AND FARMERS

The study area consists of the Shoshone River watershed beginning at its headwaters in Yellowstone National Park and extending downstream to the vicinity of Powell. In addition, the portion of the Clarks Fork of the Yellowstone River watershed that lies within the State of Wyoming is included. Please visit the Cody Conservation District website at **http://codyconservationdistrict.com/projects.html** for additional information.

>> JOIN US FOR A PUBLIC WORKSHOP <<

THURSDAY, SEPTEMBER 1ST | 4 P.M. - 7 P.M.

PARK COUNTY LIBRARY | GRIZZLY HALL

1500 HEART MOUNTAIN ST, CODY, WY

This will be an informal workshop to gain information from landowners and stakeholders on known issues and potential projects. Please mark your calendars and join us.

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CLARKS FORK UPPER SHOSHONE

WATERSHED STUDY

PARK COUNTY, WYOMING

CLARKS FORK / UPPER SHOSHONE RIVER WATERSHED STUDY PROVIDES OPPORTUNITIES FOR PARK COUNTY LANDOWNERS, RANCHERS, AND FARMERS

The Cody and Powell Clarks Fork Conservation Districts announce the initiation of the Clarks Fork / Upper Shoshone River Watershed Study (Study). The Study area consists of the Shoshone River watershed beginning at its headwaters in Yellowstone National Park and extending downstream to the vicinity of Powell. In addition, the portion of the Clarks Fork of the Yellowstone River watershed that lies within the State of Wyoming is included. Please visit the Cody Conservation District website at http://codyconservationdistrict.com/projects.html to view the Study area map.

One key component of the Study is the development of a Watershed Management and Rehabilitation Plan (Plan), which will be a prioritized list of projects that will improve the health of the watersheds. THIS IS WHERE THE OPPORTUNITIES LIE FOR LANDOWNERS AND STAKEHOLDERS. A large focus will be to identify water-related issues on private property and develop projects to resolve those issues. If a project is selected for the Plan, a preliminary design, cost estimate, funding alternatives, and permitting requirements will be provided at no cost to the owner. Furthermore, match funding up to $35,000 may be available through the Wyoming Water Development Commission's (WWDC) Small Water Project Program (SWPP). Samples of SWPP-eligible projects may include irrigation infrastructure (diversions, headgates, etc.), upland water sources (stock reservoirs, pipelines/stock tanks, etc.), wells, solar platforms, and stream channel restoration efforts, to name a few. Additional information on the SWPP can be found on the WWDC website at:
https://wwdc.state.wy.us/small_water_projects/small_water_project.html

We are relying on local knowledge and participation to make this Study a success. If there are known water issues on your property, please reach out and share this information with us. We would welcome very much the opportunity to meet with you and discuss and evaluate the issues. Again, there is no cost to participate. Many landowners and stakeholders have reaped the benefits of other watershed studies and management plans that have performed and developed throughout the State of Wyoming.

The next public workshop will be held on Thursday, September 1, 2022 at the Park County Library, Grizzly Hall from 4 p.m. to 7 p.m. This will be an informal workshop to gain information from landowners and stakeholders on known issues and potential projects. Please mark your calendars and join us.

To share information, gain information, or simply ask questions, please contact:

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(307) 754-9301
pcfcd1@gmail.com

Brittany Swope
Cody Conservation District
(307) 578-8335
conservecody@gmail.com

PUBLIC WORKSHOP ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Date / Time of Meeting	September 1, 2022, 4 p.m. – 7 p.m.
Meeting Location	Cody, Wyoming – Park County Library, Grizzly Hall
Project Title	Clarks Fork / Upper Shoshone Watershed, Level I Study
Project Sponsors	Cody Conservation District and Powell Clarks Fork Conservation District
Funding Agency	Wyoming Water Development Commission
Consulting Firm	Trihydro Corporation
Consultant Project No.	06N-006-001

Name	Telephone	Email	Onsite Visit? (Yes / No)
MARTIN KIMMET	307 645-3160	martinkimmet@yahoo.com	? No
Neil Christofferson	405-227-8018	neil_susan78@yahoo.com	yes
Cecil/Alice Johnstone	307-254-~~[illegible]~~ 4843	Cecil/Alicejohnstone@gmail.com	? No
Lynne Whitmore	307-754-5418	whitmore.lynne@outlook.com	Yes, please
Alan Rosenbaum	307-587-3176	codyfeed@tctwest.net	Yes
Bruce Shackleford	501-765-9009	bruce@thewyldlifefund.org	yes
Sally Martin	307-645-3250		yes ~~(contact)~~
[illegible]	770-489-8931		yes
Juanita Hawley	307 548 6314	oneortwosh@GMAIL.Com	yes
Marion Morrison	307-754-4930	theduchess@tctwest.net	Yes

PUBLIC WORKSHOP ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Name	Telephone	Email	Onsite Visit? (Yes / No)
Roger Brazelton	307-202-0476	wyo.stilgoin@yahoo.com	
Craig + Dorrie Tysse	307-254-4865	cjt338@gmail.com	No
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Jim Montgomery	307-578-6694	montgomeryjim66@gmail.com	yes call me please
Mary Montgomery	307-899-2941	memontgomery44@gmail.com	yes
/ Michael Koller	520-704-2198	mjkoller@cliffhanger.com	yes
CARMEN HORNE - MCGEHEE			
Brittany Swope			
Jason Van Tassell	(406) 679-1301	jvantassell@sunlightranches.com	NO
/ Troy Broussard	(307) 272-4865	TroyBroussard3@Q.Com	Yes
/ Dale Nichols	321-246-3216	grandpianoman4x5@gmail.com	yes
/ Louis Nugent	503-828-4180	Lwnuge2@gmail.com	Yes
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Mike Robertson	307-777-7626	mike.robertson1@wyo.gov	
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CLARKS FORK/UPPER SHOSHONE RIVER WATERSHED STUDY

OPPORTUNITIES FOR PARK COUNTY LANDOWNERS, RANCHERS, AND FARMERS

The study area consists of the Shoshone River watershed beginning at its headwaters in Yellowstone National Park and extending downstream to the vicinity of Powell. In addition, the portion of the Clarks Fork of the Yellowstone River watershed that lies within the State of Wyoming is included. Please visit the Cody Conservation District website at **http://codyconservationdistrict.com/projects.html** for additional information.

>> JOIN US FOR A PUBLIC WORKSHOP <<

THURSDAY, MARCH 16TH | 4 P.M. - 7 P.M.

PARK COUNTY LIBRARY | GRIZZLY HALL

1500 HEART MOUNTAIN ST, CODY, WY

This will be an informal workshop to gain information from landowners and stakeholders on known issues and potential projects. Potential projects must be identified by Spring 2023 to be included in the study. Please mark your calendars and join us.

To share information, gain information, or simply ask questions, please contact:

Carmen McIntyre
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(307) 578-8335
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ann.trosper@wy.nacdnet.net

Clarks Fork
Upper Shoshone
Watershed Study
Park County, Wyoming

CLARKS FORK / UPPER SHOSHONE RIVER WATERSHED STUDY PROVIDES OPPORTUNITIES FOR PARK COUNTY LANDOWNERS, RANCHERS, AND FARMERS

The Cody and Powell Clarks Fork Conservation Districts present the ongoing Clarks Fork / Upper Shoshone River Watershed Study (Study). The Study area consists of the Shoshone River watershed beginning at its headwaters in Yellowstone National Park and extending downstream to the vicinity of Powell. In addition, the portion of the Clarks Fork of the Yellowstone River watershed that lies within the State of Wyoming is included. Please visit the Cody Conservation District website at http://codyconservationdistrict.com/projects.html to view the Study area map.

One key component of the Study is the development of a Watershed Management and Rehabilitation Plan (Plan), which will be a prioritized list of projects that will improve the health of the watersheds. THIS IS WHERE THE OPPORTUNITIES LIE FOR LANDOWNERS AND STAKEHOLDERS. A large focus will be to identify water-related issues on private property and develop projects to resolve those issues. If a project is selected for the Plan, a preliminary design, cost estimate, funding alternatives, and permitting requirements will be provided at no cost to the owner. Furthermore, match funding up to $35,000 may be available through the Wyoming Water Development Commission's (WWDC) Small Water Project Program (SWPP). Samples of SWPP-eligible projects may include irrigation infrastructure (diversions, headgates, etc.), upland water sources (stock reservoirs, pipelines/stock tanks, etc.), wells, solar platforms, and stream channel restoration efforts, to name a few. Additional information on the SWPP can be found on the WWDC website at:
https://wwdc.state.wy.us/small_water_projects/small_water_project.html

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RESCHEDULED - The next public workshop will be held on Thursday, March 16, 2023 at the Park County Library, Grizzly Hall from 4 p.m. to 7 p.m. This will be an informal workshop to gain information from landowners and stakeholders on known issues and potential projects. Please mark your calendars and join us.

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Powell Clarks Fork Conservation District
(307) 754-9301
ann.trosper@wy.nacdnet.net

PUBLIC WORKSHOP ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Date / Time of Meeting	March 16, 2023, 4 p.m. – 7 p.m.
Meeting Location	Cody, Wyoming – Park County Library, Grizzly Hall
Project Title	Clarks Fork / Upper Shoshone Watershed, Level I Study
Project Sponsors	Cody Conservation District and Powell Clarks Fork Conservation District
Funding Agency	Wyoming Water Development Commission
Consulting Firm	Trihydro Corporation
Consultant Project No.	06N-006-001

Name	Telephone	Email	Onsite Visit? (Yes / No)
Donald G Talman	307 645 3176	Talman @ nemontel net	
George Magargal	272-5992	gmagargal@gmail.com	yes
Alex Arnette	5 356-4737	alex.a...te@gmail.com	Yes
Jerry + Dalyn Farwell	307-202-2047	307betty@gmail.com	Maybe
Shaleas Harrison	307-254-7819		
Rick Harrison	307 899 3994	rck.harrison@gmail.com	Yes
Douglas Eden	307 899 5806	prospect_ranch@sbcglobal.net,	yes
Shauna Roberts	3072506377	shaunaroberts@live.com	yes
Robert J. Horner	307 250-7288	rthorner22 @gmail.com	
CARMEN HORNE-McINTYRE	307 578 8335	conservecody@gmail.com	
Ann Trosper	307 527 6381	Powell Clarks Fork CD	

PUBLIC WORKSHOP ATTENDANCE ROSTER
Clarks Fork / Upper Shoshone Watershed Study

Name	Telephone	Email	Onsite Visit? (Yes / No)
Jim Montgomery	307-578-6694	montgomeryjim66@gmail.com	yes.
Russ Dwyer	307-254-3048	Russ@ODUZDUSR.NET	Yes
Scott Lee	307-335-3169	slee@trihydro.com	—
Jay Schug	970-449-2921	jschug@trihydro.com	—

APPENDIX 4A

GEOLOGIC UNITS

APPENDIX 4A. GEOLOGIC UNITS OF THE CLARKSFORK / UPPER SHOSHONE RIVER WATERSHED

Appendix [4A] - Geologic Units of the Clarksfork / Upper Shoshone River Watershed

Formation descriptions have been compiled from Pierce (1966), Pierce and Nelson (1968), Pierce and Nelson (1971), and Pierce (1965); geologic symbols are added in parentheses as necessary to conform with the larger groupings of Love and Christensen (1985) cited on report Figure 8 and displayed on Figure 2.

CENOZOIC-AGE GEOLOGIC UNITS

Qa Alluvium - Unconsolidated deposits of silt, sand, gravel, and cobbles along stream valley and at or near present stream level; Includes alluvial fans Quaternary age.

Qt Unconsolidated deposits of gravel, sand, cobbles, and silt.. Locally subdivided into “Cody” and “Powell” terraces along the Shoshone River, the Chapman terrace along Pat O’hara Creek, and the Polecat Bench; Quaternary age.

Qu Undivided deposits, including: landslide material - Heterogeneous aggregate of rock debris. Many of the large areas are very slow-moving landslips of slightly to moderately deformed bedrock; colluvium - Heterogeneous deposits of rock detritus; and in isolated small areas along the Shoshone River upstream of Cody and along Dead Indian Creek, travertine “of irregular thickness from 0 to 75 feet; Quaternary age.

Tv Volcanic rocks. Includes: 1) Trout Peak Trachyandcsite (Ttp) - Gray massive trachyandesite flows; weathers brown and reddish brown; contains planioclase, pyroxene, and locally olivine phenocrysts. Flows commonly separated by a few to several tens of feet of tan or red tuff and volcanic detritus. Flows range from about 20 to 150 feet and average ahout 100 feet in thickness. Thickness about 900 feet;
2) Wapiti Formation (Twp) - andesitic breccfo, lava flows, ttnd volcanic sandstone, siltstone, and conglomerate undivided. Breccia is brown, reddish brown, gray, and rarely greenish gray; it occurs as irregularly bedded to massive wedge-like masses a few feet to several hundred feet thick. Trachyandesite and dacite flows and flow breccias; gray, weather brown and reddish brown. Volcanic sandstone, siltstone, and conglomerate, medium to light gray, occur in well-bedded sequences a few feet to many feet thick; clasts dominantly andesite with lesser amounts of quartz and petrified wood; conglomerates locally rich in quartzite. Thickness about 4000 feet. Jim Mountain Member, pyroxene and locally pyroxene-olivine trachyandesite lava flows and flow breccias, commonly with thin interbeds of tuff and volcanic sediments. Thickness about 1000 feet. Lava flows of trachyandesite, volcanic sandstone, siltstone, and conglomerate locally attains thickness of 300 feet; limestone fragments and masses in and near base of formation; commonly Madison Limestone which has been secondarily derived from Heart Mountain fault masses, but a few may be the tops of Heart Mountain fault blocks which protrude through volcanicelastic rocks; masses of sedimentary rocks derived from Willwood Formation.
3) Cathedral Cliffs Formation (Taw) - Tuff, volcanic sediment, lapilli tuff, and breccia, light colored; present only in northwest corner of Pat O’Hara Mountian Quadrangle, deposited prior to the Heart Mountain faulting and transported to its present position by that fault movement. These rocks are similar to light colored layers in the Wapiti Formation. Eocene age.

Tfu Fort Union Formation - Thin-bedded, light-colored sandston.e and conglomerate; drab to olive-brown shale with some red shale and some carbonaceous shale. Forms badlands. Thickness, 5000 feet or more. Paleocene age.

Twl Willwood Formation - Varicolored clay, sandstone, and shale; so-me carbonaceous shale with thin coal lenses; some conglomerate in lower part. Forms badlands. Thickness 2000 feet. Eocene age.

MESOZOIC-AGE GEOLOGIC UNITS (MzPz)

Kz - Cretaceous (KJ):

Lance Formation (Kl) - Thick-bedded buff-colored sandstone; drab and green shale. Thickness about 1800 feet.

Meeteetse Formation (Km) - Gray to white clayey sand, drab sandstone, gray and brown shale, and bentonitic clay; locally contains a thin coal bed. Thickness about 1200 feet.

Mesaverde Formation (Kmv) - Interbedded sandstone and shale in upper part; lower part massive light-buff ledge-forming sandstone with thin lenticular coal bed. Thickness about 1100 feet.

Cody Shale (Kc) - Upper part buff sandy shale and thinly laminated buff sandstone; lower part dark-gray thin-bedded shale. Thickness, 1800 to 2200 feet.

Frontier Formation (Kf) - Thick lenticular gray sandstone, gray, brown, and carbonaceous shale and bentonite. Thickness, 450 to 500 feet.

Mowry Shale - Gray and brown shale, in part siliceous with numerous bentonite beds and abundant fish scales. Thickness about 400 feet.

Thermopolis Shale (Kft) - Soft black shale with numerous bentonite beds; Muddy Sandstone Member about 200 feet above base. Thickness, 550 to 600 feet.

Jz - Jurassic (KJ):

Cloverly and Formation - Cloverly Formation is light gray sandstone, gray and variegated shale, and lenticular chert conglomerate. "Rusty beds" at top.

Morrison Formation - dully variegated claystone and gray silty sandstone. Combined thickness of Cloverly and Morrison Formations about 600 feet.

Sundance Formation (Jsg, KJs) - green and gray shale, greenish-gray glauconitic limy sandstone, and thin beds of fossiliferous limestone.

Gypsum Spring Formation (Jsg, KJg) - red and gray shale, fossiliferous limestone, and gypsum; gypsum bed at base up to 50 feet or more thick. Combined thickness of Sundance and Gypsum Spring Formations about 500 feet.

TrJz - Triassic/Jurassic undivided:

Chugwater Formation (Trc- Red siltstone, red shale, and fine-grained, red sandstone; gypsiferous. Thickness, 650 to 750 feet.

Dinwoody Formation (Trcd - tan, gray, and red siltstone, gypsum, and dolomite. Thickness, 20 to 50 feet.

Pz - PALEOZOIC-AGE GEOLOGIC UNITS (MzPz)

Permian:

Park City Formation - siliceous limestone and dolomite, nodular chert and tan and gray shale. (Formerly called Phosphoria Formation in this area.) Thickness, 70 to 110 feet.

Pennsylvanian (PM):

Tensleep Sandstone - Light-gray, well-sorted, crossbedded, massive sandstone; thin bed.11 of limestone and dolomite in lower part. Thickness, 170 to 220 feet. Pennsylvanian age.

Mississippian (MD, PM):

Amsden Formation - Red shale, with some dolomitic limestone beds; some chert and hematite nodules; basal part commonly siltstone or sandstone. Thickness, 200 to 300 feet.

Madison Limestone (Mm)- Blue-gray massive limestone, dolomitic in part; upper half somewhat thicker bedded and more massive than lower half. Thickness, 700 to 900 feet.

Devonian:

Three Forks Formation - yellow, greenish-gray and dark gray dolomitic siltstone, black fissile shale, and silty dolomite.

Jefferson Formation - fetid brown dolomite and light-gray and tan limestone; uppermost part is mottled yellowish-orange dolomite and yellowish-gray siltstone. Combined thickness of Three Forks and Jefferson Formations, 190 to 300 feet.

Beartooth Butte Formation - Stream channel deposit of red calcareous siltstone, red and yellowish-gray silty limestone and siltstone, and some siltstone and limestone conglomerate and breccia. Present only at Beartooth Butte (0 to 150 feet thick) and at the mouth of the Clarksfork River canyon (0 to 75 feet thick).

Ordovician (MDO, DO):

Bighorn Dolomite (Ob) - gray, massive, cliff-forming dolomite and dolomitic limestone. Thickness, 400 feet.

Cambrian (Cr)

Grove Creek Formation - gray, buff, and orange limestone and dolomite, green shale, and gray-green limestone-pebble conglomerate. Thickness 30 to 40 feet.

Snowy Range Formation - gray-green shale and greenish flat pebble conglomerate. Thickness about 300 feet.

Pilgrim Limestone - Massive, light~gray, mottled oolitic limestone; forms a prominent ledge. Thickness about 100 feet.

Gros Ventre Formation - Green, micaceous shale, thin-bedded, gray limestone, and limestone-pebble conglomerate. A 30 to 50-foot ledge-forming unit of thin-bedded, nodular limestone and interbedded green shale 200 feet above base is probably equivalent to the Meagher Limestone (Middle Cambrian) in Montana. Thickness, 740 feet.

Flathead Sandstone - Hard, ledge-forming, quartzitic sandstone, becoming softer and brown speckled in upper part. Thickness, 120 to 150 feet.

pC - PRECAMBRIAN-AGE ROCKS

Granitic rocks, chiefly granitic gneiss and granite

APPENDIX 4B

SENSITIVE SPECIES

Wyoming Natural Diversity Database: Animal Species of Concern									
Clarks Fork Watershed									
Taxonomic Group	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
Animals: Amphibians	Columbia Spotted Frog	Rana luteiventris		Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S3	Species of Concern (SOC)
Animals: Amphibians	Northern Leopard Frog	Lithobates pipiens	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Animals: Amphibians	Plains Spadefoot	Spea bombifrons				NSS4(Bc)	G5	S4	Species of Concern (SOC)
Animals: Amphibians	Western Tiger Salamander	Ambystoma mavortium				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Amphibians	Western Toad	Anaxyrus boreas	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS1(Aa)	G4	S1	Species of Concern (SOC)
Animals: Birds	American Avocet	Recurvirostra americana					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	American Bittern	Botaurus lentiginosus			USFS-R2	NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	American Dipper	Cinclus mexicanus	Not Warranted for Listing (NW)				G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	American Kestrel	Falco sparverius				NSS4(Bc)	G5	S5	
Animals: Birds	American Pipit	Anthus rubescens				NSS4(Bc)	G5	S2	
Animals: Birds	American Three-toed Woodpecker	Picoides dorsalis			USFS-R4		G5	S3	Species of Concern (SOC)
Animals: Birds	American White Pelican	Pelecanus erythrorhynchos				NSS4(Bc)	G4	S3S4	Species of Concern (SOC)
Animals: Birds	Bald Eagle	Haliaeetus leucocephalus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G5	S4BS5N	Species of Concern (SOC)
Animals: Birds	Barn Owl	Tyto alba					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Black Rosy-Finch	Leucosticte atrata				NSSU(U)	G4	S1BS2N	Species of Concern (SOC)
Animals: Birds	Black-backed Woodpecker	Picoides arcticus	Not Warranted for Listing (NW)		USFS-R2	NSSU(U)	G5	S2	Species of Concern (SOC)
Animals: Birds	Black-crowned Night-Heron	Nycticorax nycticorax				NSS3(Bb)	G5	S2S3	Species of Potential Concern (SOPC)
Animals: Birds	Black-necked Stilt	Himantopus mexicanus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Black-throated Gray Warbler	Setophaga nigrescens				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Animals: Birds	Blue-gray Gnatcatcher	Polioptila caerulea				NSS4(Bc)	G5	S3S4	
Animals: Birds	Bobolink	Dolichonyx oryzivorus				NSS4(Bc)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	Boreal Owl	Aegolius funereus			USFS-R2, USFS-R4	NSS3(Bb)	G5	S2	Species of Concern (SOC)
Animals: Birds	Brewer's Sparrow	Spizella breweri		Sensitive	USFS-R2	NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Animals: Birds	Bufflehead	Bucephala albeola					G5	S2B	Species of Potential Concern (SOPC)
Animals: Birds	Burrowing Owl	Athene cunicularia		Sensitive	USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Birds	California Gull	Larus californicus					G5	S2B	Species of Potential Concern (SOPC)
Animals: Birds	Calliope Hummingbird	Selasphorus calliope				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Animals: Birds	Canyon Wren	Catherpes mexicanus				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Cassin's Sparrow	Peucaea cassinii			USFS-R2		G5	SNR	Species of Potential Concern (SOPC)
Animals: Birds	Chestnut-collared Longspur	Calcarius ornatus			USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Animals: Birds	Chimney Swift	Chaetura pelagica					G4G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Clark's Nutcracker	Nucifraga columbiana				NSS4(Bc)	G5	S3S4	
Animals: Birds	Clay-colored Sparrow	Spizella pallida					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Common Goldeneye	Bucephala clangula					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Common Loon	Gavia immer			USFS-R4	NSS1(Aa)	G5	S1BS3N	Species of Concern (SOC)
Animals: Birds	Common Nighthawk	Chordeiles minor				NSS4(Bc)	G5	S5	
Animals: Birds	Common Tern	Sterna hirundo					G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Common Yellowthroat	Geothlypis trichas				NSS4(Bc)	G5	S5	
Animals: Birds	Dark-eyed Junco	Junco hyemalis					G5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Dickcissel	Spiza americana				NSSU(U)	G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Eastern Screech-Owl	Megascops asio					G5	S3	Species of Potential Concern (SOPC)
Animals: Birds	Ferruginous Hawk	Buteo regalis	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S4S5BS3N	Species of Concern (SOC)
Animals: Birds	Flammulated Owl	Psiloscops flammeolus			USFS-R2, USFS-R4	NSSU(U)	G4	S1	Species of Potential Concern (SOPC)
Animals: Birds	Franklin's Gull	Leucophaeus pipixcan				NSSU(U)	G5	S1	
Animals: Birds	Golden Eagle	Aquila chrysaetos				NSS4(Bc)	G5	S5BS4S5N	Species of Potential Concern (SOPC)
Animals: Birds	Golden-crowned Kinglet	Regulus satrapa					G5	S3BS4N	Species of Potential Concern (SOPC)
Animals: Birds	Great Blue Heron	Ardea herodias				NSS4(Bc)	G5	S4	
Animals: Birds	Great Gray Owl	Strix nebulosa			USFS-R4	NSSU(U)	G5	S2	Species of Concern (SOC)
Animals: Birds	Greater Sage-Grouse	Centrocercus urophasianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G3G4	S4	Species of Concern (SOC)
Animals: Birds	Hammond's Flycatcher	Empidonax hammondii					G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Harlequin Duck	Histrionicus histrionicus			USFS-R2, USFS-R4	NSS3(Bb)	G4	S1	Species of Concern (SOC)
Animals: Birds	Indigo Bunting	Passerina cyanea					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Lewis's Woodpecker	Melanerpes lewis			USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Birds	Loggerhead Shrike	Lanius ludovicianus		Sensitive	USFS-R2	NSS4(Bc)	G4	S4S5	Species of Concern (SOC)
Animals: Birds	Long-billed Curlew	Numenius americanus		Sensitive	USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	MacGillivray's Warbler	Geothlypis tolmiei				NSS4(Bc)	G5	S4	
Animals: Birds	Merlin	Falco columbarius				NSSU(U)	G5	S4	Species of Potential Concern (SOPC)

Wyoming Natural Diversity Database: Animal Species of Concern									
Clarks Fork Watershed									
Taxonomic Group	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
Animals: Birds	Mountain Plover	Charadrius montanus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSSU(U)	G3	S3	Species of Concern (SOC)
Animals: Birds	Northern Bobwhite	Colinus virginianus					G4G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Northern Goshawk	Accipiter gentilis	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSSU(U)	G5	S2S3BS3N	Species of Concern (SOC)
Animals: Birds	Northern Harrier	Circus hudsonius			USFS-R2		G5	S4BS5N	
Animals: Birds	Northern Pygmy-Owl	Glaucidium gnoma				NSSU(U)	G4G5	S1S2	Species of Concern (SOC)
Animals: Birds	Olive-sided Flycatcher	Contopus cooperi			USFS-R2		G4	S4B	Species of Potential Concern (SOPC)
Animals: Birds	Oregon Junco	Junco hyemalis oreganus					G5T5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Osprey	Pandion haliaetus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Peregrine Falcon	Falco peregrinus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S2BS2S3N	Species of Concern (SOC)
Animals: Birds	Pink-sided Junco	Junco hyemalis mearnsi					G5T5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Pinyon Jay	Gymnorhinus cyanocephalus	Petition Under Review (UR)				G5	S5BS5N	
Animals: Birds	Red Crossbill	Loxia curvirostra				NSS4(Bc)	G5	S5	
Animals: Birds	Red-eyed Vireo	Vireo olivaceus				NSS4(Bc)	G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Red-headed Woodpecker	Melanerpes erythrocephalus				NSS4(Bc)	G5	S2S3	
Animals: Birds	Ring-billed Gull	Larus delawarensis					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Ring-necked Duck	Aythya collaris					G5	S4B	Species of Potential Concern (SOPC)
Animals: Birds	Rose-breasted Grosbeak	Pheucticus ludovicianus					G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Rufous Hummingbird	Selasphorus rufus				NSS4(Bc)	G5	S3	
Animals: Birds	Sage Thrasher	Oreoscoptes montanus		Sensitive		NSS4(Bc)	G4	S5	Species of Potential Concern (SOPC)
Animals: Birds	Sagebrush Sparrow	Artemisiospiza nevadensis		Sensitive	USFS-R2	NSS4(Bc)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Sandhill Crane	Antigone canadensis					G5	S3BS5N	Species of Potential Concern (SOPC)
Animals: Birds	Short-eared Owl	Asio flammeus				NSS4(Bc)	G5	S1S2	Species of Concern (SOC)
Animals: Birds	Sprague's Pipit	Anthus spragueii	Not Warranted for Listing (NW)				G3G4	SNA	Species of Potential Concern (SOPC)
Animals: Birds	Swainson's Hawk	Buteo swainsoni				NSSU(U)	G5	S5	
Animals: Birds	Thick-billed Longspur	Rhynchophanes mccownii			USFS-R2	NSS4(Bc)	G4	S3	Species of Concern (SOC)
Animals: Birds	Trumpeter Swan	Cygnus buccinator	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS2(Ba)	G4	S3	Species of Concern (SOC)
Animals: Birds	Tundra Swan	Cygnus columbianus					G5	S2N	Species of Potential Concern (SOPC)
Animals: Birds	Upland Sandpiper	Bartramia longicauda				NSSU(U)	G5	S4S5	
Animals: Birds	Virginia Rail	Rallus limicola				NSSU(U)	G5	S2S4	Species of Potential Concern (SOPC)
Animals: Birds	Western Grebe	Aechmophorus occidentalis				NSSU(U)	G5	S3S4	
Animals: Birds	White-faced Ibis	Plegadis chihi		Sensitive		NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	White-winged Crossbill	Loxia leucoptera					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Williamson's Sapsucker	Sphyrapicus thyroideus				NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Willow Flycatcher	Empidonax traillii				NSS3(Bb)	G5	S5	
Animals: Birds	Winter Wren	Troglodytes hiemalis					G5	SNA	Species of Potential Concern (SOPC)
Animals: Fishes	Yellowstone Cutthroat Trout	Oncorhynchus clarkii bouvieri	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4T4	S2	Species of Concern (SOC)
Animals: Invertebrates	Glacier Forestfly	Zapada glacier	Listed Threatened (LT)				G1	SNR	
Animals: Invertebrates	Tadpole Shrimp	Triopsidae				NSSU(U)			
Animals: Mammals	American Bison	Bos bison					G4	S1	Species of Concern (SOC)
Animals: Mammals	American Pika	Ochotona princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5	S2	Species of Concern (SOC)
Animals: Mammals	Bighorn Sheep	Ovis canadensis			USFS-R2, USFS-R4	NSS4(Bc)	G4	S2S3	Species of Potential Concern (SOPC)
Animals: Mammals	Canada Lynx	Lynx canadensis	Listed Threatened (LT)			NSS1(Aa)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Dwarf Shrew	Sorex nanus				NSS3(Bb)	G4	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Fisher	Pekania pennanti	Not Warranted for Listing (NW)		USFS-R4		G5	SNA	Species of Concern (SOC)
Animals: Mammals	Fringed Myotis	Myotis thysanodes		Sensitive	USFS-R2	NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Gray Wolf	Canis lupus	Petition Under Review (UR)		USFS-R4		G5	S1	Species of Concern (SOC)
Animals: Mammals	Grizzly Bear	Ursus arctos	Listed Threatened (LT)				G4	S1	Species of Concern (SOC)
Animals: Mammals	Jumping Mice	Zapus							Species of Concern (SOC)
Animals: Mammals	Long-eared Myotis	Myotis evotis		Sensitive		NSS4(Cb)	G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Long-legged Myotis	Myotis volans				NSS4(Cb)	G4G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Moose	Alces alces				NSS4(Bc)	G5	S4	
Animals: Mammals	Northern Flying Squirrel	Glaucomys sabrinus				NSS4(Cb)	G5	S3S4	
Animals: Mammals	Northern Hoary Bat	Aeorestes cinereus			USFS-R2		G3G4	S4	Species of Potential Concern (SOPC)
Animals: Mammals	Northern River Otter	Lontra canadensis	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Mammals	Northern Rocky Mountain Pika	Ochotona princeps princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5TNR	S2	Species of Concern (SOC)
Animals: Mammals	Olive-backed Pocket Mouse	Perognathus fasciatus				NSS4(Cb)	G5	S3S5	Species of Potential Concern (SOPC)
Animals: Mammals	Pacific Marten	Martes caurina	Not Warranted for Listing (NW)		USFS-R2		G4G5	S3	Species of Potential Concern (SOPC)

Wyoming Natural Diversity Database: Animal Species of Concern									
Clarks Fork Watershed									
Taxonomic Group	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
Animals: Mammals	Silver-haired Bat	Lasionycteris noctivagans					G3G4	S3B	Species of Potential Concern (SOPC)
Animals: Mammals	Spotted Bat	Euderma maculatum		Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G4	S1S2	Species of Concern (SOC)
Animals: Mammals	Swift Fox	Vulpes velox	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G3	S2	Species of Concern (SOC)
Animals: Mammals	Uinta Ground Squirrel	Urocitellus armatus					G5	S3S4	Species of Potential Concern (SOPC)
Animals: Mammals	Water Vole	Microtus richardsoni			USFS-R2	NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Western Jumping Mouse	Zapus princeps					G5	S3S4	Species of Concern (SOC)
Animals: Mammals	Western Little Brown Myotis	Myotis carissima	Petition Under Review (UR)			NSS3(Bb)	G3	S5	Species of Potential Concern (SOPC)
Animals: Mammals	Western Small-footed Myotis	Myotis ciliolabrum				NSS4(Cb)	G5	S4	Species of Potential Concern (SOPC)
Animals: Mammals	White-tailed Prairie Dog	Cynomys leucurus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Wolverine	Gulo gulo	Petition Under Review (UR)			NSS3(Bb)	G4	S1S2	Species of Concern (SOC)
Animals: Reptiles	Bullsnake	Pituophis catenifer sayi					G5T5	S4	Species of Potential Concern (SOPC)
Animals: Reptiles	Common Gartersnake	Thamnophis sirtalis				NSSU(U)	G5	S5	Species of Potential Concern (SOPC)
Animals: Reptiles	Eastern Yellow-bellied Racer	Coluber constrictor flaviventris					G5T5	S4	Species of Potential Concern (SOPC)
Animals: Reptiles	Northern Rubber Boa	Charina bottae				NSS3(Bb)	G5	S2	Species of Concern (SOC)
Animals: Reptiles	Plains Short-horned Lizard	Phrynosoma hernandesi brevirostris				NSS4(Bc)	G5TNR	SNR	
Animals: Reptiles	Prairie Rattlesnake	Crotalus viridis				NSS4(Bc)	G5	S5	
Animals: Reptiles	Valley Gartersnake	Thamnophis sirtalis fitchi				NSSU(U)	G5TNR	S2	Species of Potential Concern (SOPC)
Animals: Reptiles	Western Milksnake	Lampropeltis gentilis				NSS3(Bb)	G5	S3	Species of Potential Concern (SOPC)
			For Code information see: Federal Status Codes				For Code Information see: State Status Codes		For Code Information see: WYNDD Status Codes

Wyoming Natural Diversity Database: Animal Species of Concern									
Upper Shoshone Watershed									
Taxonomic Group	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
Animals: Amphibians	Columbia Spotted Frog	Rana luteiventris		Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S3	Species of Concern (SOC)
Animals: Amphibians	Northern Leopard Frog	Lithobates pipiens	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Animals: Amphibians	Northern Leopard Frog	Lithobates pipiens	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Animals: Amphibians	Plains Spadefoot	Spea bombifrons				NSS4(Bc)	G5	S4	Species of Concern (SOC)
Animals: Amphibians	Western Tiger Salamander	Ambystoma mavortium				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Amphibians	Western Tiger Salamander	Ambystoma mavortium				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Amphibians	Western Toad	Anaxyrus boreas	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS1(Aa)	G4	S1	Species of Concern (SOC)
Animals: Birds	American Avocet	Recurvirostra americana					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	American Avocet	Recurvirostra americana					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	American Bittern	Botaurus lentiginosus			USFS-R2	NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	American Bittern	Botaurus lentiginosus			USFS-R2	NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	American Dipper	Cinclus mexicanus	Not Warranted for Listing (NW)				G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	American Dipper	Cinclus mexicanus	Not Warranted for Listing (NW)				G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	American Kestrel	Falco sparverius				NSS4(Bc)	G5	S5	
Animals: Birds	American Kestrel	Falco sparverius				NSS4(Bc)	G5	S5	
Animals: Birds	American Pipit	Anthus rubescens				NSS4(Bc)	G5	S2	
Animals: Birds	American Pipit	Anthus rubescens				NSS4(Bc)	G5	S2	
Animals: Birds	American Three-toed Woodpecker	Picoides dorsalis			USFS-R4		G5	S3	Species of Concern (SOC)
Animals: Birds	American White Pelican	Pelecanus erythrorhynchos				NSS4(Bc)	G4	S3S4	Species of Concern (SOC)
Animals: Birds	American White Pelican	Pelecanus erythrorhynchos				NSS4(Bc)	G4	S3S4	Species of Concern (SOC)
Animals: Birds	Bald Eagle	Haliaeetus leucocephalus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G5	S4BS5N	Species of Concern (SOC)
Animals: Birds	Bald Eagle	Haliaeetus leucocephalus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G5	S4BS5N	Species of Concern (SOC)
Animals: Birds	Barn Owl	Tyto alba					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Black Rosy-Finch	Leucosticte atrata				NSSU(U)	G4	S1BS2N	Species of Concern (SOC)
Animals: Birds	Black Tern	Chlidonias niger			USFS-R2	NSS3(Bb)	G4G5	S1	Species of Concern (SOC)
Animals: Birds	Black Tern	Chlidonias niger			USFS-R2	NSS3(Bb)	G4G5	S1	Species of Concern (SOC)
Animals: Birds	Black-backed Woodpecker	Picoides arcticus	Not Warranted for Listing (NW)		USFS-R2	NSSU(U)	G5	S2	Species of Concern (SOC)
Animals: Birds	Black-chinned Hummingbird	Archilochus alexandri				NSSU(U)	G5	S2	
Animals: Birds	Black-crowned Night-Heron	Nycticorax nycticorax				NSS3(Bb)	G5	S2S3	Species of Potential Concern (SOPC)
Animals: Birds	Black-crowned Night-Heron	Nycticorax nycticorax				NSS3(Bb)	G5	S2S3	Species of Potential Concern (SOPC)
Animals: Birds	Black-necked Stilt	Himantopus mexicanus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Black-necked Stilt	Himantopus mexicanus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Blue Grosbeak	Passerina caerulea				NSS4(Bc)	G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Blue-gray Gnatcatcher	Polioptila caerulea				NSS4(Bc)	G5	S3S4	
Animals: Birds	Blue-gray Gnatcatcher	Polioptila caerulea				NSS4(Bc)	G5	S3S4	
Animals: Birds	Bobolink	Dolichonyx oryzivorus				NSS4(Bc)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	Bobolink	Dolichonyx oryzivorus				NSS4(Bc)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	Boreal Owl	Aegolius funereus			USFS-R2, USFS-R4	NSS3(Bb)	G5	S2	Species of Concern (SOC)
Animals: Birds	Boreal Owl	Aegolius funereus			USFS-R2, USFS-R4	NSS3(Bb)	G5	S2	Species of Concern (SOC)
Animals: Birds	Brewer's Sparrow	Spizella breweri		Sensitive	USFS-R2	NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Animals: Birds	Brewer's Sparrow	Spizella breweri		Sensitive	USFS-R2	NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Animals: Birds	Bufflehead	Bucephala albeola					G5	S2B	Species of Potential Concern (SOPC)
Animals: Birds	Burrowing Owl	Athene cunicularia		Sensitive	USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Birds	Burrowing Owl	Athene cunicularia		Sensitive	USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Birds	California Gull	Larus californicus					G5	S2B	Species of Potential Concern (SOPC)
Animals: Birds	California Gull	Larus californicus					G5	S2B	Species of Potential Concern (SOPC)
Animals: Birds	Calliope Hummingbird	Selasphorus calliope				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Animals: Birds	Calliope Hummingbird	Selasphorus calliope				NSS4(Bc)	G5	S2	Species of Concern (SOC)
Animals: Birds	Canyon Wren	Catherpes mexicanus				NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Caspian Tern	Hydroprogne caspia				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	Caspian Tern	Hydroprogne caspia				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	Cattle Egret	Bubulcus ibis				NSS3(Bb)	G5	S1S2	
Animals: Birds	Cattle Egret	Bubulcus ibis				NSS3(Bb)	G5	S1S2	
Animals: Birds	Chestnut-collared Longspur	Calcarius ornatus			USFS-R2	NSS4(Bc)	G5	S3	Species of Concern (SOC)
Animals: Birds	Clark's Grebe	Aechmophorus clarkii				NSSU(U)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	Clark's Nutcracker	Nucifraga columbiana				NSS4(Bc)	G5	S3S4	
Animals: Birds	Clark's Nutcracker	Nucifraga columbiana				NSS4(Bc)	G5	S3S4	

Wyoming Natural Diversity Database: Animal Species of Concern									
Upper Shoshone Watershed									
Taxonomic Group	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
Animals: Birds	Clay-colored Sparrow	Spizella pallida					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Clay-colored Sparrow	Spizella pallida					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Common Goldeneye	Bucephala clangula					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Common Goldeneye	Bucephala clangula					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Common Loon	Gavia immer			USFS-R4	NSS1(Aa)	G5	S1BS3N	Species of Concern (SOC)
Animals: Birds	Common Loon	Gavia immer			USFS-R4	NSS1(Aa)	G5	S1BS3N	Species of Concern (SOC)
Animals: Birds	Common Nighthawk	Chordeiles minor				NSS4(Bc)	G5	S5	
Animals: Birds	Common Nighthawk	Chordeiles minor				NSS4(Bc)	G5	S5	
Animals: Birds	Common Tern	Sterna hirundo					G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Common Yellowthroat	Geothlypis trichas				NSS4(Bc)	G5	S5	
Animals: Birds	Common Yellowthroat	Geothlypis trichas				NSS4(Bc)	G5	S5	
Animals: Birds	Dark-eyed Junco	Junco hyemalis					G5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Dark-eyed Junco	Junco hyemalis					G5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Dickcissel	Spiza americana				NSSU(U)	G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Eastern Screech-Owl	Megascops asio					G5	S3	Species of Potential Concern (SOPC)
Animals: Birds	Eastern Screech-Owl	Megascops asio					G5	S3	Species of Potential Concern (SOPC)
Animals: Birds	Ferruginous Hawk	Buteo regalis	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S4S5BS3N	Species of Concern (SOC)
Animals: Birds	Ferruginous Hawk	Buteo regalis	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S4S5BS3N	Species of Concern (SOC)
Animals: Birds	Forster's Tern	Sterna forsteri				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	Forster's Tern	Sterna forsteri				NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	Franklin's Gull	Leucophaeus pipixcan				NSSU(U)	G5	S1	
Animals: Birds	Franklin's Gull	Leucophaeus pipixcan				NSSU(U)	G5	S1	
Animals: Birds	Golden Eagle	Aquila chrysaetos				NSS4(Bc)	G5	S5BS4S5N	Species of Potential Concern (SOPC)
Animals: Birds	Golden Eagle	Aquila chrysaetos				NSS4(Bc)	G5	S5BS4S5N	Species of Potential Concern (SOPC)
Animals: Birds	Golden-crowned Kinglet	Regulus satrapa					G5	S3BS4N	Species of Potential Concern (SOPC)
Animals: Birds	Grasshopper Sparrow	Ammodramus savannarum			USFS-R2	NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Grasshopper Sparrow	Ammodramus savannarum			USFS-R2	NSS4(Bc)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Great Blue Heron	Ardea herodias				NSS4(Bc)	G5	S4	
Animals: Birds	Great Blue Heron	Ardea herodias				NSS4(Bc)	G5	S4	
Animals: Birds	Great Gray Owl	Strix nebulosa			USFS-R4	NSSU(U)	G5	S2	Species of Concern (SOC)
Animals: Birds	Great Gray Owl	Strix nebulosa			USFS-R4	NSSU(U)	G5	S2	Species of Concern (SOC)
Animals: Birds	Greater Sage-Grouse	Centrocercus urophasianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G3G4	S4	Species of Concern (SOC)
Animals: Birds	Greater Sage-Grouse	Centrocercus urophasianus	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G3G4	S4	Species of Concern (SOC)
Animals: Birds	Hammond's Flycatcher	Empidonax hammondii					G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Hammond's Flycatcher	Empidonax hammondii					G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Harlequin Duck	Histrionicus histrionicus			USFS-R2, USFS-R4	NSS3(Bb)	G4	S1	Species of Concern (SOC)
Animals: Birds	Herring Gull	Larus argentatus					G5	SNA	Species of Potential Concern (SOPC)
Animals: Birds	Herring Gull	Larus argentatus					G5	SNA	Species of Potential Concern (SOPC)
Animals: Birds	Indigo Bunting	Passerina cyanea					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Lesser Black-backed Gull	Larus fuscus					G5	SNA	Species of Potential Concern (SOPC)
Animals: Birds	Lewis's Woodpecker	Melanerpes lewis			USFS-R2	NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Birds	Loggerhead Shrike	Lanius ludovicianus		Sensitive	USFS-R2	NSS4(Bc)	G4	S4S5	Species of Concern (SOC)
Animals: Birds	Loggerhead Shrike	Lanius ludovicianus		Sensitive	USFS-R2	NSS4(Bc)	G4	S4S5	Species of Concern (SOC)
Animals: Birds	Long-billed Curlew	Numenius americanus		Sensitive	USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Long-billed Curlew	Numenius americanus		Sensitive	USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	MacGillivray's Warbler	Geothlypis tolmiei				NSS4(Bc)	G5	S4	
Animals: Birds	MacGillivray's Warbler	Geothlypis tolmiei				NSS4(Bc)	G5	S4	
Animals: Birds	Merlin	Falco columbarius				NSSU(U)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Merlin	Falco columbarius				NSSU(U)	G5	S4	Species of Potential Concern (SOPC)
Animals: Birds	Mountain Plover	Charadrius montanus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSSU(U)	G3	S3	Species of Concern (SOC)
Animals: Birds	Mountain Plover	Charadrius montanus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSSU(U)	G3	S3	Species of Concern (SOC)
Animals: Birds	Northern Bobwhite	Colinus virginianus					G4G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Northern Bobwhite	Colinus virginianus					G4G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Northern Goshawk	Accipiter gentilis	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSSU(U)	G5	S2S3BS3N	Species of Concern (SOC)
Animals: Birds	Northern Goshawk	Accipiter gentilis	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSSU(U)	G5	S2S3BS3N	Species of Concern (SOC)
Animals: Birds	Northern Harrier	Circus hudsonius			USFS-R2		G5	S4BS5N	
Animals: Birds	Northern Harrier	Circus hudsonius			USFS-R2		G5	S4BS5N	

Wyoming Natural Diversity Database: Animal Species of Concern

Upper Shoshone Watershed

Taxonomic Group	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
Animals: Birds	Northern Pygmy-Owl	Glaucidium gnoma				NSSU(U)	G4G5	S1S2	Species of Concern (SOC)
Animals: Birds	Olive-sided Flycatcher	Contopus cooperi			USFS-R2		G4	S4B	Species of Potential Concern (SOPC)
Animals: Birds	Oregon Junco	Junco hyemalis oreganus					G5T5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Oregon Junco	Junco hyemalis oreganus					G5T5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Osprey	Pandion haliaetus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Osprey	Pandion haliaetus					G5	S3B	Species of Potential Concern (SOPC)
Animals: Birds	Peregrine Falcon	Falco peregrinus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S2BS2S3N	Species of Concern (SOC)
Animals: Birds	Peregrine Falcon	Falco peregrinus	Delisted Monitored (DM)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S2BS2S3N	Species of Concern (SOC)
Animals: Birds	Pink-sided Junco	Junco hyemalis mearnsi					G5T5	S5BS5N	Species of Concern (SOC)
Animals: Birds	Pinyon Jay	Gymnorhinus cyanocephalus	Petition Under Review (UR)				G5	S5BS5N	
Animals: Birds	Pinyon Jay	Gymnorhinus cyanocephalus	Petition Under Review (UR)				G5	S5BS5N	
Animals: Birds	Pygmy Nuthatch	Sitta pygmaea				NSS3(Bb)	G5	S2S3	Species of Concern (SOC)
Animals: Birds	Red Crossbill	Loxia curvirostra				NSS4(Bc)	G5	S5	
Animals: Birds	Red Crossbill	Loxia curvirostra				NSS4(Bc)	G5	S5	
Animals: Birds	Red-eyed Vireo	Vireo olivaceus				NSS4(Bc)	G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Red-headed Woodpecker	Melanerpes erythrocephalus				NSS4(Bc)	G5	S2S3	
Animals: Birds	Red-necked Phalarope	Phalaropus lobatus					G4G5	S3N	Species of Potential Concern (SOPC)
Animals: Birds	Ring-billed Gull	Larus delawarensis					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Ring-billed Gull	Larus delawarensis					G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	Ring-necked Duck	Aythya collaris					G5	S4B	Species of Potential Concern (SOPC)
Animals: Birds	Ring-necked Duck	Aythya collaris					G5	S4B	Species of Potential Concern (SOPC)
Animals: Birds	Rose-breasted Grosbeak	Pheucticus ludovicianus					G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Rose-breasted Grosbeak	Pheucticus ludovicianus					G5	S1	Species of Potential Concern (SOPC)
Animals: Birds	Rufous Hummingbird	Selasphorus rufus				NSS4(Bc)	G5	S3	
Animals: Birds	Rufous Hummingbird	Selasphorus rufus				NSS4(Bc)	G5	S3	
Animals: Birds	Sage Thrasher	Oreoscoptes montanus		Sensitive		NSS4(Bc)	G4	S5	Species of Potential Concern (SOPC)
Animals: Birds	Sage Thrasher	Oreoscoptes montanus		Sensitive		NSS4(Bc)	G4	S5	Species of Potential Concern (SOPC)
Animals: Birds	Sagebrush Sparrow	Artemisiospiza nevadensis		Sensitive	USFS-R2	NSS4(Bc)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Sagebrush Sparrow	Artemisiospiza nevadensis		Sensitive	USFS-R2	NSS4(Bc)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Sandhill Crane	Antigone canadensis					G5	S3BS5N	Species of Potential Concern (SOPC)
Animals: Birds	Sandhill Crane	Antigone canadensis					G5	S3BS5N	Species of Potential Concern (SOPC)
Animals: Birds	Short-eared Owl	Asio flammeus				NSS4(Bc)	G5	S1S2	Species of Concern (SOC)
Animals: Birds	Short-eared Owl	Asio flammeus				NSS4(Bc)	G5	S1S2	Species of Concern (SOC)
Animals: Birds	Snowy Egret	Egretta thula				NSS3(Bb)	G5	S1S2	Species of Potential Concern (SOPC)
Animals: Birds	Swainson's Hawk	Buteo swainsoni				NSSU(U)	G5	S5	
Animals: Birds	Swainson's Hawk	Buteo swainsoni				NSSU(U)	G5	S5	
Animals: Birds	Townsend's Warbler	Setophaga townsendi					G5	SNA	Species of Potential Concern (SOPC)
Animals: Birds	Trumpeter Swan	Cygnus buccinator	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS2(Ba)	G4	S3	Species of Concern (SOC)
Animals: Birds	Trumpeter Swan	Cygnus buccinator	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS2(Ba)	G4	S3	Species of Concern (SOC)
Animals: Birds	Tundra Swan	Cygnus columbianus					G5	S2N	Species of Potential Concern (SOPC)
Animals: Birds	Tundra Swan	Cygnus columbianus					G5	S2N	Species of Potential Concern (SOPC)
Animals: Birds	Upland Sandpiper	Bartramia longicauda				NSSU(U)	G5	S4S5	
Animals: Birds	Virginia Rail	Rallus limicola				NSSU(U)	G5	S2S4	Species of Potential Concern (SOPC)
Animals: Birds	Virginia Rail	Rallus limicola				NSSU(U)	G5	S2S4	Species of Potential Concern (SOPC)
Animals: Birds	Western Grebe	Aechmophorus occidentalis				NSSU(U)	G5	S3S4	
Animals: Birds	Western Grebe	Aechmophorus occidentalis				NSSU(U)	G5	S3S4	
Animals: Birds	Western Screech-Owl	Megascops kennicottii					G4G5	S2	Species of Potential Concern (SOPC)
Animals: Birds	White-faced Ibis	Plegadis chihi		Sensitive		NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	White-faced Ibis	Plegadis chihi		Sensitive		NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Birds	Whooping Crane	Grus americana	LE (E half WY), LEXN (W half WY)				G1	SNA	Species of Concern (SOC)
Animals: Birds	Williamson's Sapsucker	Sphyrapicus thyroideus				NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Birds	Willow Flycatcher	Empidonax traillii				NSS3(Bb)	G5	S5	
Animals: Birds	Willow Flycatcher	Empidonax traillii				NSS3(Bb)	G5	S5	
Animals: Fishes	Flathead Chub	Platygobio gracilis				NSS4(Bc)	G5	S5	Species of Potential Concern (SOPC)
Animals: Fishes	Lake Chub	Couesius plumbeus			USFS-R2		G5	S5	Species of Potential Concern (SOPC)
Animals: Fishes	Mountain Sucker	Catostomus platyrhynchus			USFS-R2		G5	S5	Species of Potential Concern (SOPC)
Animals: Fishes	Mountain Sucker	Catostomus platyrhynchus			USFS-R2		G5	S5	Species of Potential Concern (SOPC)

Wyoming Natural Diversity Database: Animal Species of Concern									
Upper Shoshone Watershed									
Taxonomic Group	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
Animals: Fishes	Mountain Whitefish	Prosopium williamsoni					G5	S5	Species of Potential Concern (SOPC)
Animals: Fishes	Yellowstone Cutthroat Trout	Oncorhynchus clarkii bouvieri	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4T4	S2	Species of Concern (SOC)
Animals: Fishes	Yellowstone Cutthroat Trout	Oncorhynchus clarkii bouvieri	Not Warranted for Listing (NW)	Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4T4	S2	Species of Concern (SOC)
Animals: Invertebrates	Disc Gyro	Gyraulus circumstriatus				NSSU(U)	G5	S3	Species of Concern (SOC)
Animals: Invertebrates	Disc Gyro	Gyraulus circumstriatus				NSSU(U)	G5	S3	Species of Concern (SOC)
Animals: Invertebrates	Dusky Fossaria	Galba dalli				NSSU(U)	G5	S3	
Animals: Invertebrates	Dusky Fossaria	Galba dalli				NSSU(U)	G5	S3	
Animals: Invertebrates	Glossy Valvata	Valvata humeralis				NSSU(U)	G5	S3	Species of Concern (SOC)
Animals: Invertebrates	Golden Fossaria	Galba obrussa				NSSU(U)	G5	S3	Species of Concern (SOC)
Animals: Invertebrates	Marsh Ramshorn	Planorbella trivolvis				NSSU(U)	G5	S4	Species of Concern (SOC)
Animals: Invertebrates	Pewter Physa	Physella acuta				NSSU(U)	G5	S4	Species of Concern (SOC)
Animals: Invertebrates	Pewter Physa	Physella acuta				NSSU(U)	G5	S4	Species of Concern (SOC)
Animals: Invertebrates	Prairie Fossaria	Galba bulimoides				NSSU(U)	G5	SNR	
Animals: Invertebrates	Tadpole Physa	Physella gyrina				NSSU(U)	G5	S4	Species of Concern (SOC)
Animals: Invertebrates	Tadpole Shrimp	Triopsidae				NSSU(U)			
Animals: Invertebrates	Umbilicate Sprite	Promenetus umbilicatellus				NSSU(U)	G4	S3	Species of Concern (SOC)
Animals: Invertebrates	Western Bumble Bee	Bombus occidentalis	Petition Under Review (UR)		USFS-R2		G3	SNR	Species of Concern (SOC)
Animals: Mammals	American Bison	Bos bison					G4	S1	Species of Concern (SOC)
Animals: Mammals	American Bison	Bos bison					G4	S1	Species of Concern (SOC)
Animals: Mammals	American Pika	Ochotona princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5	S2	Species of Concern (SOC)
Animals: Mammals	American Pika	Ochotona princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5	S2	Species of Concern (SOC)
Animals: Mammals	Bear Lodge Meadow Jumping Mouse	Zapus hudsonius campestris				NSS4(Bc)	G5T3	S1	Species of Concern (SOC)
Animals: Mammals	Bear Lodge Meadow Jumping Mouse	Zapus hudsonius campestris				NSS4(Bc)	G5T3	S1	Species of Concern (SOC)
Animals: Mammals	Bighorn Sheep	Ovis canadensis			USFS-R2, USFS-R4	NSS4(Bc)	G4	S2S3	Species of Potential Concern (SOPC)
Animals: Mammals	Bighorn Sheep	Ovis canadensis			USFS-R2, USFS-R4	NSS4(Bc)	G4	S2S3	Species of Potential Concern (SOPC)
Animals: Mammals	Canada Lynx	Lynx canadensis	Listed Threatened (LT)			NSS1(Aa)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Canada Lynx	Lynx canadensis	Listed Threatened (LT)			NSS1(Aa)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Eastern Cottontail	Sylvilagus floridanus					G5	S3	Species of Potential Concern (SOPC)
Animals: Mammals	Feral Horse	Equus caballus	Petition Under Review (UR)				GNA	SNA	
Animals: Mammals	Feral Horse	Equus caballus	Petition Under Review (UR)				GNA	SNA	
Animals: Mammals	Fringed Myotis	Myotis thysanodes		Sensitive	USFS-R2	NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Fringed Myotis	Myotis thysanodes		Sensitive	USFS-R2	NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Gray Wolf	Canis lupus	Petition Under Review (UR)		USFS-R4		G5	S1	Species of Concern (SOC)
Animals: Mammals	Grizzly Bear	Ursus arctos	Listed Threatened (LT)				G4	S1	Species of Concern (SOC)
Animals: Mammals	Long-eared Myotis	Myotis evotis		Sensitive		NSS4(Cb)	G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Long-eared Myotis	Myotis evotis		Sensitive		NSS4(Cb)	G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Long-legged Myotis	Myotis volans				NSS4(Cb)	G4G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Long-legged Myotis	Myotis volans				NSS4(Cb)	G4G5	S4S5	Species of Potential Concern (SOPC)
Animals: Mammals	Moose	Alces alces				NSS4(Bc)	G5	S4	
Animals: Mammals	Moose	Alces alces				NSS4(Bc)	G5	S4	
Animals: Mammals	Northern Hoary Bat	Aeorestes cinereus			USFS-R2		G3G4	S4	Species of Potential Concern (SOPC)
Animals: Mammals	Northern Hoary Bat	Aeorestes cinereus			USFS-R2		G3G4	S4	Species of Potential Concern (SOPC)
Animals: Mammals	Northern River Otter	Lontra canadensis	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Mammals	Northern River Otter	Lontra canadensis	Not Warranted for Listing (NW)		USFS-R2	NSS3(Bb)	G5	S3S4	Species of Concern (SOC)
Animals: Mammals	Northern Rocky Mountain Pika	Ochotona princeps princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5TNR	S2	Species of Concern (SOC)
Animals: Mammals	Northern Rocky Mountain Pika	Ochotona princeps princeps	Not Warranted for Listing (NW)			NSS2(Ba)	G5TNR	S2	Species of Concern (SOC)
Animals: Mammals	Olive-backed Pocket Mouse	Perognathus fasciatus				NSS4(Cb)	G5	S3S5	Species of Potential Concern (SOPC)
Animals: Mammals	Pacific Marten	Martes caurina	Not Warranted for Listing (NW)		USFS-R2		G4G5	S3	Species of Potential Concern (SOPC)
Animals: Mammals	Pacific Marten	Martes caurina	Not Warranted for Listing (NW)		USFS-R2		G4G5	S3	Species of Potential Concern (SOPC)
Animals: Mammals	Pallid Bat	Antrozous pallidus				NSS3(Bb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Silver-haired Bat	Lasionycteris noctivagans					G3G4	S3B	Species of Potential Concern (SOPC)
Animals: Mammals	Silver-haired Bat	Lasionycteris noctivagans					G3G4	S3B	Species of Potential Concern (SOPC)
Animals: Mammals	Spotted Bat	Euderma maculatum		Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G4	S1S2	Species of Concern (SOC)
Animals: Mammals	Spotted Bat	Euderma maculatum		Sensitive	USFS-R2, USFS-R4	NSS4(Bc)	G4	S1S2	Species of Concern (SOC)
Animals: Mammals	Swift Fox	Vulpes velox	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G3	S2	Species of Concern (SOC)
Animals: Mammals	Townsend's Big-eared Bat	Corynorhinus townsendii		Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S2BS1N	Species of Concern (SOC)
Animals: Mammals	Townsend's Big-eared Bat	Corynorhinus townsendii		Sensitive	USFS-R2, USFS-R4	NSS3(Bb)	G4	S2BS1N	Species of Concern (SOC)

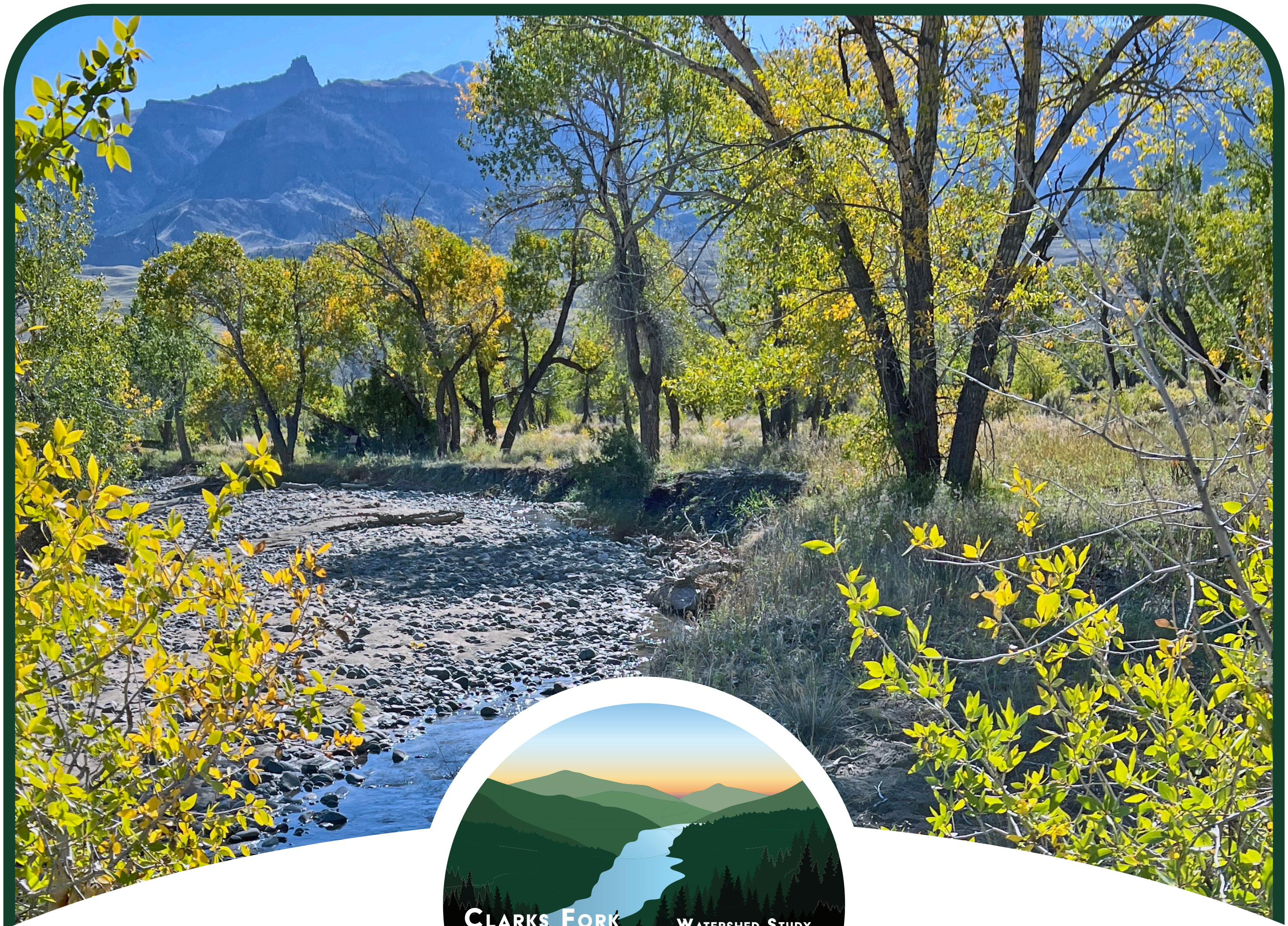
APPENDIX 4B. SENSITIVE SPECIES

Wyoming Natural Diversity Database: Animal Species of Concern									
Upper Shoshone Watershed									
Taxonomic Group	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
Animals: Mammals	Water Vole	Microtus richardsoni			USFS-R2	NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Water Vole	Microtus richardsoni			USFS-R2	NSS3(Bb)	G5	S1	Species of Concern (SOC)
Animals: Mammals	Western Jumping Mouse	Zapus princeps					G5	S3S4	Species of Concern (SOC)
Animals: Mammals	Western Little Brown Myotis	Myotis carissima	Petition Under Review (UR)			NSS3(Bb)	G3	S5	Species of Potential Concern (SOPC)
Animals: Mammals	Western Little Brown Myotis	Myotis carissima	Petition Under Review (UR)			NSS3(Bb)	G3	S5	Species of Potential Concern (SOPC)
Animals: Mammals	Western Small-footed Myotis	Myotis ciliolabrum				NSS4(Cb)	G5	S4	Species of Potential Concern (SOPC)
Animals: Mammals	Western Small-footed Myotis	Myotis ciliolabrum				NSS4(Cb)	G5	S4	Species of Potential Concern (SOPC)
Animals: Mammals	White-tailed Prairie Dog	Cynomys leucurus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	White-tailed Prairie Dog	Cynomys leucurus	Not Warranted for Listing (NW)	Sensitive	USFS-R2	NSS4(Cb)	G4	S2S3	Species of Concern (SOC)
Animals: Mammals	Wolverine	Gulo gulo	Petition Under Review (UR)			NSS3(Bb)	G4	S1S2	Species of Concern (SOC)
Animals: Mammals	Wolverine	Gulo gulo	Petition Under Review (UR)			NSS3(Bb)	G4	S1S2	Species of Concern (SOC)
Animals: Mammals	Wyoming Ground Squirrel	Urocitellus elegans					G5	S3S4	Species of Potential Concern (SOPC)
Animals: Mammals	Yuma Myotis	Myotis yumanensis				NSS4(Cb)	G5	S1	Species of Concern (SOC)
Animals: Reptiles	Bullsnake	Pituophis catenifer sayi					G5T5	S4	Species of Potential Concern (SOPC)
Animals: Reptiles	Bullsnake	Pituophis catenifer sayi					G5T5	S4	Species of Potential Concern (SOPC)
Animals: Reptiles	Common Gartersnake	Thamnophis sirtalis				NSSU(U)	G5	S5	Species of Potential Concern (SOPC)
Animals: Reptiles	Great Basin Gophersnake	Pituophis catenifer deserticola				NSS2(Ba)	G5T5	S3	Species of Potential Concern (SOPC)
Animals: Reptiles	Greater Short-horned Lizard	Phrynosoma hernandesi				NSS4(Bc)	G5	S4	
Animals: Reptiles	Northern Rubber Boa	Charina bottae				NSS3(Bb)	G5	S2	Species of Concern (SOC)
Animals: Reptiles	Plains Short-horned Lizard	Phrynosoma hernandesi brevirostris				NSS4(Bc)	G5TNR	SNR	
Animals: Reptiles	Plains Short-horned Lizard	Phrynosoma hernandesi brevirostris				NSS4(Bc)	G5TNR	SNR	
Animals: Reptiles	Prairie Rattlesnake	Crotalus viridis				NSS4(Bc)	G5	S5	
Animals: Reptiles	Prairie Rattlesnake	Crotalus viridis				NSS4(Bc)	G5	S5	
Animals: Reptiles	Red-sided Gartersnake	Thamnophis sirtalis parietalis				NSSU(U)	G5T5	S5	Species of Potential Concern (SOPC)
Animals: Reptiles	Valley Gartersnake	Thamnophis sirtalis fitchi				NSSU(U)	G5TNR	S2	Species of Potential Concern (SOPC)
Animals: Reptiles	Valley Gartersnake	Thamnophis sirtalis fitchi				NSSU(U)	G5TNR	S2	Species of Potential Concern (SOPC)
Animals: Reptiles	Western Milksnake	Lampropeltis gentilis				NSS3(Bb)	G5	S3	Species of Potential Concern (SOPC)
Animals: Reptiles	Western Painted Turtle	Chrysemys picta bellii				NSS4(Bc)	G5T5	S4	
			For Code information see: Federal Status Codes				For Code Information see: State Status Codes		For Code Information see: WYNDD Status Codes

APPENDIX 6A

PROJECTS

(UNDER SEPARATE COVER)



Clarks Fork Upper Shoshone Watershed Study
Park County, Wyoming

Clarks Fork/Upper Shoshone Watershed Level I Study

Appendix 6A: Projects

Prepared For:

Wyoming Water Development Commission | Cody Conservation District | Powell-Clarks Fork Conservation District

Prepared By:

Trihydro Corporation

In Association With:

Anderson Consulting Engineers, Inc. | Hinckley Consulting
RESPEC Company LLC | Wyoming Water Rights Consulting, Inc.

ATTRIBUTE	PROJECT EVALUATION CATEGORIES		
	LESS PREFERABLE	→	MORE PREFERABLE
WWDC Priority[1, 2]	LOW: WWDC Priority 5 or 6	MEDIUM: WWDC Priority 3 or 4	HIGH: WWDC Priority 1, 2, or "Shovel Ready"
Land Ownership	Includes Federal	Mixed	Private Only
Practicability	Challenging Effort	Moderate Effort	Routine Effort
Ease of Permitting	Federal Permits/NEPA	Local or State permits	Permits approved or none required

Notes:

[1] Per the SWPP Operating Criteria (2021), new development projects (Account I) are prioritized as follows:

1 - Source Water Development
2 - Storage
3 - Pipelines, Conveyance Facilities, Solar Platforms, and Windmills
4 - Irrigation
5 - Environmental
6 - Recreational

[2] Per the SWPP Operating Criteria (2021), rehabilitation projects (Account II) are prioritized as follows:

1 - Diversion Structures and Spring Developments
2 - Storage
3 - Pipelines, Conveyance Facilities, Solar Platforms, and Windmills
4 - Irrigation (other than the above)
5 - Environmental
6 - Recreational

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
ENV-001	Koller-002	Ishawooa Creek Streambank Stabilization	Construct bioengineered treatment along 400 feet of streambank.	Yes	New	Low	Includes Federal	Challenging	Federal/NEPA	$ 59,702.50
ENV-002	Nugent-001	Nugent Pond No. 1 Improvements	Install solar-powered aeration system to promote fishery.	No	Rehab	Low	Private Only	Routine	Approved/Exempt	$ 14,175.00
ENV-003	Montgomery-002	North Fork Streambank Stabilization	Construct bioengineered treatment along 300 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$ 112,970.00
ENV-004	HMR-001	Crandall Creek Streambank Stabilization	Construct bioengineered treatment 900 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$ 321,860.00
ENV-005	Hoene-001	Clarks Fork Streambank Stabilization	Construct bioengineered treatment at two select locations and install interception ditch to prevent streambank saturation.	Yes	New	Low	Private Only	Moderate	Federal/NEPA	$ 54,857.00
ENV-006	Jensen-001	Sediment Retention Structure	Install sheet pile grade control structures and construct riprap armor downstream of structures.	Yes	New	Low	Private Only	Moderate	Approved/Exempt	$ 28,201.25
ENV-007	Morrison-004	Wildlife Pond	Excavate off-channel pond.	Yes	New	High	Private Only	Moderate	Approved/Exempt	$ 133,045.00
ENV-008	B4-002	Streambank Protection	Construct bioengineered treatment along 300 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$ 112,970.00
ENV-009	Mick-001	North Fork Streambank Stabilization	Construct bioengineered treatment along 200 feet of streambank.	Yes	New	Low	Private Only	Challenging	Federal/NEPA	$ 38,046.25
FS-001	RLWA-001	Sunset Lane Water Tank	Remove and replace water tank and install fittings to fill fire trucks.	Yes	Rehab	High	Private Only	Moderate	Local/State	$ 96,250.00
IRR-001	Morrison-002	Morrison Check Structure and Turnout Replacement	Remove and replace existing check structure and turnout.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 13,341.63
IRR-002	Nugent-002	Nugent Pond No. 2 Reconstruction	Rehabilitate existing irrigation pond.	Yes	Rehab	High	Private Only	Moderate	Local/State	$ 92,592.50
IRR-003	Nugent-003	Nugent Pond No. 3	Construct a new irrigation pond.	Yes	New	High	Private Only	Moderate	Local/State	$ 123,282.50
IRR-004	Nugent-004	Nugent Spring Improvement	Rehabilitate existing spring and supply water to irrigation ponds.	Yes	New and Rehab	High	Private Only	Moderate	Local/State	$ 9,242.75
IRR-005	Montgomery-001	Ditch to Pipe	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 175,312.50
IRR-006	Whitlock-001	Ditch to Pipe	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 276,065.63
IRR-007	Vogt-001	Vogt Ditch Splitter	Remove and replace existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 15,860.63
IRR-008	Neff-001	Neff Ditch Throwback	Rehabilitate existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 11,412.50
IRR-009	Boot and Bottle-001	Boot and Bottle Irrigation	Improve irrigation for memorial area.	Yes	New	Medium	Private Only	Moderate	Local/State	$ 9,900.00
IRR-010	Harrison-001	Harrison Ditch to Pipe Project	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 86,350.00
IRR-011	Harrison-002	Splitter box replacement	Install hydraulic control structure.	Yes	New	Medium	Private Only	Moderate	Approved/Exempt	$ 21,085.63
IRR-012	TCR-001	Trout Creek Lateral Diversion Replacement	Remove and replace existing hydraulic control structure.	Yes	Rehab	Medium	Private Only	Moderate	Approved/Exempt	$ 27,410.63
IRR-013	TCR-002	Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 74,023.13
IRR-014	TCR-003	Sediment trap replacement	Remove and replace existing concrete vault.	Yes	Rehab	Medium	Private Only	Moderate	Approved/Exempt	$ 137,500.00
IRR-015	TCR-010	Trout Creek Lateral Ditch to Pipe Conversion	Convert open ditch to irrigation pipe.	Yes	Rehab	Medium	Private Only	Routine	Approved/Exempt	$ 294,456.25
L/W-001	Morrison-001	Morrison Pond	Construct excavated pond.	Yes	New	High	Private Only	Moderate	Local/State	$ 232,595.00
L/W-002	Morrison-003	Morrison Springs	Develop two springs and install pipelines to existing stock tanks.	Yes	New	High	Private Only	Moderate	Local/State	$ 21,785.50
L/W-003	Christofferson-001	Christofferson Pond	Construct excavated pond.	Yes	New	High	Private Only	Moderate	Local/State	$ 664,262.50
L/W-004	Koller-001	Koller Wildlife Water Source and Solar Well	Grade shallow watering area and install well with solar-powered pump.	Yes	New	High	Private Only	Moderate	Local/State	$ 81,262.50
L/W-005	Nichols-001	Nichols Pond Improvements	Rehabilitate existing pond.	Yes	Rehab	High	Private Only	Moderate	Local/State	$ 66,000.00
L/W-006	Whitlock-002	Whitlock Stock Tank	Install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Routine	Approved/Exempt	$ 5,527.50
L/W-007	Vogt-002	Vogt Stock Reservoir	Construct dam and reservoir.	Yes	New	High	Private Only	Moderate	Local/State	$ 70,785.00
L/W-008	Broussard-001	Broussard Stock Tank	Install pipeline and 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Approved/Exempt	$ 26,626.88
L/W-009	Arnote-001	Arnote Reservoir No. 1	Construct dam and reservoir	Yes	New	High	Private Only	Moderate	Local/State	$ 21,972.50
L/W-010	Arnote-002	Arnote Reservoir No. 2	Construct dam and reservoir.	Yes	New	High	Private Only	Moderate	Local/State	$ 21,972.50

PROJECT ID	SPONSOR REFERENCE	PROJECT NAME	DESCRIPTION	SWPP ELIGIBLE	DEVELOPMENT TYPE	WWDC PRIORITY	LAND OWNERSHIP	PRACTICABILITY	EASE OF PERMITTING	ESTIMATED COST
L/W-011	Bales-001	Bales Stock Tank/Pipeline Project	Install infiltration gallery, vertical wet well with solar pump, pipeline, 5,000-gallon storage tank, and 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Challenging	Federal/NEPA	$ 63,314.63
L/W-012	B4-001	Well Construction	Install well with solar-powered pump.	Yes	New	High	Private Only	Challenging	Local/State	$ 27,362.50
L/W-013	TCR-004	Four Bear Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$ 14,770.25
L/W-014	TCR-005	Four Bear Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Includes Federal	Moderate	Federal/NEPA	$ 14,770.25
L/W-015	TCR-006	Logan Mountain Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$ 14,770.25
L/W-016	TCR-007	Trout Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Includes Federal	Moderate	Federal/NEPA	$ 14,770.25
L/W-017	TCR-008	Trout Creek Spring #2 Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$ 14,770.25
L/W-018	TCR-009	Murray Creek Spring Development	Develop spring and install 1,200-gallon rubber tire stock tank.	Yes	New	High	Private Only	Moderate	Local/State	$ 14,770.25
L/W-019	FOAL-001	FOAL Project Generic	Rehabilitate existing stock reservoir(s).	Yes	Rehab	High	Includes Federal	Moderate	Federal/NEPA	$ 21,972.50
L/W-020	Roberts-001	Roberts Drainage System and Pond	Install underdrain and conveyance pipeline and construct excavated pond.	Yes	New	High	Private Only	Challenging	Local/State	$ 261,497.50
L/W-021	Corbett-001	Tippecanoe Reservoir Rehabilitation	Replace existing low-level outlet structure, sluice gate, gate stem, and operator wheel.	Yes	Rehab	High	Private Only	Moderate	Local/State	$ 23,100.00

ENV-001: Ishawooa Creek Streambank Stabilization (Koller-002)

Purpose and Need: The Ishawooa Creek streambank is severely eroded, and the June 2022 flooding worsened the problem. This erosion is contributing a significant amount of sediment to the creek and the South Fork Shoshone River. Furthermore, the erosion is migrating in a direction toward the Koller residence.

Proposed Project: Stabilize approximately 400 feet of streambank with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting. A portion of this project may fall on United States Forest Service (USFS) land.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.

Project Location:
Township 50 North, Range 105 West, Sections 28 & 33
44.2667 N, 109.5072 W

Owner/Operator: Koller, Michael

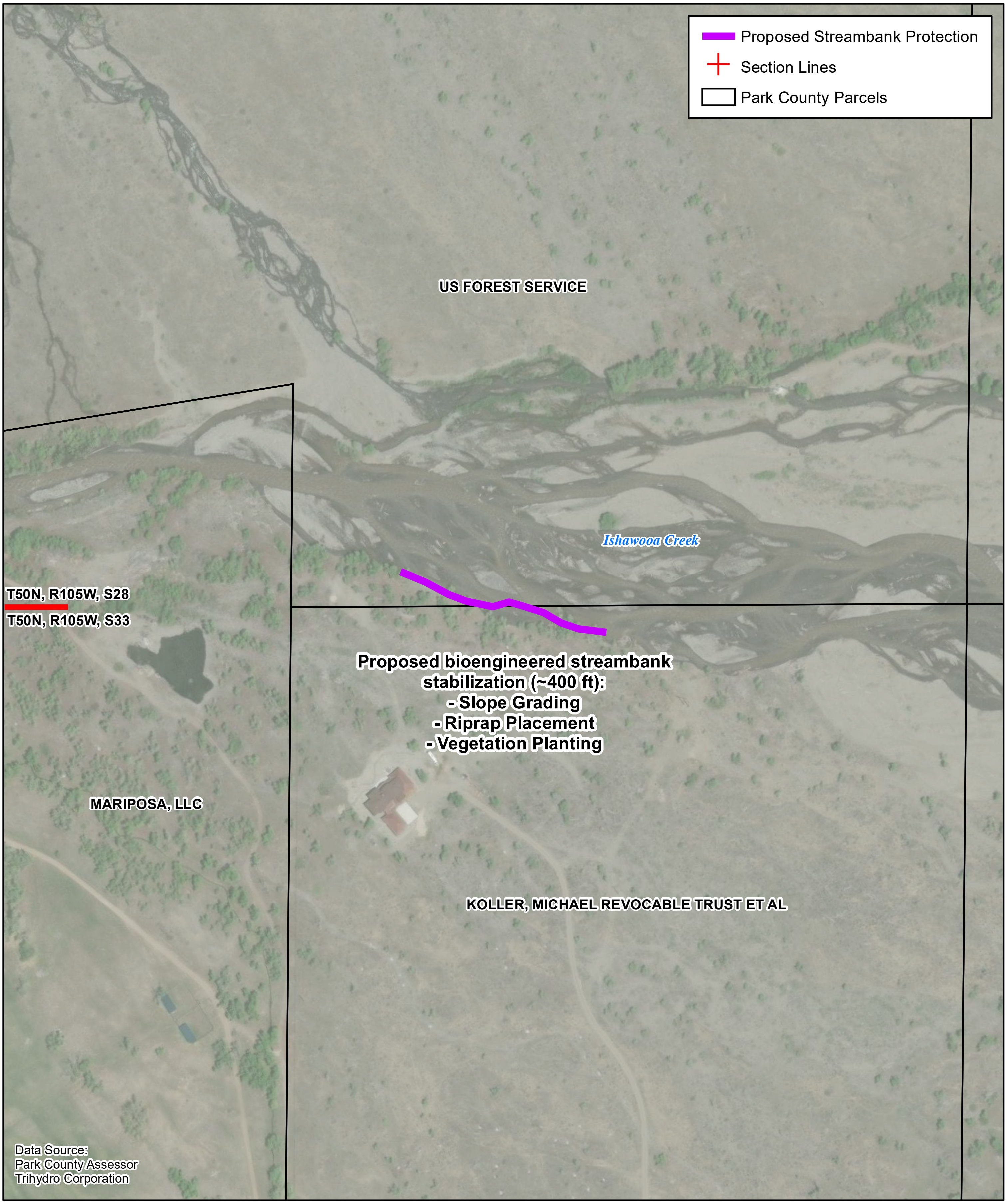
Land Ownership (Surface): Private, USFS

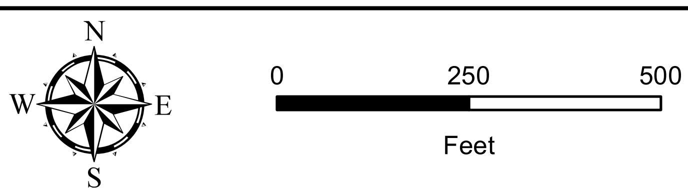
Water Source: Ishawooa Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. USFS
3. Wyoming Department of Environmental Quality – 401 Certification
4. Wyoming Game and Fish Department – construction schedule requirements
5. Park County Floodplain Development Permit





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ENV-001 (Koller-002) Ishawooa Creek Streambank Stabilization Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: ENV-001.mxd

Clarks Fork/ Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID #: ENV-001
Site Name: Ishawooa Creek Streambank Stabilization
Sponsor Reference Koller-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$4,342.00	$4,342.00
2	Excavation	CY	370	$25.00	$9,250.00
3	Riprap	CY	240	$131.00	$31,440.00
4	Geotextile, Erosion Control	SY	450	$5.00	$2,250.00
5	Cut, Collect, and Install Vegetation	EA	240	$2.00	$480.00

Project Subtotal	$47,762.00
Contingencies (15% of subtotal)	$7,164.30
Engineering and Technical Assistance (10% of subtotal)	$4,776.20
Estimated Project Cost	$59,702.50

ENV-002: Nugent Pond No. 1 Improvements (Nugent-001)

Purpose and Need: The existing pond (~0.7 acres) does not currently support a fishery due to lack of flow-through and associated aeration.

Proposed Project: Install a solar-powered aeration system to promote a fishery.

Project components would include:

- Install solar-powered aeration system.

Project Location:
Township 51 North, Range 104 West, Section 13
44.3934 N, 109.3156 W

Owner/Operator: Nugent, Louis

Land Ownership (Surface): Private

Water Source: Spring

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated

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ENV-002 (Nugent-001) Nugent Pond No. 1 Improvements Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: ENV-002.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-002
Project Name: Nugent Pond No. 1 Improvements
Sponsor Reference: Nugent-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,050.00	$1,050.00
2	Solar Powered Aeration System*	EA	1	$10,500.00	$10,500.00

* Item not eligible for SWPP funding

Project Subtotal	$11,550.00
Contingencies (15% of subtotal)	$1,575.00
Engineering and Technical Assistance (10% of subtotal)	$1,050.00
Estimated Project Cost	$14,175.00

ENV-003: North Fork Streambank Stabilization (Montgomery-002)

Purpose and Need: Streambank erosion on the North Fork Shoshone River at this location is a sediment contributor to the river and Buffalo Bill Reservoir. The erosion is also approaching the Montgomery residence, and the June 2022 flood worsened the problem. Existing fencing and waterlines could be impacted if erosion continues. Streambank stabilization is needed to mitigate the erosion and sediment contribution, while protecting existing infrastructure.

Proposed Project: Stabilize approximately 300 feet of streambank with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.

Project Location:
Township 52 North, Range 104 West, Section 15
44.4799 N, 109.3542 W

Owner/Operator: Montgomery, Jim

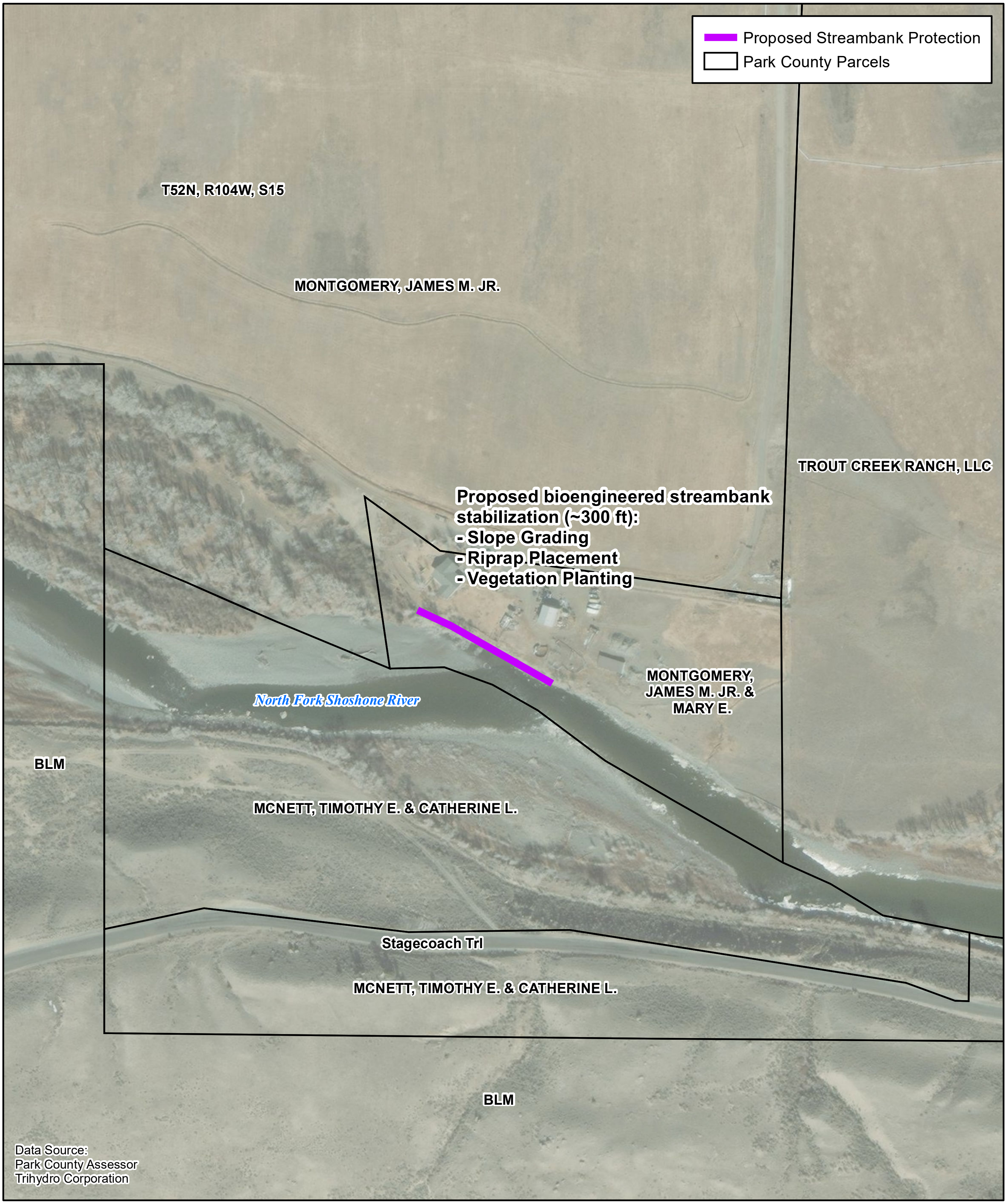
Land Ownership (Surface): Private

Water Source: North Fork Shoshone River

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. Wyoming Department of Environmental Quality – 401 Certification
3. Wyoming Game and Fish Department – construction schedule requirements
4. Park County Floodplain Development Permit



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ENV-003 (Montgomery-002) North Fork Streambank Stabilization Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: ENV-003.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-003
Project Name: North Fork Streambank Stabilization
Sponsor Reference: Montgomery-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$8,216.00	$8,216.00
2	Excavation	CY	1,300	$15.00	$19,500.00
3	Riprap	CY	450	$131.00	$58,950.00
4	Geotextile, Erosion Control	SY	670	$5.00	$3,350.00
5	Cut, Collect, and Install Vegetation	EA	180	$2.00	$360.00

Project Subtotal	$90,376.00
Contingencies (15% of subtotal)	$13,556.40
Engineering and Technical Assistance (10% of subtotal)	$9,037.60
Estimated Project Cost	$112,970.00

ENV-004: Crandall Creek Streambank Stabilization (HMR-001)

Purpose and Need: Streambank erosion at the confluence of North Fork Crandall Creek and Crandall Creek is a sediment contributor to the creek and the Clarks Fork Yellowstone River. The erosion is also impacting private grazing land and approaching a private residence. The June 2022 flood greatly worsened the problem, washed out fencing, and eroded the streambank to within 30 feet of the residence. Another large flood event could result in the erosion reaching and undermining the house. As evidenced by comparing aerial photographs, channel geomorphology at this confluence is prone to drastic changes, with a large S-curve in North Fork Crandall Creek before it converges with Crandall Creek. Streambank stabilization is needed to mitigate the erosion and sediment contribution, while protecting existing infrastructure.

Proposed Project: Stabilize approximately 900 feet of streambank with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting. Depending on the final starting point of the stabilization on North Fork Crandall Creek (upstream end), a portion of this project may fall on United States Forest Service (USFS) land. This project also lies within a Nature Conservancy easement.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.

Project Location:
Township 56 North, Range 106 West, Section 8
44.8433 N, 109.6583 W

Owner/Operator: Hurricane Mesa Ranch, Inc./Vaughan, Peter

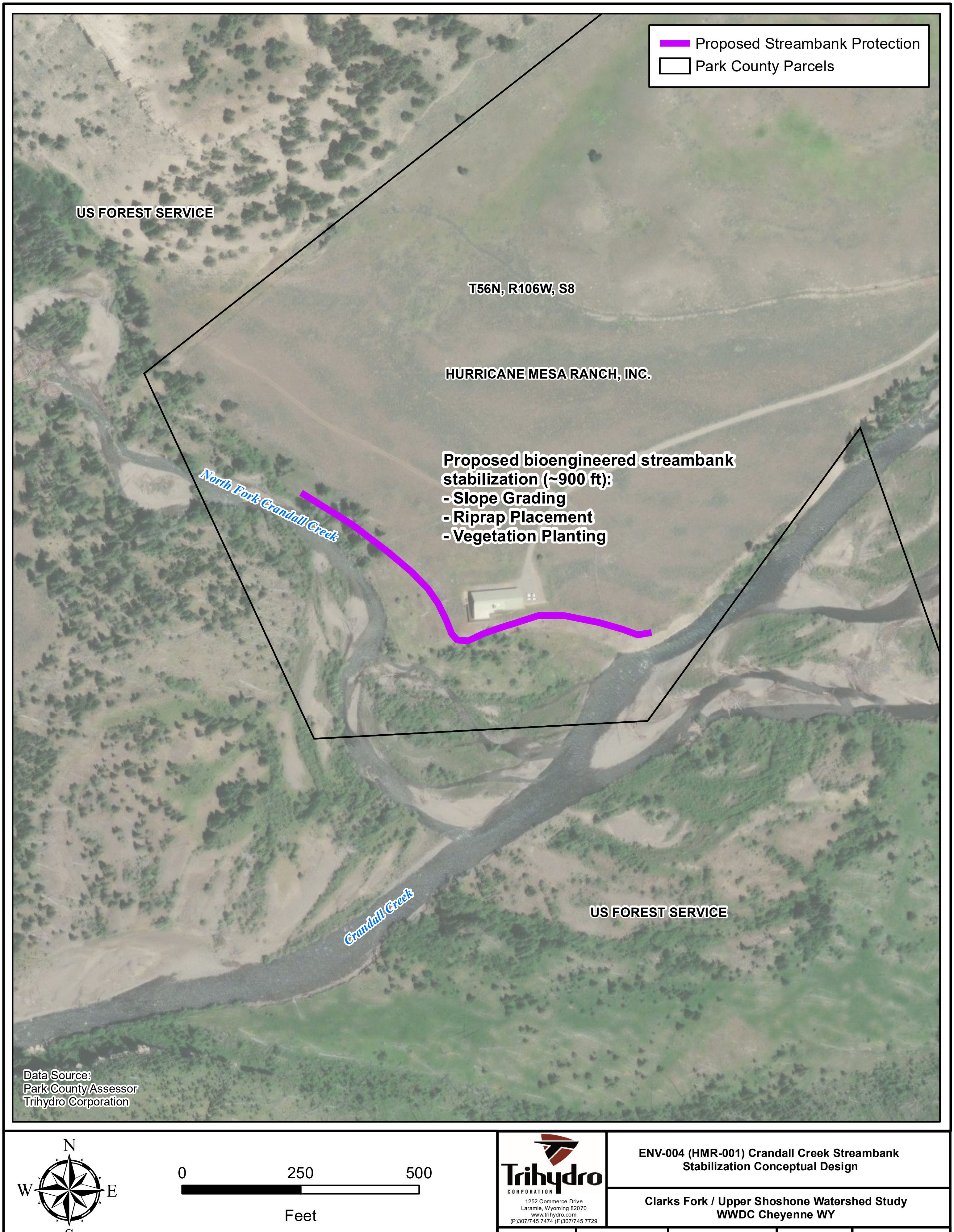
Land Ownership (Surface): Private

Water Source: North Fork Crandall Creek/Crandall Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. USFS
3. Wyoming Department of Environmental Quality – 401 Certification
4. Wyoming Game and Fish Department – construction schedule requirements
5. Park County Floodplain Development Permit
6. The Nature Conservancy



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ENV-004 (HMR-001) Crandall Creek Streambank Stabilization Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: ENV-004.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-004
Project Name: Crandall Creek Streambank Stabilization
Sponsor Reference: HMR-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$23,408.00	$23,408.00
2	Excavation	CY	1,700	$15.00	$25,500.00
2	Riprap	CY	1,500	$131.00	$196,500.00
3	Geotextile, Erosion Control	SY	2,200	$5.00	$11,000.00
4	Cut, Collect, and Install Vegetation	EA	540	$2.00	$1,080.00

Project Subtotal	$257,488.00
Contingencies (15% of subtotal)	$38,623.20
Engineering and Technical Assistance (10% of subtotal)	$25,748.80
Estimated Project Cost	$321,860.00

ENV-005: Clarks Fork Streambank Stabilization (Hoene-001)

Purpose and Need: Streambank erosion at this location along the north bank of the Clarks Fork Yellowstone River is contributing sediment to the river and impacting production land. Two areas, each approximately 40 feet in length, have washed out. Streambank stabilization is needed to mitigate the erosion and sediment contribution, while protecting existing production land.

Proposed Project: Stabilize two streambank areas, each approximately 40 feet in length, with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting. Imported borrow (fill) may be required to reconstruct the streambank prior to riprap placement. Consider the construction of an interception ditch near the top of the streambank to capture and convey flood irrigation water to a common outfall/return. Reinforce the ditch outfall with riprap to prevent streambank erosion.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.
- Excavate interception ditch (optional).
- Reinforce interception ditch outfall with riprap (if interception ditch constructed).

Project Location:
Township 57 North, Range 101 West, Section 19
44.9064 N, 109.1122 W

Owner/Operator: Hoene Riverbanks, LLC/Hoene, Vanessa

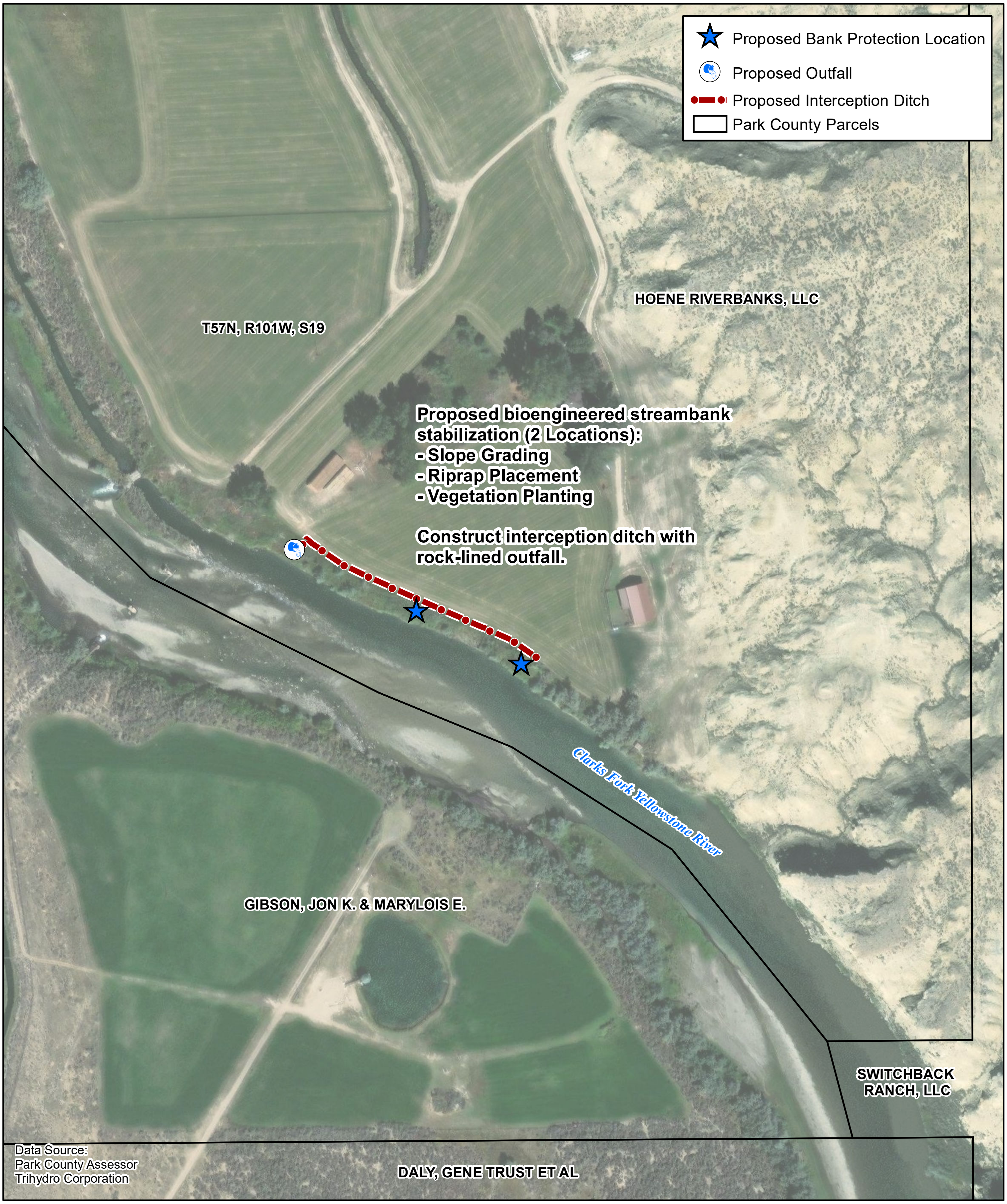
Land Ownership (Surface): Private

Water Source: Clarks Fork Yellowstone River

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. Wyoming Department of Environmental Quality – 401 Certification
3. Wyoming Game and Fish Department – construction schedule requirements
4. Park County Floodplain Development Permit



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ENV-005 (Hoene-001) Clarks Fork Streambank Stabilization Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: ENV-005.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-005
Project Name: Clarks Fork Streambank Stabilization
Sponsor Reference: Hoene-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$3,989.60	$3,989.60
2	Imported Borrow (Fill)	CY	300	$50.00	$15,000.00
3	Excavation	CY	160	$25.00	$4,000.00
4	Riprap	CY	150	$131.00	$19,650.00
5	Geotextile, Erosion Control	SY	230	$5.00	$1,150.00
6	Cut, Collect, and Install Vegetation	EA	48	$2.00	$96.00

Project Subtotal	$43,885.60
Contingencies (15% of subtotal)	$6,582.84
Engineering and Technical Assistance (10% of subtotal)	$4,388.56
Estimated Project Cost	$54,857.00

ENV-006: Sediment Retention Structure (Jensen-001)

Purpose and Need: The project owner has observed severe streambank erosion and constructed an improvised check dam. The owner would like to capture sediment with a series of newly constructed check structures through the incised channel reach. This could also serve as a pilot project for sediment retention measures in the McCollough Peaks area.

Proposed Project: Construct check dams out of sheet piles. Install approximately 75 linear feet of sheet piles across the entrenched channel at each location to a depth of approximately 5 feet below the existing channel and a height of approximately 3 feet above the channel, for a total pile height of 8 feet. Incorporate a low point in the sheet pile cross section to centralize flow. Ensure the sheet pile extends high enough up sides of the incised channel to prevent water from bypassing the structure. Install approximately 10 cubic yards of riprap on the downstream side of the structure to minimize scour.

Project components would include:

- Install sheet pile grade control structures at locations to be determined in the entrenched channel.
- Extend sheet piles up stream bank to ensure flow does not bypass.
- Armor downstream side of sheet pile wall with riprap to dissipate energy and protect channel bed from scour.

Project Location:
Township 54 North, Range 100 West, Section 1
44.6858 N, 108.8426 W

Owner/Operator: Jensen, John

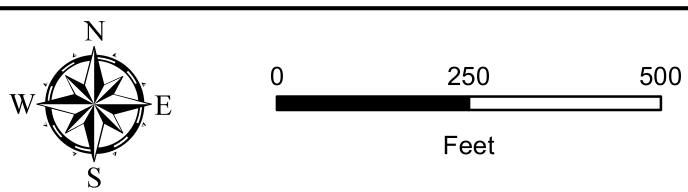
Land Ownership (Surface): Private, U.S. Bureau of Reclamation

Water Source: Unnamed drainage

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Bureau of Reclamation – Use Authorization



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ENV-006 (Jensen-001) Sediment Retention Structure Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: ENV-006.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID:	ENV-006
Project Name:	Sediment Retention Structure
Sponsor Reference:	Jensen-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$2,051.00	$2,051.00
2	Sheet Piles	SF	600	$32.00	$19,200.00
3	Riprap	CY	10	$131.00	$1,310.00

Project Subtotal	$22,561.00
Contingencies (15% of subtotal)	$3,384.15
Engineering and Technical Assistance (10% of subtotal)	$2,256.10
Estimated Project Cost	$28,201.25

ENV-007: Wildlife Pond (Morrison-004)

Purpose and Need: Construct a pond as a water source for stock and wildlife use.

Proposed Project: The proposed pond would be an off-channel feature located between two forks of an unnamed stream (between Lateral H-103 and Lateral H-105). The pond would be entirely excavated; there currently is no topographic feature. Water would be diverted from both forks via newly constructed supply ditches. Water will drain downstream to Lateral H-103. The pond would likely be approximately 1 acre in size.

Project components would include:

- Construct excavated pond and inlet/outlet channel (approximately 6,500 cubic yards).
- Install Agri Drain water level control structure and PVC outlet pipe.
- Construct earthen berms as needed using excavated material.
- Construct concrete headwalls with 12" slide gates.

Project Location:
Township 54 North, Range 101 West, Section 2
44.6828 N, 108.9817 W

Owner/Operator: Morrison, Rod

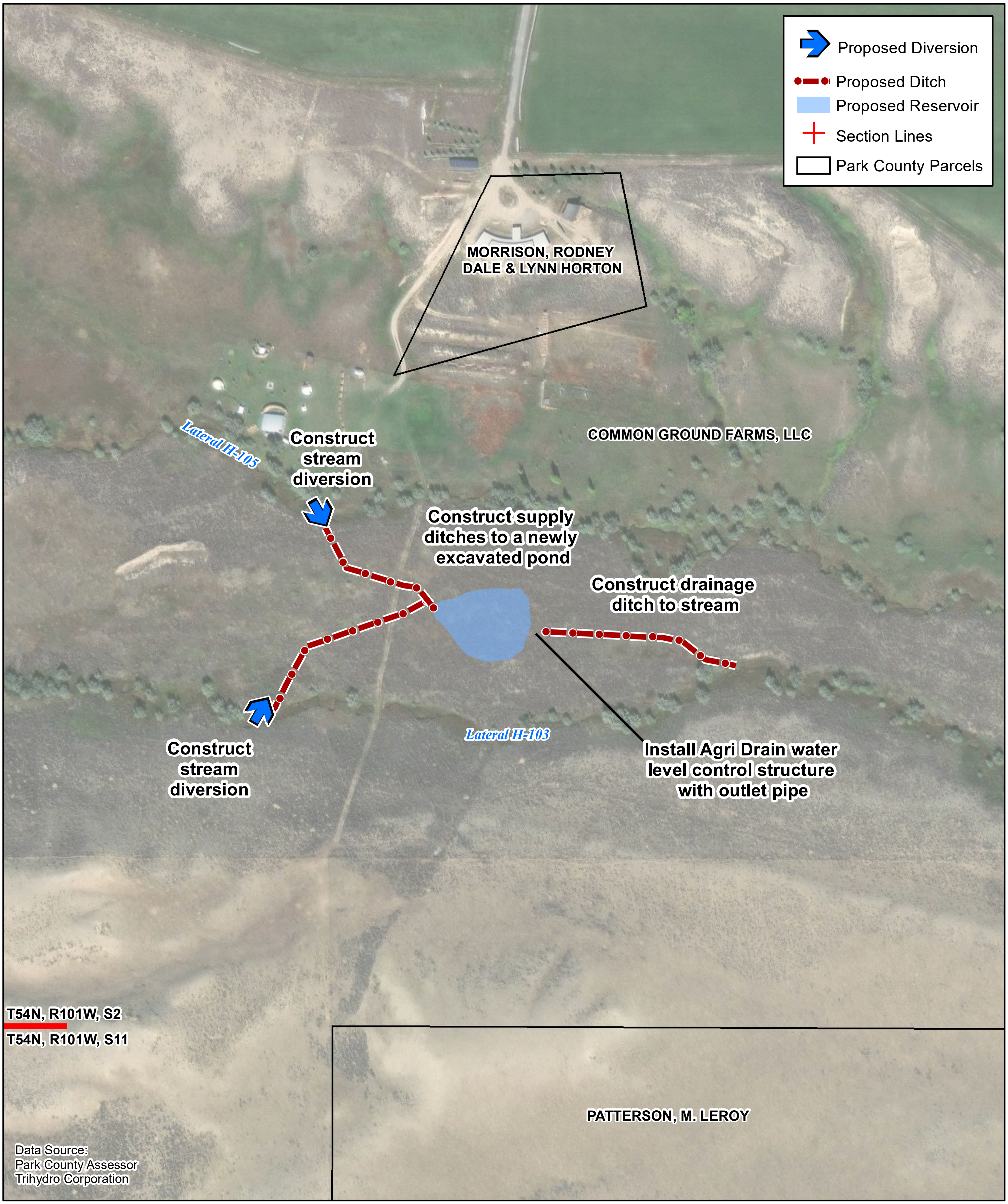
Land Ownership (Surface): Private

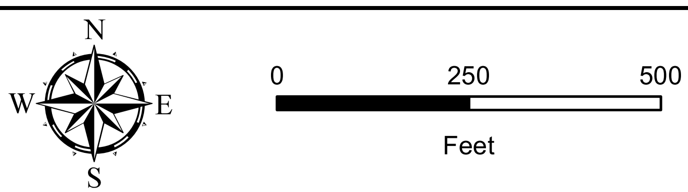
Water Source: Unnamed ephemeral tributary to Eaglesnest Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. U.S. Army Corps of Engineers – 404 Permit
3. Wyoming Department of Environmental Quality – 401 Certification





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ENV-007 (R Morrison-001) Wildlife Pond Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/15/23	File: ENV-007.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-007
Project Name: Wildlife Pond
Sponsor Reference: Morrison-004

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$9,676.00	$9,676.00
2	Excavation	CY	6,500	$13.00	$84,500.00
3	Concrete Turnout Structure, Small	EA	2	$3,000.00	$6,000.00
4	12" Slide Gate	EA	2	$1,800.00	$3,600.00
5	12" Agri Drain Water Level Control Structure	EA	1	$1,700.00	$1,700.00
6	12" Plastic Irrigation Pipe (PIP 80)	LF	40	$24.00	$960.00

Project Subtotal	$106,436.00
Contingencies (15% of subtotal)	$15,965.40
Engineering and Technical Assistance (10% of subtotal)	$10,643.60
Estimated Project Cost	$133,045.00

ENV-008: Streambank Protection (B4-002)

Purpose and Need: South bank of the Clarks Fork needs stabilizing. Erosion has caused channel morphology to shift significantly in recent years. June 2022 saw as much as 50 or 100 feet of movement along this reach. This erosion is contributing a significant amount of sediment to the Clarks Fork.

Proposed Project: Stabilize approximately 300 feet of streambank with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting. A portion of this project may fall on United States Forest Service (USFS) land. Examine previous stabilization projects for best management practices to implement.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.

Project Location:
Township 57 North, Range 107 West, Section 10
44.9414 N, 109.7778 W

Owner/Operator: B4 Ranch

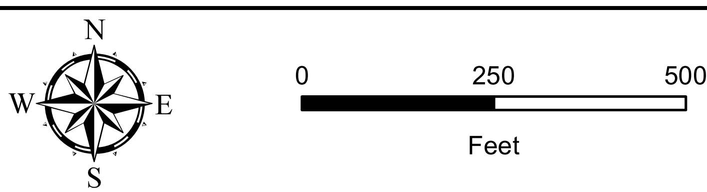
Land Ownership (Surface): Private, U.S. Forest Service

Water Source: Clarks Fork of the Yellowstone River

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. USFS
3. Wyoming Department of Environmental Quality – 401 Certification
4. Wyoming Game and Fish Department – construction schedule requirements
5. Park County Floodplain Development Permit



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ENV-008 (B4-002) Streambank Protection Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/6/23	File: ENV-008.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-008
Project Name: Streambank Protection
Sponsor Reference: B4-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$8,216.00	$8,216.00
2	Excavation	CY	1,300	$15.00	$19,500.00
3	Riprap	CY	450	$131.00	$58,950.00
4	Geotextile, Erosion Control	SY	670	$5.00	$3,350.00
5	Cut, Collect, and Install Vegetation	EA	180	$2.00	$360.00

Project Subtotal	$90,376.00
Contingencies (15% of subtotal)	$13,556.40
Engineering and Technical Assistance (10% of subtotal)	$9,037.60
Estimated Project Cost	$112,970.00

ENV-009: North Fork Streambank Stabilization (Mick-001)

Purpose and Need: Streambank erosion on the North Fork Shoshone River at this location is a sediment contributor to the river and Buffalo Bill Reservoir. The erosion is also carving out a pool, which is encroaching into the Mick's property and compromising prior erosion mitigation work done by the previous owner. The June 2022 flood worsened the problem. Streambank stabilization is needed to mitigate the erosion and sediment contribution, while protecting existing infrastructure.

Proposed Project: Stabilize approximately 200 feet of streambank with bioengineered treatment, which includes slope grading, riprap placement, and vegetation planting.

Project components would include:

- Streambank slope grading.
- Placement of erosion control geotextile and riprap.
- Cutting, collecting, and installation of riparian vegetation cuttings.

Project Location:
Township 52 North, Range 104 West, Section 19
44.4726 N, 109.4050 W

Owner/Operator: Mick, Bryan

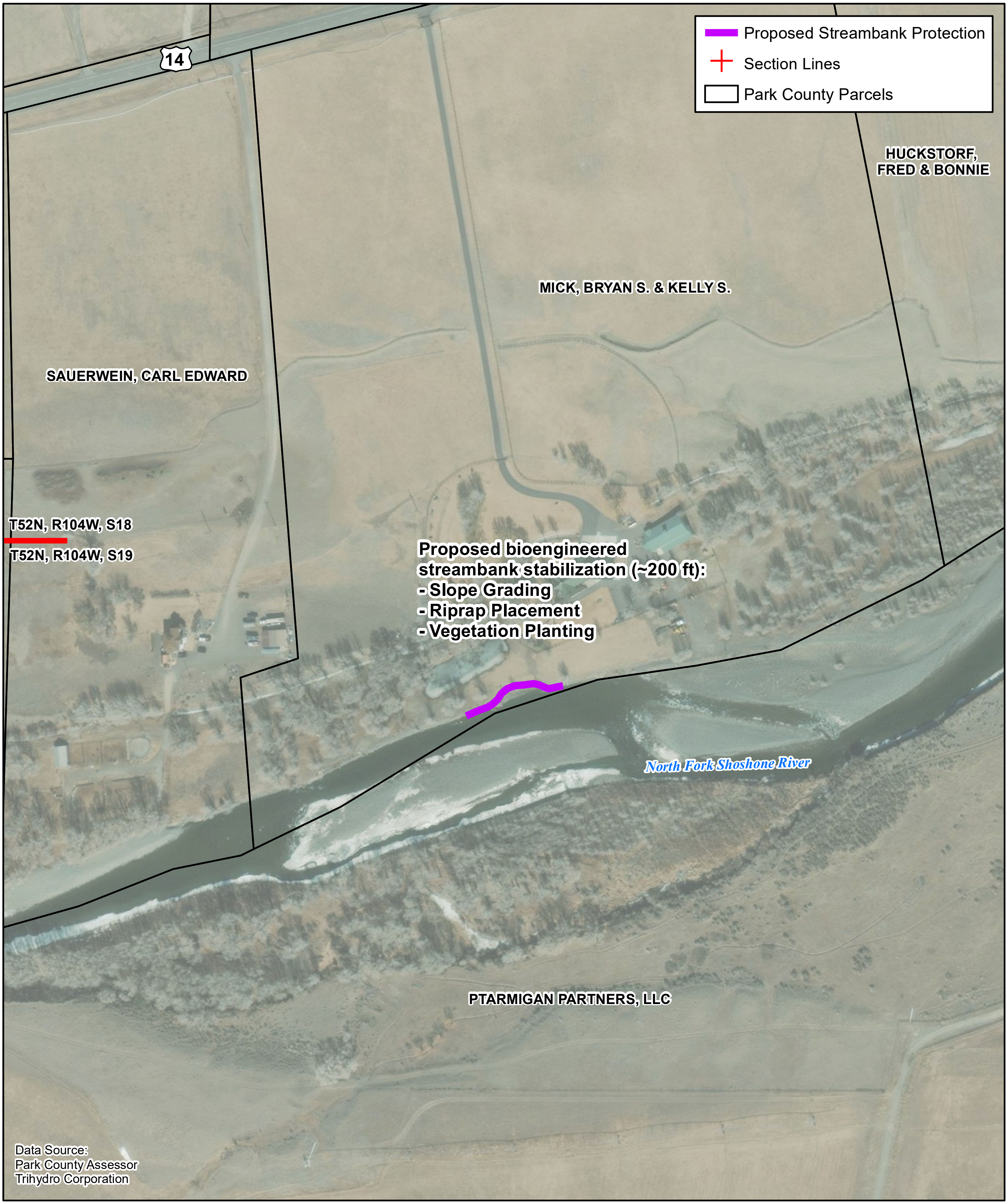
Land Ownership (Surface): Private

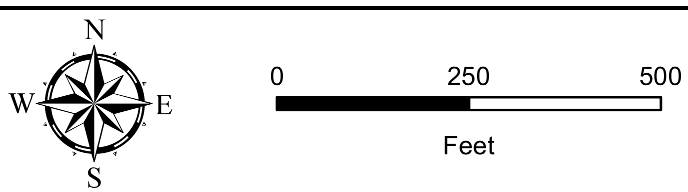
Water Source: North Fork Shoshone River

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit
2. Wyoming Department of Environmental Quality – 401 Certification
3. Wyoming Game and Fish Department – construction schedule requirements
4. Park County Floodplain Development Permit





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ENV-009 (Mick-001) North Fork Streambank Stabilization Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/15/23	File: ENV-009.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-009
Project Name: North Fork Streambank Stabilization
Sponsor Reference: Mick-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$2,767.00	$2,767.00
2	Excavation	CY	100	$25.00	$2,500.00
3	Riprap	CY	180	$131.00	$23,580.00
4	Geotextile, Erosion Control	SY	270	$5.00	$1,350.00
5	Cut, Collect, and Install Vegetation	EA	120	$2.00	$240.00

Project Subtotal	$30,437.00
Contingencies (15% of subtotal)	$4,565.55
Engineering and Technical Assistance (10% of subtotal)	$3,043.70
Estimated Project Cost	$38,046.25

FS-001: Sunset Lane Water Tank (RWLA-001)

Purpose and Need: A large water storage tank (approximately 37,000 gallons) is used to irrigate 75 acres of land. The tank is in poor condition, and frequent repairs are required to stop leaks. Repairs are losing effectiveness, and it is necessary to replace the storage tank.

Proposed Project: Replace the existing storage tank and install corresponding hardware to optimize water storage/conveyance. Coordinate with the Park County Fire Department to select a tank and fittings according to storage restrictions and requirements for fire suppression.

Project components would include:

- Remove existing storage tank and leaking fittings.
- Install new storage tank and new fittings. Assume galvanized steel.

Project Location:
Township 52 North, Range 101 West, Section 2
44.5088 N, 108.9678 W

Owner/Operator: Country Club Ranchette Lane Water Association

Land Ownership (Surface): Private

Water Source: North Fork Shoshone River

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Memorandum of Understanding with fire authority

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FS-001 (RLWA-001) Sunset Lane Water Tank
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: FS-001

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: FS-001
Project Name: Sunset Lane Water Tank
Sponsor Reference: RLWA-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$7,000.00	$7,000.00
2	Remove Water Tank	LS	LS	$10,000.00	$10,000.00
3	37,000-Gallon Water Tank	LS	LS	$60,000.00	$60,000.00

Project Subtotal	$77,000.00
Contingencies (15% of subtotal)	$11,550.00
Engineering and Technical Assistance (10% of subtotal)	$7,700.00
Estimated Project Cost	$96,250.00

IRR-001: Morrison Check Structure and Turnout Replacement (Morrison-002)

Purpose and Need: The existing sheet pile check structure, concrete turnout, and slide gate are failing and need to be replaced. Checked water spreads to a low area beyond the turnout, reducing efficiency. An earthen berm is needed for water containment and conservation for downstream users on the Garland Canal. The check structure is directly upstream of a culvert crossing underneath the access road to Morrison's property. Localized erosion is an issue for road stability at the culvert inlet, with damage to existing slope protection.

Proposed Project: Construct a new reinforced concrete check structure and turnout with an 18-inch slide gate. Construct an earthen berm to contain the checked flow and reconstruct the riprap slope protection at the check structure outfall to preserve the roadway.

Project components would include:

- Remove existing check structure, turnout, and slide gate.
- Construct reinforced concrete check structure and turnout.
- Install new 18-inch slide gate.
- Reconstruct riprap slope protection at check structure outfall.
- Construct earthen berm as needed to contain checked flow at turnout.

Project Location:
Township 54 North, Range 100 West, Section 7
44.6751 N, 108.9416 W

Owner/Operator: Morrison, Marion

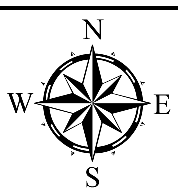
Land Ownership (Surface): Private

Water Source: North Buck Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers (categorical exclusion - irrigation structure replacement)



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IRR-001 (Morrison-002) Morrison Check Structure and Turnout Replacement Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/11/23	File: IRR-001.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-001
Project Name: Morrison Check Structure and Turnout Replacement
Sponsor Reference: Morrison-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$970.30	$970.30
2	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
3	18" Slide Gate	EA	1	$2,400.00	$2,400.00
4	Embankment	CY	5	$25.00	$125.00
5	Riprap	CY	3	$131.00	$393.00
6	Geotextile, Erosion Control	SY	10	$5.00	$50.00

Project Subtotal	$10,673.30
Contingencies (15% of subtotal)	$1,601.00
Engineering and Technical Assistance (10% of subtotal)	$1,067.33
Estimated Project Cost	$13,341.63

IRR-002: Nugent Pond No. 2 Reconstruction (Nugent-002)

Purpose and Need: The existing irrigation pond (~0.12 acres) has lost capacity due to sedimentation and needs to be excavated to reestablish capacity. The existing earthen dam has settled and needs to be reconstructed to support the capacity and provide required freeboard. Seepage losses are also a concern.

Proposed Project: Excavate approximately 4 feet to 5 feet of material from the existing pond basin. Place the excavated material as fill on the existing earthen dam to re-level the dam crest and raise the crest elevation approximately 2 feet to provide freeboard. Construct earthen emergency spillway (auxiliary spillway) as needed. Install an Agri Drain water level control structure (assume 12-inch) with PVC outlet pipe. Construct compacted soil pond liner treated with bentonite and place riprap on both the wet side and dry side of the dam for erosion protection. Install a solar-powered aeration system if a fishery is desired.

Project components would include:

- Excavation of approximately 1000 cubic yards.
- Placement of excavated material as fill on existing earthen dam (~500 cubic yards).
- Installation of Agri Drain water level control structure and PVC outlet pipe.
- Construction of bentonite pond liner (assume 12 inches thick).
- Placement of geotextile and riprap on dam.
- Installation of solar-powered aeration system if fishery is desired.

Project Location:
Township 51 North, Range 104 West, Sections 13
44.3913 N, 109.3157 W

Owner/Operator: Nugent, Louis

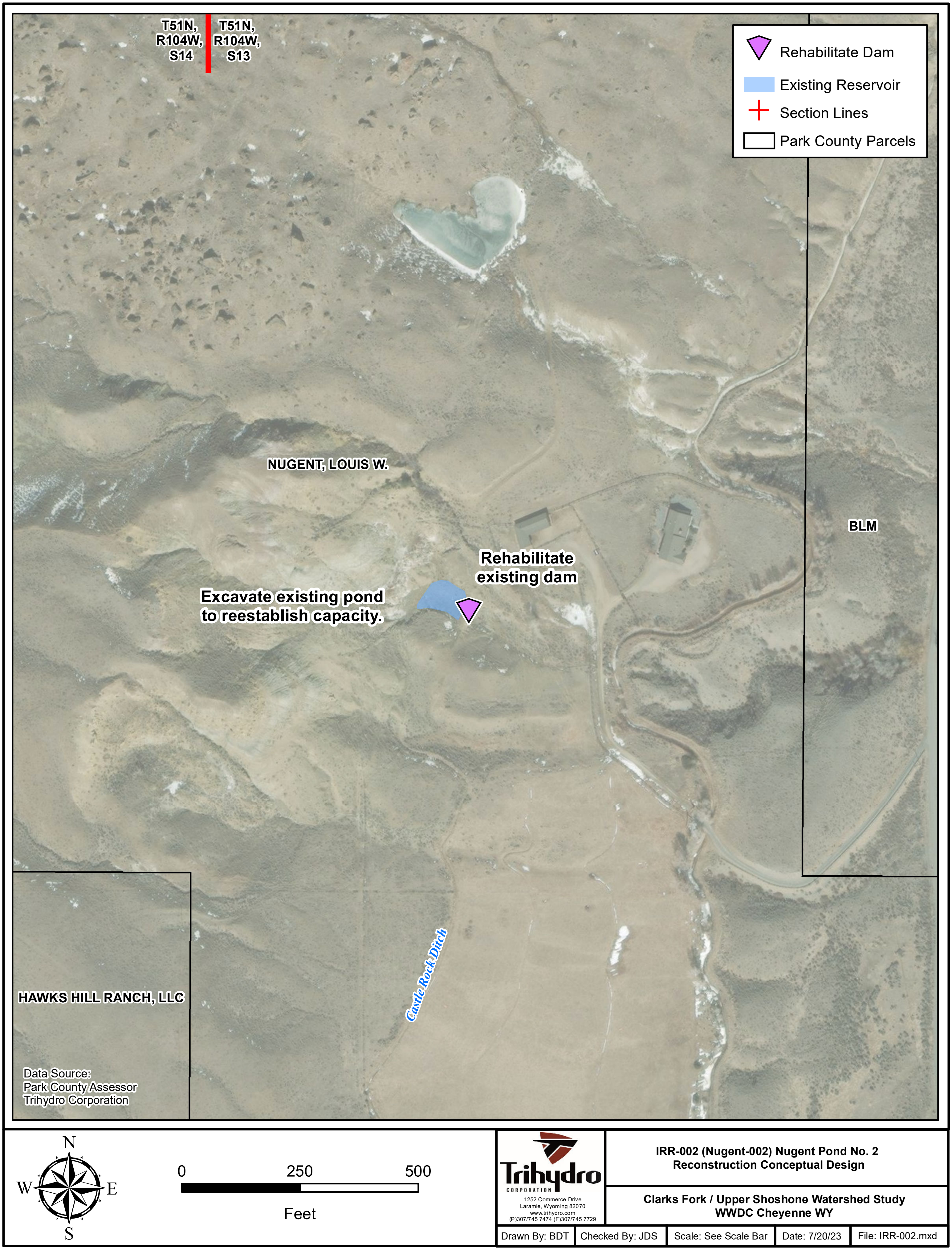
Land Ownership (Surface): Private

Water Source: Castle Rock Ditch

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office



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IRR-002 (Nugent-002) Nugent Pond No. 2
Reconstruction Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: IRR-002.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-002
Project Name: Nugent Pond No. 2 Reconstruction
Sponsor Reference: Nugent-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$6,734.00	$6,734.00
2	Excavation	CY	1,000	$15.00	$15,000.00
3	Embankment (N)	CY	500	--	--
4	12" Agri Drain Water Level Control Structure	EA	1	$2,760.00	$2,760.00
5	12" Piastic Irrigation Pipe (PIP 80)	LF	50	$24.00	$1,200.00
6	Riprap	CY	180	$131.00	$23,580.00
7	Geotextile, Erosion Control	SY	540	$5.00	$2,700.00
8	Betonite Pond Liner (Soil-Bentonite Mix)	CY	200	$58.00	$11,600.00
9	Solar Powered Aeration System *	EA	1	$10,500.00	$10,500.00

(N) Not a separate pay item. Cost included in excavation item.
* Item not eligible for SWPP funding

Project Subtotal	$74,074.00
Contingencies (15% of subtotal)	$11,111.10
Engineering and Technical Assistance (10% of subtotal)	$7,407.40
Estimated Project Cost	$92,592.50

IRR-003: Nugent Pond No. 3 (Nugent-003)

Purpose and Need: The landowner would like to create additional water storage on his property to provide for irrigation. Secondary purposes would be to serve as wildlife habitat and a wildlife watering source. This proposed pond would be immediately downstream of the Nugent Pond No. 2 dam (IRR-002 – Nugent Pond No. 2 – Nugent-002).

Proposed Project: Construct a new pond approximately 0.15 acres in size through excavation and earthen dam construction. The existing topography contains a natural depression, so excavation may be minimal. For quantity and cost estimate purposes, 2 feet of excavation is assumed, while a 12-foot dam height is assumed with a 3:1 slope on the wet side and 2:1 slope on the dry side. A dam crest width of 12 feet and length of 90 feet are also assumed. Surplus excavated material from IRR-002 – Nugent Pond No. 2 Reconstruction (Nugent-002) may be available for use as dam fill. Construct earthen emergency spillway (auxiliary spillway) as needed. Install an Agri Drain water level control structure (assume 12-inch) with PVC outlet pipe. Construct compacted soil pond liner treated with bentonite and place riprap on both the wet side and dry side of the dam for erosion protection. Install a solar-powered aeration system if a fishery is desired.

Project components would include:

- Excavation of approximately 500 cubic yards.
- Construction of earthen dam using excavated material (~1,400 cubic yards).
- Installation of Agri Drain water level control structure and PVC outlet pipe.
- Construction of bentonite pond liner (assume 12 inches thick).
- Placement of geotextile and riprap on dam.
- Installation of solar-powered aeration system if fishery is desired.

Project Location:
Township 51 North, Range 104 West, Sections 13
44.3912 N, 109.3154 W

Owner/Operator: Nugent, Louis

Land Ownership (Surface): Private

Water Source: Castle Rock Ditch

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office

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IRR-003 (Nugent-003) Nugent Pond No. 3
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: IRR-003.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-003
Project Name: Nugent Pond No. 3
Sponsor Reference: Nugent-003

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$8,966.00	$8,966.00
2	Excavation	CY	500	$25.00	$12,500.00
3	Embankment	CY	900	$25.00	$22,500.00
4	12" Agri Drain Water Level Control Structure	EA	1	$2,760.00	$2,760.00
5	12" Piastic Irrigation Pipe (PIP 80)	LF	50	$24.00	$1,200.00
6	Riprap	CY	180	$131.00	$23,580.00
7	Geotextile, Erosion Control	SY	540	$5.00	$2,700.00
8	Betonite Pond Liner (Soil-Bentonite Mix)	CY	240	$58.00	$13,920.00
9	Solar Powered Aeration System *	EA	1	$10,500.00	$10,500.00

* Item not eligible for SWPP funding

Project Subtotal	$98,626.00
Contingencies (15% of subtotal)	$14,793.90
Engineering and Technical Assistance (10% of subtotal)	$9,862.60
Estimated Project Cost	$123,282.50

IRR-004: Nugent Spring Improvement (Nugent-004)

Purpose and Need: An existing spring currently supplies two 1200-gallon cisterns. The landowner would like to modify and improve the existing spring to be used as a supplemental water supply for an existing irrigation pond (IRR-002 – Nugent Pond No. 2 Reconstruction – Nugent-002).

Proposed Project: Construct spring improvements and install approximately 200 feet of 2-inch plastic pipe from the existing spring box to the existing irrigation pond (Nugent Pond No. 2).

Project components would include:

- Improve (one) existing spring.
- Install 2-inch plastic pipe from existing spring box to existing irrigation pond (approx. 200 linear feet).

Project Location:
Township 51 North, Range 104 West, Sections 13
44.3919 N, 109.3158 W

Owner/Operator: Nugent, Louis

Land Ownership (Surface): Private

Water Source: Spring

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office

Trihydro Corporation
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P)307/745 7474 (F)307/745 7729

IRR-004 (Nugent-004) Nugent Spring Improvement Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: IRR-004.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-004
Project Name: Nugent Spring Improvement
Sponsor Reference: Nugent-004

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$672.20	$672.20
2	Spring Development	EA	1	$5,922.00	$5,922.00
3	2" HDPE Pipe	LF	200	$4.00	$800.00

Project Subtotal	$7,394.20
Contingencies (15% of subtotal)	$1,109.13
Engineering and Technical Assistance (10% of subtotal)	$739.42
Estimated Project Cost	$9,242.75

IRR-005: Ditch to Pipe (Montgomery-001)

Purpose and Need: There are seepage loss concerns with the existing irrigation ditch. Furthermore, existing irrigation infrastructure is not safe for maintenance and operations. A majority of the existing irrigation ditch and the two check structures/turnouts are located immediately off the highway shoulder. Operator safety is a concern since they are required to park vehicles on the narrow shoulder and work near a high-speed roadway (U.S. Route 14).

Proposed Project: Replace the existing irrigation ditch with 15-inch Plastic Irrigation Pipe (PIP). Remove two existing concrete check structures at the two existing turnouts. Connect the 15-inch PIP to the existing pipes at the two turnouts and install two 15-inch line gates. Consider a Coanda screen or other screening device at the pipeline inlet to remove sediment and debris. Please note a Coanda screen may not be feasible given the location and configuration of existing irrigation infrastructure. This project should be coordinated with Project IRR-013 (Trout Creek Ranch-002).

Project components would include:

- Remove two existing concrete check structures.
- Install 15-inch PIP in the existing irrigation ditch (approx. 2,500 feet).
- Connect 15-inch PIP to existing pipe at turnouts and install 15-inch line gates.
- Install Coanda screen at pipeline inlet (optional).
- Backfill around PIP with compacted, earthen material to match existing grade.

Project Location:
Township 52 North, Range 104 West, Sections 15 & 16
44.4855 N, 109.3557 W

Owner/Operator: Montgomery, Jim

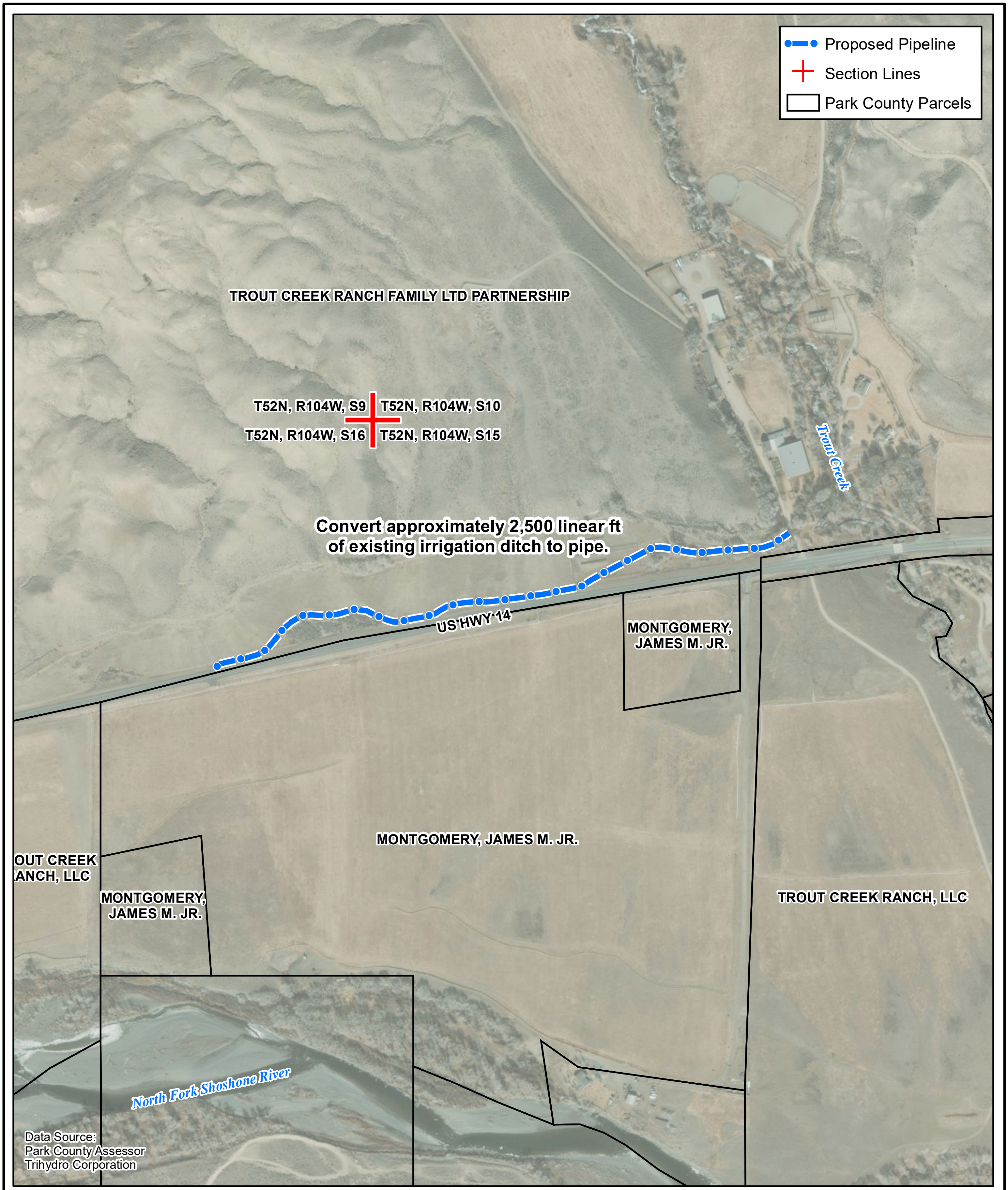
Land Ownership (Surface): Private

Water Source: Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming Department of Transportation



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IRR-005 (Montgomery-001) Irrigation Ditch to Pipe Conversion Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: IRR-005.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-005
Project Name: Ditch to Pipe
Sponsor Reference: Montgomery-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$12,750.00	$12,750.00
2	Imported Borrow (Backfill)	CY	750	$50.00	$37,500.00
3	15" Plastic Irrigation Pipe (PIP 80)	LF	2,500	$32.00	$80,000.00
4	15" Line Gate	EA	2	$2,500.00	$5,000.00
5	Coanda screen	EA	1	$5,000.00	$5,000.00

Project Subtotal	$140,250.00
Contingencies (15% of subtotal)	$21,037.50
Engineering and Technical Assistance (10% of subtotal)	$14,025.00
Estimated Project Cost	$175,312.50

IRR-006: Ditch to Pipe (Whitlock-001)

Purpose and Need: There are seepage loss concerns with the existing unlined irrigation ditch, so the landowner would like to convert the ditch to an irrigation pipeline to support water conservation and increased efficiency.

Proposed Project: Replace the existing irrigation ditch with 18-inch Plastic Irrigation Pipe (PIP). Connect the PIP to two existing center pivot supply pipelines.

Project components would include:

- Install 18-inch PIP in the existing irrigation ditch (approx. 3,350 feet).
- Connect PIP to two center pivot supply pipelines.
- Backfill around PIP with compacted, earthen material to match existing grade.

Project Location:
Township 51 North, Range 103 West, Section 3
44.4222 N, 109.2337 W

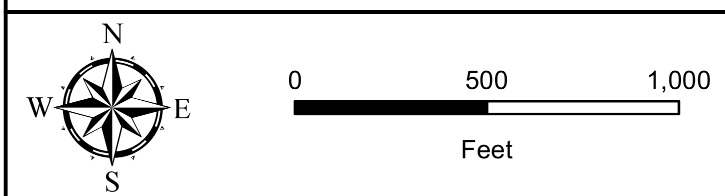
Owner/Operator: Whitlock, George

Land Ownership (Surface): Private

Water Source: Marquette Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated



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IRR-006 (Whitlock-001) Irrigation Ditch to Pipe Conversion Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: IRR-006.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-006
Project Name: Ditch to Pipe
Sponsor Reference: Whitlock-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$20,077.50	$20,077.50
2	Imported Borrow (Backfill)	CY	900	$50.00	$45,000.00
3	18" Plastic Irrigation Pipe (PIP 80)	LF	3,350	$46.50	$155,775.00

Project Subtotal	$220,852.50
Contingencies (15% of subtotal)	$33,127.88
Engineering and Technical Assistance (10% of subtotal)	$22,085.25
Estimated Project Cost	$276,065.63

IRR-007: Vogt Ditch Splitter (Vogt-001)

Purpose and Need: Small ditch on Vogt property is divided at existing splitter structure to deliver flow to two users: Vogt and Corbett. Existing structure is failing, and replacement is recommended.

Proposed Project: Remove existing structure and construct new splitter structure. Replacement structure to include two 18-inch slide gates to control flow into existing diversion ditches.

Project components would include:

- Construct new splitter structure.
- Install two 18-inch slide gates on the new splitter structure.

Project Location:
Township 56 North, Range 103 West, Section 26
44.8000 N, 109.2367 W

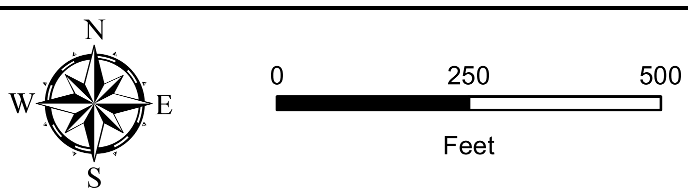
Owner/Operator: Vogt, Steve

Land Ownership (Surface): Private

Water Source: Unnamed irrigation ditch

Sage Grouse Core Area: Core Management Area

Potential Permitting: None Anticipated



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IRR-007 (Vogt-001) Vogt Ditch Splitter
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: IRR-007.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: ENV-007
Project Name: Vogt Ditch Splitter
Sponsor Reference: Vogt-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,153.50	$1,153.50
2	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
3	18" Slide Gate	EA	2	$2,400.00	$4,800.00

Project Subtotal	$12,688.50
Contingencies (15% of subtotal)	$1,903.28
Engineering and Technical Assistance (10% of subtotal)	$1,268.85
Estimated Project Cost	$15,860.63

IRR-008: Neff Ditch Throwback (Neff-001)

Purpose and Need: A throwback structure on Neff Ditch at Bear Creek needs upgrading. The existing is located at the point where the ditch crosses Bear Creek. The structure allows ditch managers to capture Bear Creek streamflow or allow it to bypass the ditch and continue downstream. The existing structure condition is in fair condition, however upgrades to structure walls and check boards will see improved efficiency and safety.

Proposed Project: Add 2 feet of height to concrete structure walls, providing sufficient freeboard. Replace existing structure check boards with Waterman canal gate or equivalent.

Project components would include:

- Extend height of existing concrete structure walls by 2 feet.
- Remove existing check boards.
- Install 2 new slide gates in check board locations, assume 18-inch diameter each.

Project Location:
Township 51 North, Range 103 West, Section 7
44.4114 N, 109.2950 W

Owner/Operator: Lewis, Tony

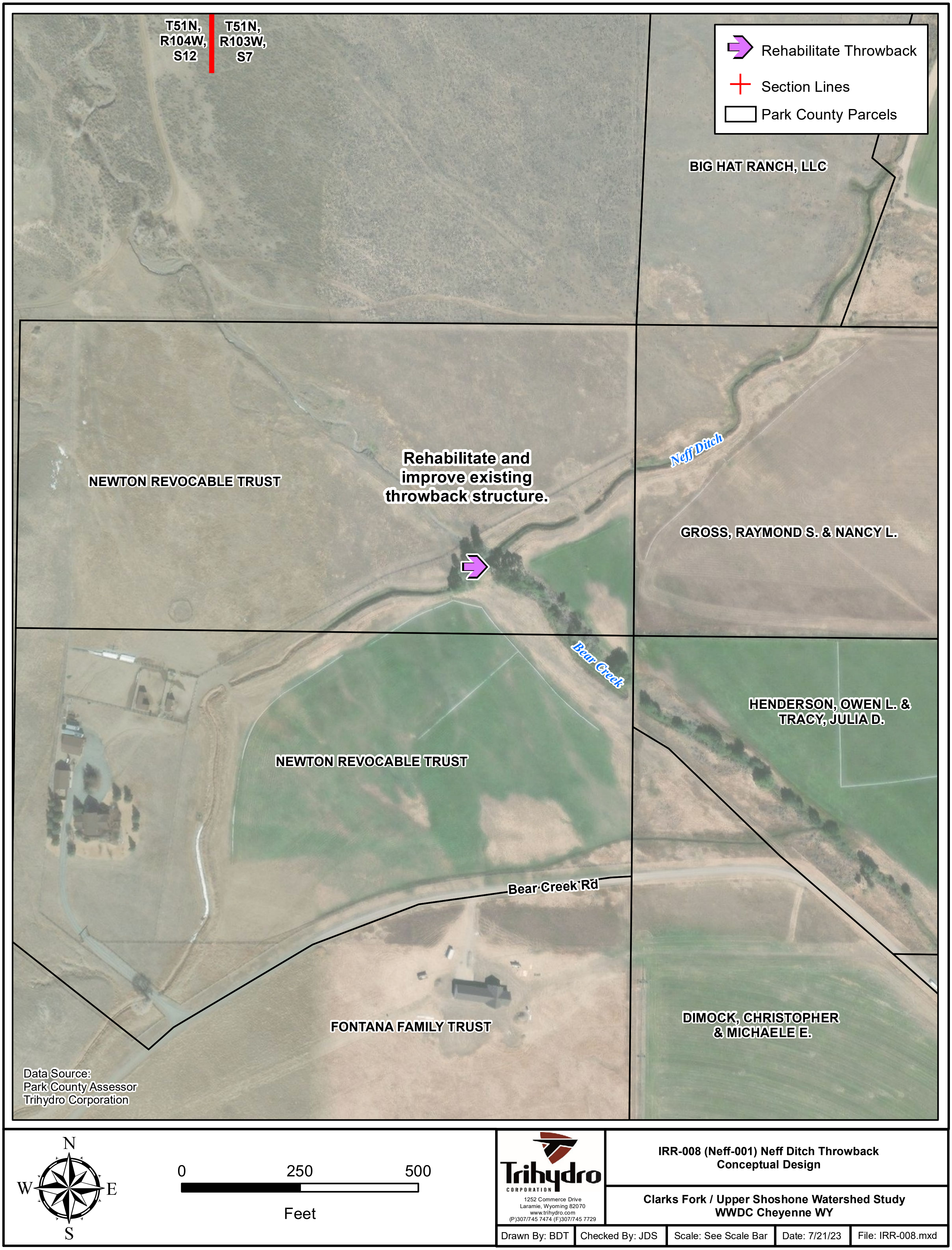
Land Ownership (Surface): Private

Water Source: Bear Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers (categorical exclusion – irrigation structure replacement)



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IRR-008 (Neff-001) Neff Ditch Throwback Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: IRR-008.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-008
Project Name: Neff Ditch Throwback
Sponsor Reference: Neff-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$830.00	$830.00
2	Concrete Wall Extension	EA	1	$3,500.00	$3,500.00
3	18" Slide Gate	EA	2	$2,400.00	$4,800.00

Project Subtotal	$9,130.00
Contingencies (15% of subtotal)	$1,369.50
Engineering and Technical Assistance (10% of subtotal)	$913.00
Estimated Project Cost	$11,412.50

IRR-009: Boot and Bottle Irrigation (Boot and Bottle-001)

Purpose and Need: The Boot and Bottle club currently irrigates a small grove of memorial trees using water provided by the local water district. Supply from this source is limited and its use is labor intensive. The proposed project would provide a greater supply of water in comparison to the water district and reduce irrigation labor.

Proposed Project: This project would entail utilizing shares in the Cody Canal Irrigation District owned by the Boot and Bottle Club. A new diversion on the Indian Pass Lateral would be constructed and used to convey water downslope to the property via gravity flow through a pipeline. At the end of the pipeline, a hydrant would be placed to control the water. From the hydrant, property owners could later distribute the water via conventional garden hoses and tee fittings.

Project components would include:

- Small headgate would be placed on the Indian Pass Lateral. The headgate would include a 6-inch diameter slide gate.
- Install approximately 800 feet of 2-inch HDPE pipeline.
- At the pipeline terminus, a frost-free hydrant would be installed.

Project Location:
Township 52 North, Range 102 West, Section 3
44.5078 N, 109.1028 W

Owner/Operator: Eden, Doug

Land Ownership (Surface): Private

Water Source: Cody Canal Irrigation District

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office

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IRR-009 (Boot and Bottle-001) Boot and Bottle Irrigation Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
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Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: IRR-009.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-009
Project Name: Boot and Bottle Irrigation
Sponsor Reference: Boot and Bottle-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$720.00	$720.00
2	Headgate Structure	EA	1	$3,500.00	$3,500.00
3	2" HDPE Pipe	LF	800	$4.00	$3,200.00
4	Frost Free Hydrant	EA	1	$500.00	$500.00

Project Subtotal	$7,920.00
Contingencies (15% of subtotal)	$1,188.00
Engineering and Technical Assistance (10% of subtotal)	$792.00
Estimated Project Cost	$9,900.00

IRR-010: Harrison Ditch to Pipe (Harrison-001)

Purpose and Need: This limited section of open ditch experiences heavy losses due to seepage. Convert the selected reach to buried pipeline to reduce these losses.

Proposed Project: Replace existing open ditch with buried plastic irrigation pipe (PIP), including inlet and outlet control structures.

Project components would include:

- Install approximately 1,000 feet of 15-inch PIP along open ditch.
- Construct two concrete headwalls with slide gates at the PIP inlet and outlet.
- Backfill ditch around PIP with compacted earthen material.

Project Location:
Township 55 North, Range 99 West, Section N/A
44.7628 N, 108.7241 W

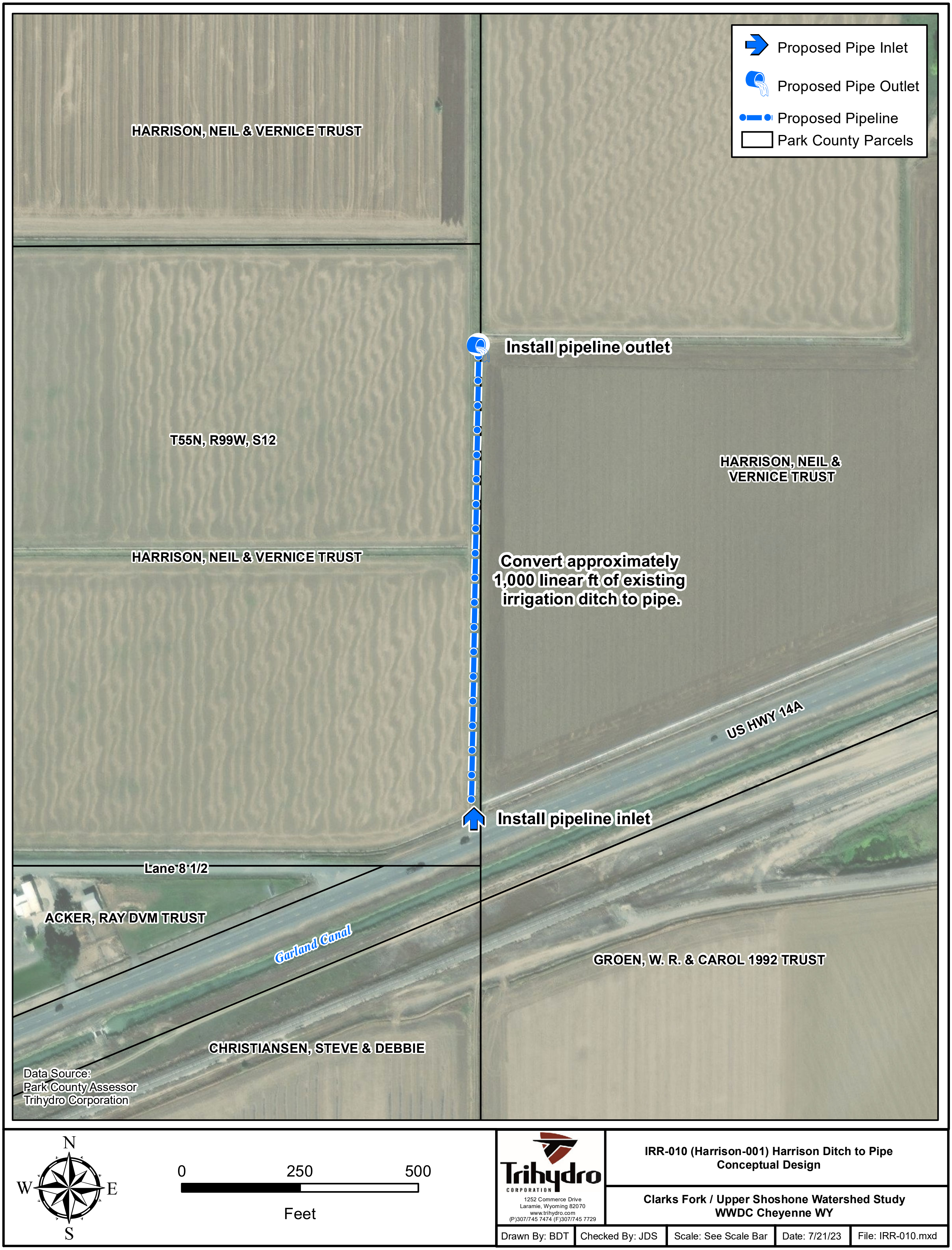
Owner/Operator: Harrison, Rick

Land Ownership (Surface): Private

Water Source: Garland Canal

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated



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IRR-010 (Harrison-001) Harrison Ditch to Pipe Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: IRR-010.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-010
Project Name: Harrison Ditch to Pipe
Sponsor Reference: Harrison-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$6,280.00	$6,280.00
2	Imported Borrow (Backfill)	CY	400	$50.00	$20,000.00
3	Concrete Headwalls	EA	2	$3,000.00	$6,000.00
4	15" Plastic Irrigation Pipe (PIP 80)	LF	1,000	$32.00	$32,000.00
5	15" Slide Gate	EA	2	$2,400.00	$4,800.00

Project Subtotal	$69,080.00
Contingencies (15% of subtotal)	$10,362.00
Engineering and Technical Assistance (10% of subtotal)	$6,908.00
Estimated Project Cost	$86,350.00

IRR-011: Splitter Box Replacement (Harrison-002)

Purpose and Need: The existing open ditch splits at this location by means of a failing existing concrete structure.

Proposed Project: Construct new splitter structure at this location. Install two slide gates, one in each outlet of the splitter box, and install a Coanda screen on the side supplying water to the pivot sprinkler.

Project components would include:

- Construct a splitter structure at the existing fork (approximately 6 feet square).
- Install one Coanda screen on the pivot sprinkler side.
- Install two 12-inch slide gates at the splitter outlets.

Project Location:
Township 55 North, Range 99 West, Section N/A
44.7650 N, 108.7075 W

Owner/Operator: Harrison, Rick

Land Ownership (Surface): Private

Water Source: Garland Canal

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated

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IRR-011 (Harrison-002) Splitter Box Replacement Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/15/23	File: IRR-011.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-011
Project Name: Splitter Box Replacement
Sponsor Reference: Harrison-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,533.50	$1,533.50
2	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
3	12" Slide Gate	EA	2	$1,800.00	$3,600.00
4	Coanda Screen	EA	1	$5,000.00	$5,000.00

Project Subtotal	$16,868.50
Contingencies (15% of subtotal)	$2,530.28
Engineering and Technical Assistance (10% of subtotal)	$1,686.85
Estimated Project Cost	$21,085.63

IRR-012: Trout Creek Lateral Diversion Replacement (Trout Creek Ranch-001)

Purpose and Need: Irrigation diversion structure is failing. Waterman style headgate is separated from concrete headwall and the headwall is damaged beyond repair. There is also a fish screen 500 feet down ditch that requires daily maintenance and needs repairs. Aging infrastructure needs replaced to improve efficiency at diversion and better management of stakeholder water rights.

Proposed Project: Replace existing diversion structure and flow control device. Design new structure for landowner to operate without daily maintenance. This project should be coordinated with Project IRR-015 (Trout Creek Ranch-010).

Project components would include:

- Remove existing concrete headwall and slide gate.
- Construct new reinforced concrete headwall.
- Install new 18-inch slide gate and fish screen.
- Install Parshall flume (18-inch).

Project Location:
Township 52 North, Range 104 West, Section 10
44.4958 N, 109.3558 W

Owner/Operator: Williams, Cory

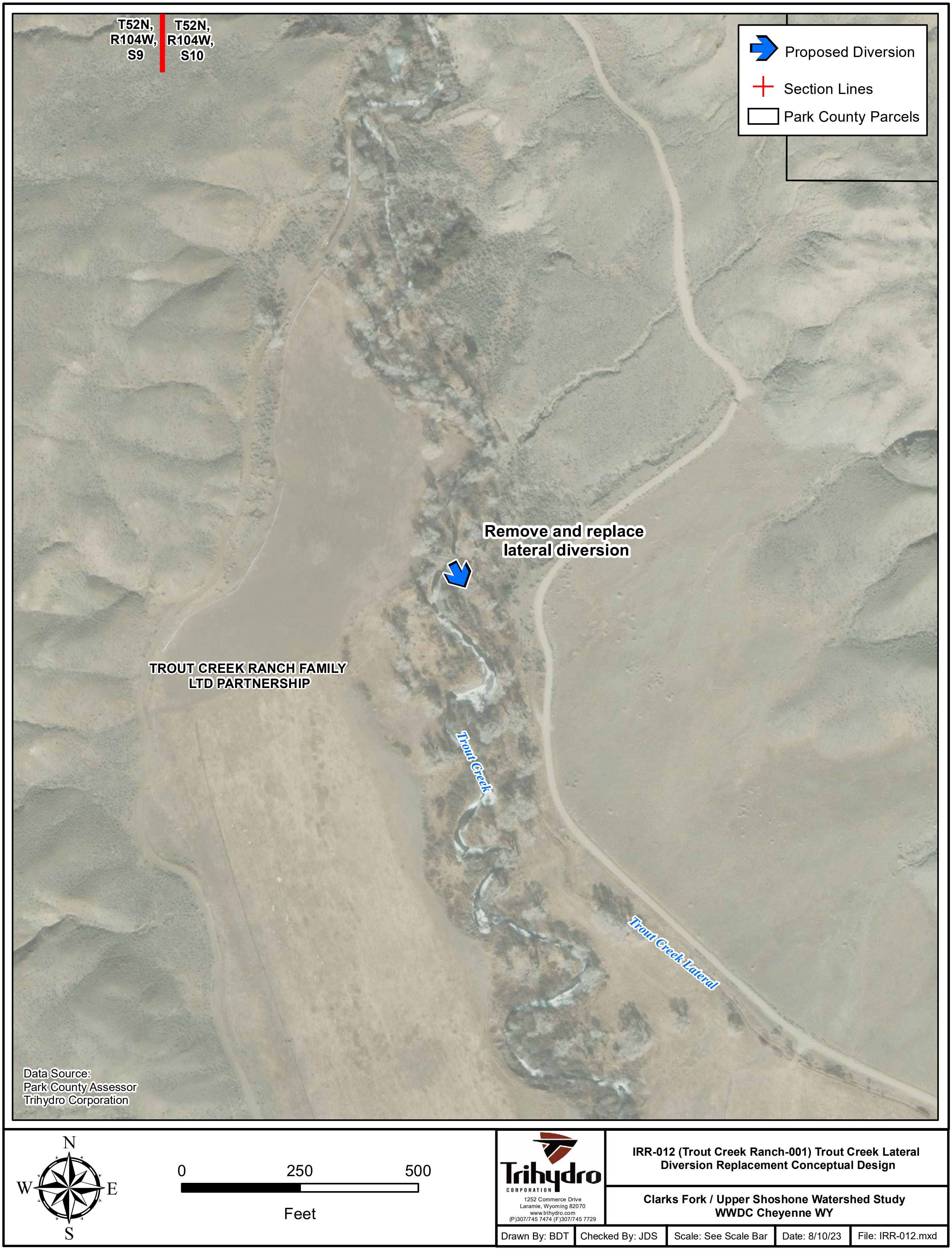
Land Ownership (Surface): Private

Water Source: Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers (categorical exclusion - irrigation structure replacement)



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IRR-012 (Trout Creek Ranch-001) Trout Creek Lateral Diversion Replacement Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-012
Project Name: Trout Creek Lateral Diversion Replacement
Sponsor Reference: Trout Creek Ranch-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,993.50	$1,993.50
2	Remove Concrete Structure and Slide Gate	LS	LS	$2,000.00	$2,000.00
3	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
4	18" Slide Gate	EA	1	$2,400.00	$2,400.00
5	Fish Screen	EA	1	$1,000.00	$1,000.00
6	Parshall Flume (18")	EA	1	$7,800.00	$7,800.00

Project Subtotal	$21,928.50
Contingencies (15% of subtotal)	$3,289.28
Engineering and Technical Assistance (10% of subtotal)	$2,192.85
Estimated Project Cost	$27,410.63

IRR-013: Ditch to Pipe Conversion (Trout Creek Ranch-002)

Purpose and Need: Open ditch needs significant maintenance. Open ditch experiencing major losses to seepage.

Proposed Project: Convert select reach of open ditch to pipe. Include an inlet structure. This project should be coordinated with Project IRR-005 (Montgomery-001).

Project components would include:

- Install concrete headwall and 18-inch slide gate.
- Install 800 linear feet of 18-inch plastic irrigation pipe (PIP).
- Backfill open ditch with compacted earthen material.

Project Location:
Township 52 North, Range 104 West, Section 10
44.4875 N, 109.3514 W

Owner/Operator: Williams, Cory

Land Ownership (Surface): Private

Water Source: Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated

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Feet

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IRR-013 (Trout Creek Ranch-002) Ditch to Pipe Conversion Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

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Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-013
Project Name: Ditch to Pipe Conversion
Sponsor Reference: Trout Creek Ranch-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$5,383.50	$5,383.50
2	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
3	18" Slide Gate	EA	1	$2,400.00	$2,400.00
4	18" Plastic Irrigation Pipe (PIP 80)	LF	800	$46.50	$37,200.00
5	Embankment	CY	300	$25.00	$7,500.00

Project Subtotal	$59,218.50
Contingencies (15% of subtotal)	$8,882.78
Engineering and Technical Assistance (10% of subtotal)	$5,921.85
Estimated Project Cost	$74,023.13

IRR-014: Sediment Trap Replacement (Trout Creek Ranch-003)

Purpose and Need: An existing concrete vault (20' x 20' x 10') removes sediment from water supply to a side roll sprinkler. A sluice gate was installed with the structure to clear out settled solids but does not work as intended. Accumulated sediment needs to be removed using a backhoe. Aging infrastructure needs to be replaced and improvements made so sediment can be flushed regularly without specialized equipment.

Proposed Project: Remove and replace the existing concrete structure with a new reinforced concrete vault and sluice gate. The new vault will be designed with a sloped floor to facilitate sediment flushing via the sluice gate.

Project components would include:

- Remove existing concrete vault and sluice gate.
- Install new, improved concrete vault and sluice gate.

Project Location:
Township 52 North, Range 104 West, Section 10
44.4894 N, 109.3508 W

Owner/Operator: Williams, Cory

Land Ownership (Surface): Private

Water Source: Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated

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IRR-014 (Trout Creek Ranch-003) Sediment Trap Replacement Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
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Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-014
Project Name: Sediment Trap Replacement
Sponsor Reference: Trout Creek Ranch-003

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$10,000.00	$10,000.00
2	Remove Concrete Structure	LS	LS	$10,000.00	$10,000.00
3	Irrigation Structure, Very Large	EA	1	$90,000.00	$90,000.00

Project Subtotal	$110,000.00
Contingencies (15% of subtotal)	$16,500.00
Engineering and Technical Assistance (10% of subtotal)	$11,000.00
Estimated Project Cost	$137,500.00

IRR-015: Trout Creek Lateral Ditch to Pipe Conversion (Trout Creek Ranch-010)

Purpose and Need: Existing open ditch requires frequent maintenance and experiences seepage losses.

Proposed Project: Increase efficiency along lateral diversion by replacing open ditch with irrigation pipe. This project should be coordinated with Project IRR-012 (Trout Creek Ranch-001).

Project components would include:

- Install 3,100 linear feet of 18-inch plastic irrigation pipe (PIP).
- Backfill around PIP with compacted, earthen material to match existing grade.

Project Location:
Township 52 North, Range 104 West, Section 10
44.4958 N, 109.3558 W

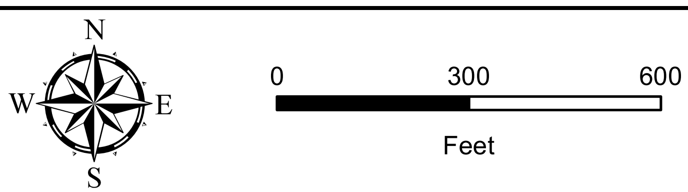
Owner/Operator: Williams, Cory

Land Ownership (Surface): Private

Water Source: Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated



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IRR-015 (Trout Creek Ranch-010) Trout Creek Lateral Ditch to Pipe Conversion Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/14/23	File: IRR-015.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: IRR-015
Project Name: Trout Creek Lateral Ditch to Pipe Conversion
Sponsor Reference: Trout Creek Ranch-010

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$21,415.00	$21,415.00
2	Imported Borrow (Backfill)	CY	1,400	$50.00	$70,000.00
3	18" Plastic Irrigation Pipe (PIP 80)	LF	3,100	$46.50	$144,150.00

Project Subtotal	$235,565.00
Contingencies (15% of subtotal)	$35,334.75
Engineering and Technical Assistance (10% of subtotal)	$23,556.50
Estimated Project Cost	$294,456.25

L/W-001: Morrison Pond (Morrison-001)

Purpose and Need: A select section of an existing hay field has been too wet to hay in recent years. The water table at this location is very high due to North Buck Creek and adjacent flood irrigation. The landowner would like make use of the groundwater and construct an excavated pond to provide a livestock and wildlife watering source.

Proposed Project: Construct an excavated pond approximately 1 acre in size with an average depth of 6 feet to 8 feet. A couple locations up to 12 feet deep and a solar-powered aeration system may be desirable if also trying to promote a fishery. Excavate a pond outlet/return channel to North Buck Creek and install an Agri Drain water level control structure (assume 12-inch) with PVC outlet pipe. Earthen berm construction may be needed in select locations around the pond perimeter due to topography.

Project components would include:

- Construct excavated pond and outlet/return channel (approximately 12,000 cubic yards).
- Install Agri Drain water level control structure and PVC outlet pipe.
- Construct earthen berms as needed using excavated material.
- Install solar-powered aeration system if fishery is desired.

Project Location:
Township 54 North, Range 100 West, Section 7
44.6760 N, 108.9441 W

Owner/Operator: Morrison, Marion

Land Ownership (Surface): Private

Water Source: Groundwater

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. Wyoming Department of Environmental Quality – Small Construction General Permit

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L/W-001 (Morrison-001) Morrison Pond Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/11/23	File: LW-001.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-001
Project Name: Morrison Pond
Sponsor Reference: Morrison-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$16,916.00	$16,916.00
2	Excavation	CY	12,000	$13.00	$156,000.00
3	12" Agri Drain Water Level Control Structure	EA	1	$1,700.00	$1,700.00
4	12" Plastic Irrigation Pipe (PIP 80)	LF	40	$24.00	$960.00
5	Solar Powered Aeration System*	EA	1	$10,500.00	$10,500.00

* Item not eligible for SWPP funding

Project Subtotal	$186,076.00
Contingencies (15% of subtotal)	$27,911.40
Engineering and Technical Assistance (10% of subtotal)	$18,607.60
Estimated Project Cost	$232,595.00

L/W-002: Morrison Springs (Morrison-003)

Purpose and Need: The landowner has observed water seeping from the bottom of a hillside and would like to develop springs to capture this water and use it as an alternate livestock water source. The existing livestock water source is assumed to be a well, so this project also has a potential benefit of lowering demand on the aquifer.

Proposed Project: Develop two springs at the bottom of the hillside where water is seeping. Pipe water from the springs to the landowner's existing corrals and stock tanks. The springs and proposed spring boxes may be located on Bureau of Reclamation land.

Project components would include:

- Develop two (2) springs.
- Install 2-inch plastic pipe from spring boxes to livestock corrals and stock tanks (approx. 1,000 linear feet).

Project Location:
Township 54 North, Range 100 West, Section 7
44.6749 N, 108.9437 W

Owner/Operator: Morrison, Marion

Land Ownership (Surface): Bureau of Reclamation, Private

Water Source: Groundwater

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. Bureau of Reclamation

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L/W-002 (Morrison-003) Morrison Springs Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/11/23	File: LW-002.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-002
Project Name: Morrison Springs
Sponsor Reference: Morrison-003

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,584.40	$1,584.40
2	Spring Development	EA	2	$5,922.00	$11,844.00
3	2" HDPE Pipe	LF	1,000	$4.00	$4,000.00

Project Subtotal	$17,428.40
Contingencies (15% of subtotal)	$2,614.26
Engineering and Technical Assistance (10% of subtotal)	$1,742.84
Estimated Project Cost	$21,785.50

L/W-003: Christofferson Pond (Christofferson-001)

Purpose and Need: Irrigation return flows from two irrigation ditches constantly flood a lower bench on the property, as the ditches terminate prior to reaching the Shoshone River. Since this land is not suitable for grazing, and the water supply is there, the landowner would like to construct an excavated pond to provide a livestock and wildlife watering source.

Proposed Project: Construct an excavated pond approximately 3 acres in size with an average depth of 6 feet to 8 feet. A couple locations up to 12 feet deep and a solar-powered aeration system may be desirable if also trying to promote a fishery. Excavate a pond outlet channel to spill water over the bluff to the Shoshone River floodplain and install an Agri Drain water level control structure (assume 12-inch) with PVC outlet pipe. Place riprap erosion control in the outlet channel as needed. Earthen berm construction may be needed in select locations around the pond perimeter due to topography.

Project components would include:

- Construct excavated pond and outlet/return channel (approximately 35,000 cubic yards).
- Install Agri Drain water level control structure and PVC outlet pipe.
- Construct earthen berms as needed.
- Place riprap in outlet channel.
- Install solar-powered aeration system if fishery is desired.

Project Location:
Township 55 North, Range 100 West, Section 36
44.7039 N, 108.8385 W

Owner/Operator: Christofferson, Neil

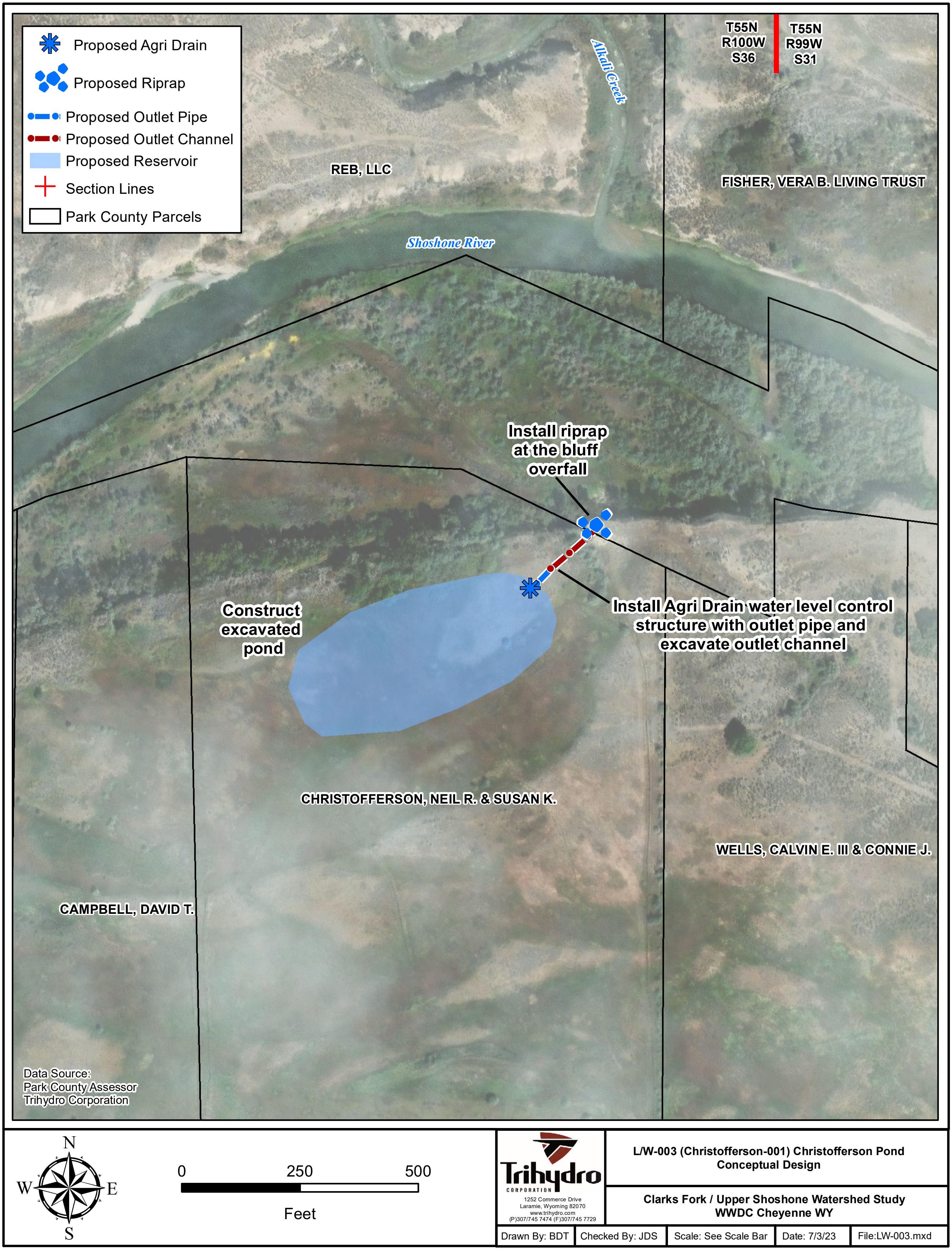
Land Ownership (Surface): Private

Water Source: Irrigation return water, groundwater

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. Wyoming Department of Environmental Quality – Small Construction General Permit



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L/W-003 (Christofferson-001) Christofferson Pond Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/3/23	File:LW-003.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-003
Project Name: Christofferson Pond
Sponsor Reference: Christofferson-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$48,310.00	$48,310.00
2	Excavation	CY	35,000	$13.00	$455,000.00
3	12" Agri Drain Water Level Control Structure	EA	1	$1,700.00	$1,700.00
4	12" Plastic Irrigation Pipe (PIP 80)	LF	40	$24.00	$960.00
5	Riprap	CY	15	$131.00	$1,965.00
6	Geotextile, Erosion Control	SY	45	$5.00	$225.00
7	Solar-Powered Aeration System*	EA	1	$23,250.00	$23,250.00

* Item not eligible for SWPP funding

Project Subtotal	$531,410.00
Contingencies (15% of subtotal)	$79,711.50
Engineering and Technical Assistance (10% of subtotal)	$53,141.00
Estimated Project Cost	$664,262.50

L/W-004: Koller Wildlife Water Source and Solar Well (Koller-001)

Purpose and Need: The wildlife that crosses this property is abundant, and the landowner would like to enhance the habitat by creating a wildlife watering source in an area that is somewhat a natural depression. There is an existing ditch water right for the southern 20 acres of the 40-acre parcel, but the turnout and ditch system are dysfunctional. Plus, the land is not suitable for irrigated crops in its current condition, and the landowner does not want to impact down-ditch users. A new well with a solar-powered pump is the preferred water supply. The existing house well is approximately 50-60 feet deep.

Proposed Project: Perform light geomorphic grading to create a watering area no larger than 1 acre in size. Assumed water depth will range from 1' to 3'. An outlet may not be needed, as any water that leaves the area will sheet flow and enter natural swales towards the South Fork Shoshone River. Drill a new well to approximately 50 feet and install a solar-powered pump.

Project components would include:

- Construct shallow pond/wetland area through geomorphic grading (approximately 3,000 CY).
- Drill new well and install a solar-powered pump.

Project Location:
Township 50 North, Range 105 West, Section 33
44.2645 N, 109.5053 W

Owner/Operator: Koller, Michael

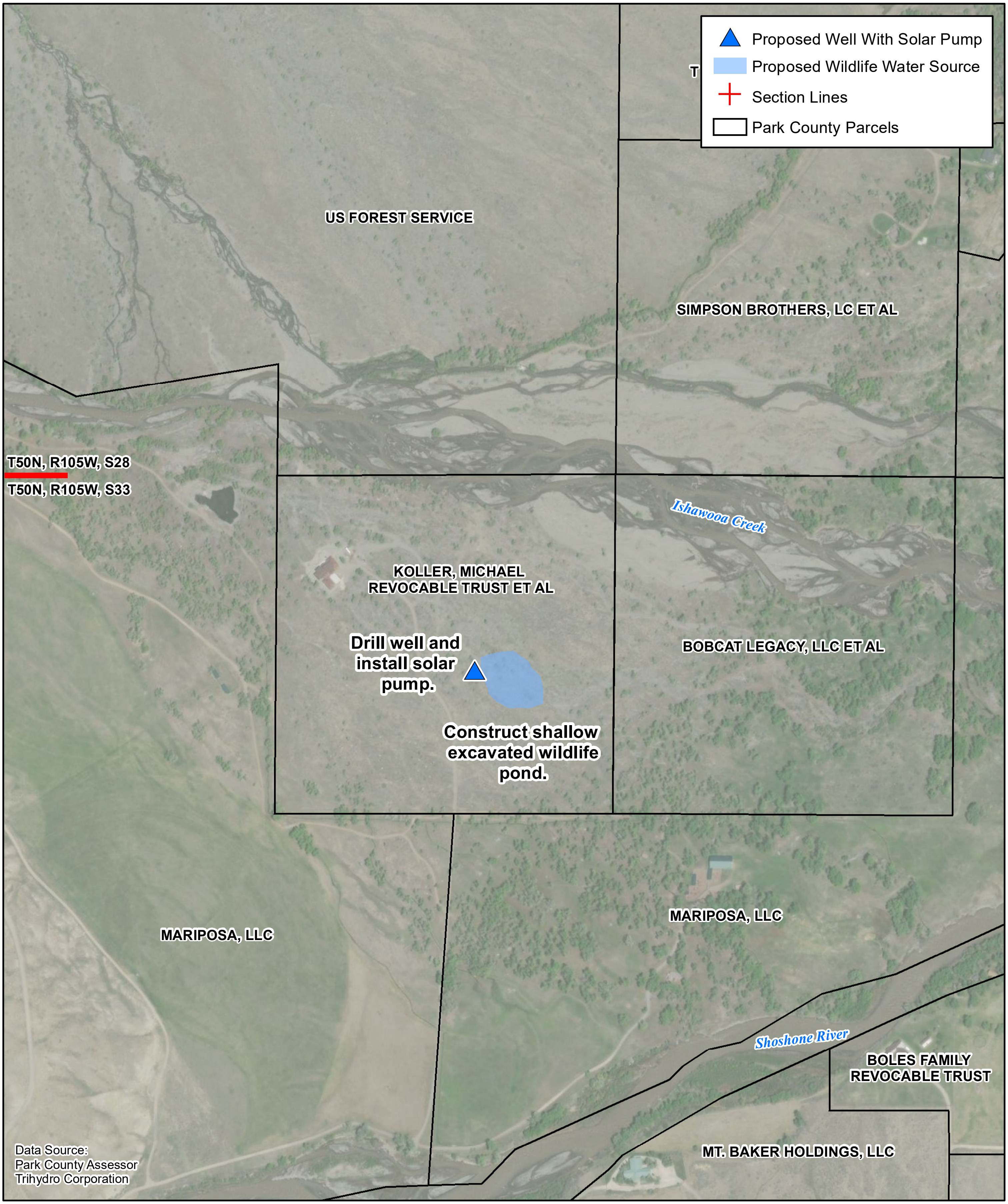
Land Ownership (Surface): Private

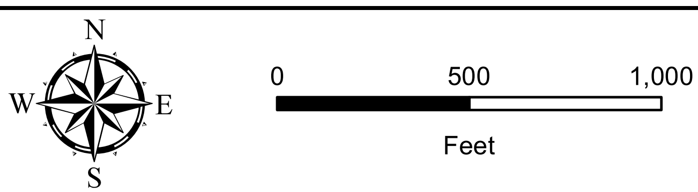
Water Source: Groundwater (well)

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. Wyoming Department of Environmental Quality – Small Construction General Permit





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L/W-004 (Koller-001) Koller Wildlife Water Source and Solar Well Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: LW-004.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-004
Project Name: Koller Wildlife Water Source and Solar Well
Sponsor Reference: Koller-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$5,910.00	$5,910.00
2	Excavation	CY	3,000	$15.00	$45,000.00
3	Well-Drill, Case, and Develop Well	LF	50	$116.00	$5,800.00
5	Solar Pump System - Less than 250' TDH	EA	1	$8,300.00	$8,300.00

Project Subtotal	$65,010.00
Contingencies (15% of subtotal)	$9,751.50
Engineering and Technical Assistance (10% of subtotal)	$6,501.00
Estimated Project Cost	$81,262.50

L/W-005: Nichols Pond Improvements (Nichols-001)

Purpose and Need: The existing pond (~0.5 acres) is currently shallow with an average depth of 4 feet to 5 feet. Heavy algae growth and vegetation also exist. The landowner would like to improve the pond, habitat, and wildlife water source by increasing the depth.

Proposed Project: Drain and excavate the existing pond to create an average depth of 6 feet to 8 feet. Steepen the slopes to minimize shallow edge areas and reduce vegetation growth. A couple locations up to 12 feet deep and a solar-powered aeration system may be desirable if also trying to promote a fishery.

Project components would include:

- Drain and excavate existing pond (~2500 cubic yards).
- Install solar-powered aeration system.

Project Location:
Township 54 North, Range 106 West, Section 3
44.6862 N, 109.6224 W

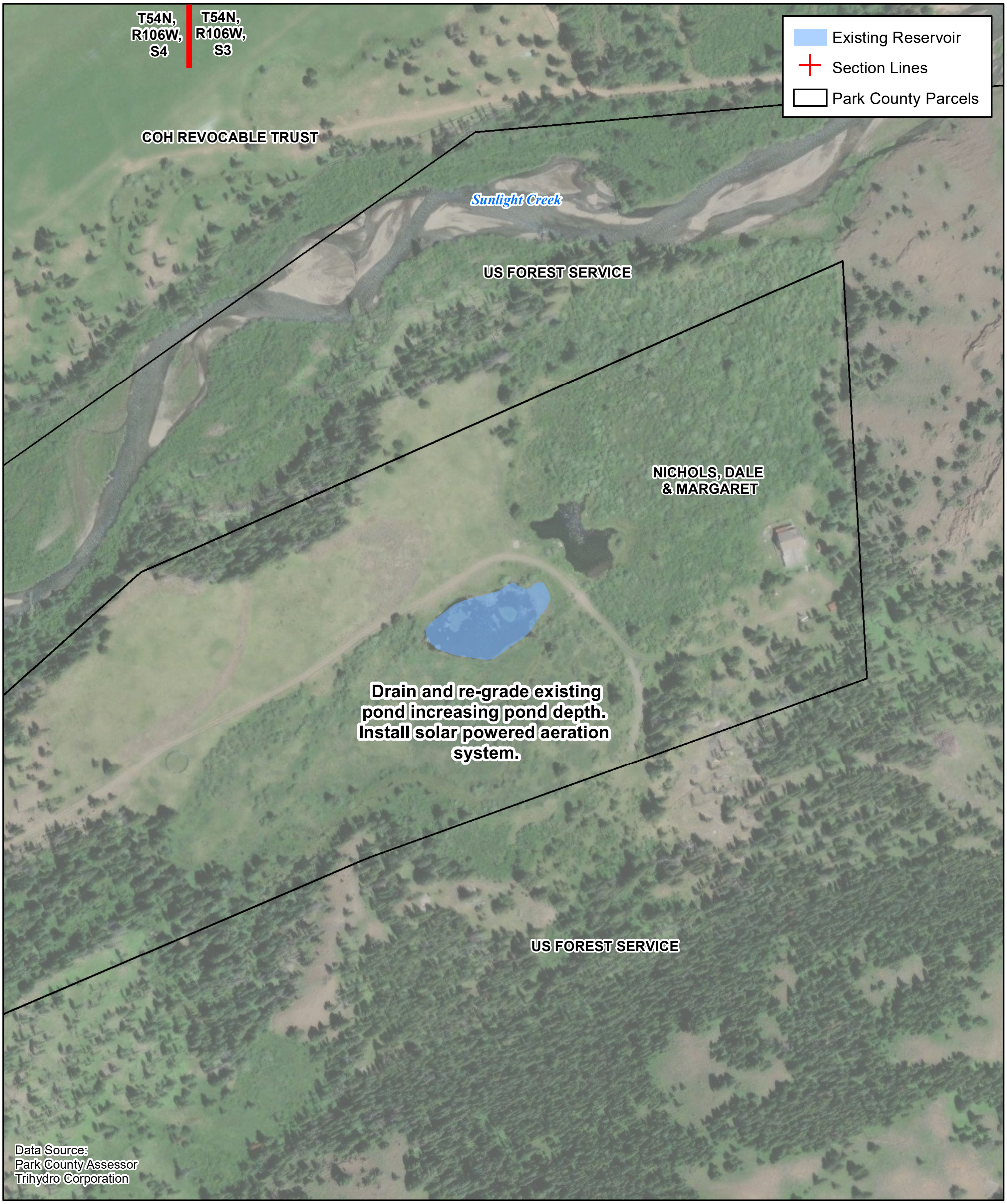
Owner/Operator: Nichols, Dale

Land Ownership (Surface): Private

Water Source: Spring

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated



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L/W-005 (Nichols-001) Nichols Pond Improvements
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/20/23	File: LW-005.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-005
Project Name: Nichols Pond Improvements
Sponsor Reference: Nichols-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$4,800.00	$4,800.00
2	Excavation	CY	2,500	$15.00	$37,500.00
3	Solar-Powered Aeration System*	EA	1	$10,500.00	$10,500.00

* Item not eligible for SWPP funding

Project Subtotal	$52,800.00
Contingencies (15% of subtotal)	$7,920.00
Engineering and Technical Assistance (10% of subtotal)	$5,280.00
Estimated Project Cost	$66,000.00

L/W-006: Whitlock Stock Tank (Whitlock-002)

Purpose and Need: The landowner has a need for an additional livestock watering facility for approximately 50 head of cattle. The new PIP pipeline (IRR-006 – Ditch to Pipe – Whitlock-001) will supply the tank.

Proposed Project: Install a 1,200-gallon rubber tire stock tank. Connect tank plumbing to the new 18-inch PIP pipeline.

Project components would include:

- Install 1,200-gallon rubber tire stock tank.
- Connect tank plumbing to 18-inch PIP pipeline.

Project Location:
Township 51 North, Range 103 West, Section 3
44.4259 N, 109.2314 W

Owner/Operator: Whitlock, George

Land Ownership (Surface): Private

Water Source: Marquette Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated

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L/W-006 (Whitlock-002) Whitlock Stock Tank
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/15/23	File: LW-006.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-006
Project Name: Whitlock Stock Tank
Sponsor Reference: Whitlock-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$402.00	$402.00
2	1,200 Gallon Rubber Tire Stock Tank	EA	1	$4,020.00	$4,020.00

Project Subtotal	$4,422.00
Contingencies (15% of subtotal)	$663.30
Engineering and Technical Assistance (10% of subtotal)	$442.20
Estimated Project Cost	$5,527.50

L/W-007: Vogt Stock Reservoir (Vogt-002)

Purpose and Need: Small intermittent drainage exhibits signs of severe erosion. Stock reservoir proposed as a means of hydrologic engineering to reduce flow velocities, provide a late season water source, and a drinking source to livestock/wildlife.

Proposed Project: Construct a stock reservoir approximately 1 acre in size through excavation and earthen dam construction. The dam will be constructed from local materials excavated at the project site. Construct an emergency overflow spillway and install an Agri-Drain water level control structure (assume 15-inch) or equivalent with a PVC outlet pipe. For quantity and cost estimate purposes, 2 feet of excavation is assumed, while an average dam height of 4 feet is assumed. The dam is assumed to have a 3:1 slope on the wet side and 2:1 slope on the dry side, with a crest width of 12 feet and a length of 200 feet.

Project components would include:

- Excavation of approximately 3,200 cubic yards.
- Construction of earthen dam using excavated material (~650 cubic yards).
- Installation of a 15-inch Agri Drain water level control structure and PVC outlet pipe.
- Construct emergency overflow spillway around dam.

Project Location:
Township 56 North, Range 103 West, Section 23
44.8125 N, 109.2289 W

Owner/Operator: Vogt, Steve

Land Ownership (Surface): Private

Water Source: Unnamed intermittent channel

Sage Grouse Core Area: Core Management Area

Potential Permitting:

1. Wyoming State Engineer’s Office
2. Wyoming Department of Environmental Quality – Small Construction General Permit
3. Wyoming Game and Fish Department – construction schedule requirements

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L/W-007 (Vogt-002) Vogt Stock Reservoir Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: LW-007.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-007
Project Name: Vogt Stock Reservoir
Sponsor Reference: Vogt-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$5,148.00	$5,148.00
2	Excavation	CY	3,200	$15.00	$48,000.00
3	Embankment (N)	CY	650	--	--
4	15" Agri Drain Water Level Control Structure	EA	1	$2,200.00	$2,200.00
5	15" Piastic Irrigation Pipe (PIP 80)	LF	40	$32.00	$1,280.00

(N) Not a separate pay item. Cost included in excavation item.

Project Subtotal	$56,628.00
Contingencies (15% of subtotal)	$8,494.20
Engineering and Technical Assistance (10% of subtotal)	$5,662.80
Estimated Project Cost	$70,785.00

L/W-008: Broussard Stock Tank (Broussard-001)

Purpose and Need: The owner would like to provide an alternate water source for livestock to graze outside riparian areas.

Proposed Project: Divert water from existing stock reservoir along the unnamed drainage and into a new stock tank. Determine a location for the stock tank to reduce livestock grazing along unnamed drainage and install HDPE pipe to connect the existing stock pond to the new stock tank.

Project components would include:

- Construct concrete headwall with 6-inch slide gate and control valve to 1.5-inch HDPE pipe.
- Install 1.5-inch HDPE pipeline from stock pond to the stock tank location.
- Install 1,200 rubber tire stock tank or equivalent.

Project Location:
Township 52 North, Range 105 West, Section 27
44.4475 N, 109.4819 W

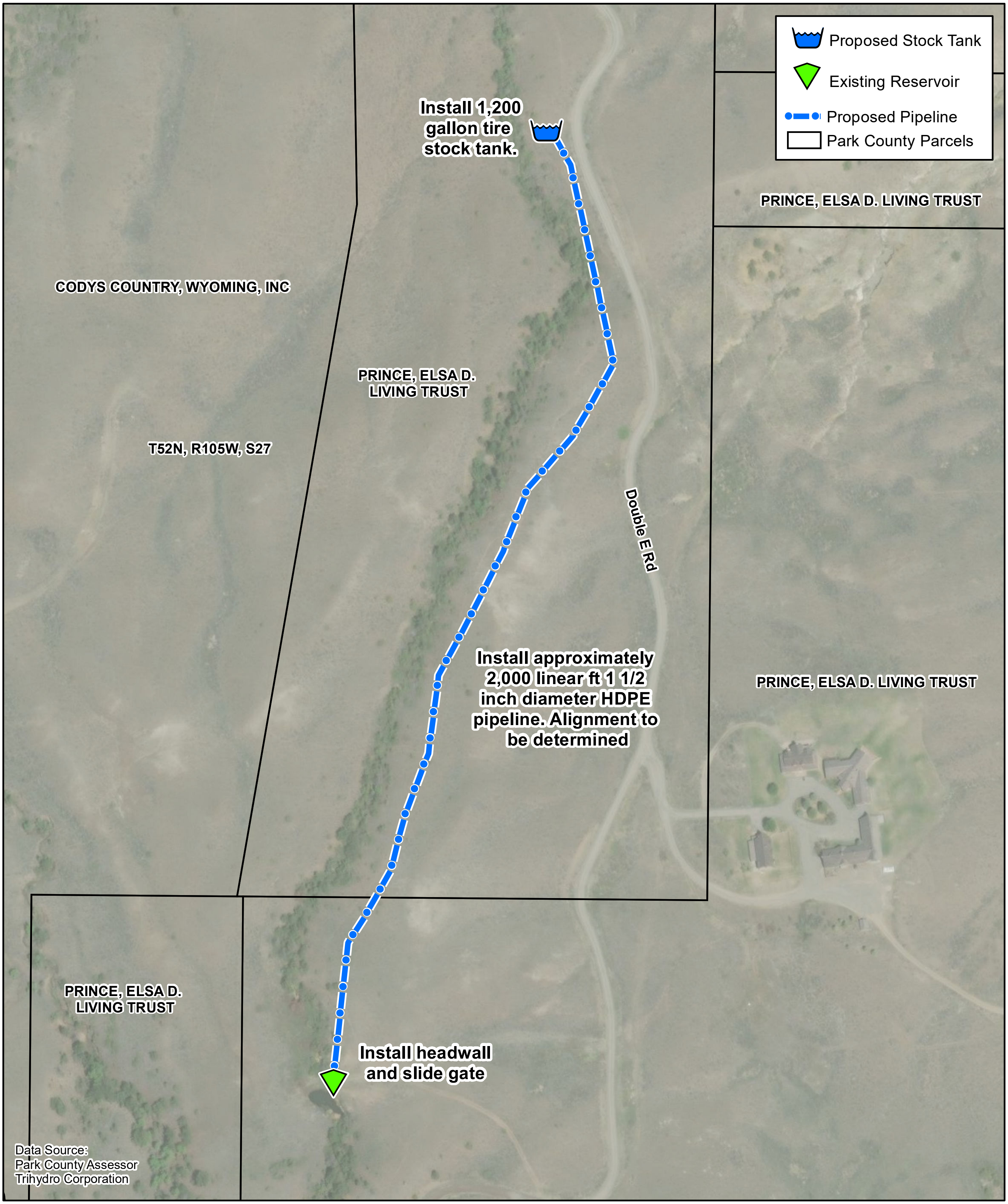
Owner/Operator: Broussard, Troy

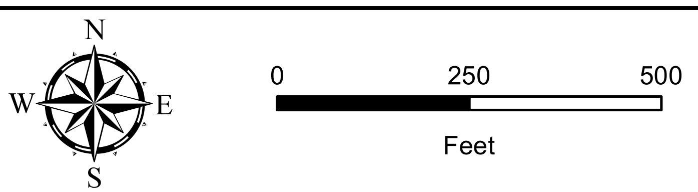
Land Ownership (Surface): Private

Water Source: unnamed tributary to Green Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting: None Anticipated





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L/W-008 (Broussard-001) Broussard Stock Tank Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/21/23	File: LW-008.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-008
Project Name: Broussard Stock Tank
Sponsor Reference: Broussard-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,936.50	$1,936.50
2	1.5" HDPE Pipe	LF	2,000	$4.00	$8,000.00
3	Irrigation Structure, Small	EA	1	$6,745.00	$6,745.00
4	6" Slide Gate	EA	1	$600.00	$600.00
5	1,200 Gal Rubber Tire Stock Tank	EA	1	$4,020.00	$4,020.00

Project Subtotal	$21,301.50
Contingencies (15% of subtotal)	$3,195.23
Engineering and Technical Assistance (10% of subtotal)	$2,130.15
Estimated Project Cost	$26,626.88

L/W-009: Arnote Reservoir #1 (Arnote-001)

Purpose and Need: Landowner has completed design and permitting through State Engineer's Office and needs funds to move forward with construction. Objective is to provide a viable source of water for wildlife and livestock.

Proposed Project: Construct earthen berm to create reservoir and install Agri Drain water level control structure or equivalent and PVC outlet pipe.

Project components would include:

- Construct earthen berm from local materials, embankment quantity and location to be determined by design engineer. Assume for cost estimate approximately 500 cubic yards of material moved via excavation and fill.
- Install 15-inch Agri Drain water level control structure and PVC outlet pipe.

Project Location:
Township 51 North, Range 103 West, Section 1
44.4181 N, 109.1814 W

Owner/Operator: Arnote, Alex

Land Ownership (Surface): Private

Water Source: Surface runoff in unnamed ephemeral stream.

Sage Grouse Core Area: Not Applicable

Potential Permitting: Already Obtained by Landowner


Proposed Stock Reservoirs
Section Lines
Park County Parcels
WHITLOCK, BRETT C. & CATHY K.
OHANA RANCH, LLC
Lakeview Ditch
L/W-010
Proposed stock reservoirs.Precise locations to be determined
L/W-009
WARD, STEVEN J. & CINDY R.
BLM
T51N, R103W, S1
T51N, R102W, S6
T51N, R103W, S12
T51N, R102W, S7
MORRIS, MATTHEW & LANDON, LAURA
Data Source:
Park County Assessor
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L/W-009 and L/W-010 (Arnote-001 & Arnote-002)
Stock Reservoir Construction Conceptual Design
Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY
Drawn By: BDT
Checked By: JDS
Scale: See Scale Bar
Date: 7/6/23
File: LW-9&10.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-009
Project Name: Arnote Res. 1
Sponsor Reference: Arnote-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,598.00	$1,598.00
2	Excavation	CY	500	$25.00	$12,500.00
3	Embankment (N)	CY	500	--	--
4	15" Agri Drain Water Level Control Structure	EA	1	$2,200.00	$2,200.00
5	15" Plastic Irrigation Pipe (PIP 80)	LF	40	$32.00	$1,280.00

(N) Not a separate pay item. Cost included in excavation item.

Project Subtotal	$17,578.00
Contingencies (15% of subtotal)	$2,636.70
Engineering and Technical Assistance (10% of subtotal)	$1,757.80
Estimated Project Cost	$21,972.50

L/W-010: Arnote Reservoir #2 (Arnote-002)

Purpose and Need: Ephemeral stream experiencing severe erosion and head cutting. Small reservoir proposed to limit streambank erosion while providing a drinking source to livestock/wildlife.

Proposed Project: Construct earthen embankment from local materials at project location. Install Agri Drain water level control structure or equivalent and PVC outlet pipe.

Project components would include:

- Construct earthen berm from local materials, embankment quantity and location to be determined by design engineer. Assume for cost estimate approximately 500 cubic yards of material moved via excavation and fill.
- Install 15-inch Agri Drain water level control structure and PVC outlet pipe.

Project Location:
Township 51 North, Range 103 West, Section 1
44.4186 N, 109.1811 W

Owner/Operator: Arnote, Alex

Land Ownership (Surface): Private

Water Source: Unnamed ephemeral channel

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office

Trihydro CORPORATION
1252 Commerce Drive
Laramie, Wyoming 82070
www.trihydro.com
(P)307/745 7474 (F)307/745 7729

L/W-009 and L/W-010 (Arnote-001 & Arnote-002)
Stock Reservoir Construction Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/6/23	File: LW-9&10.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-010
Project Name: Arnote Res. 2
Sponsor Reference: Arnote-002

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,598.00	$1,598.00
2	Excavation	CY	500	$25.00	$12,500.00
3	Embankment (N)	CY	500	--	--
4	15" Agri Drain Water Level Control Structure	EA	1	$2,200.00	$2,200.00
5	15" Plastic Irrigation Pipe (PIP 80)	LF	40	$32.00	$1,280.00

(N) Not a separate pay item. Cost included in excavation item.

Project Subtotal	$17,578.00
Contingencies (15% of subtotal)	$2,636.70
Engineering and Technical Assistance (10% of subtotal)	$1,757.80
Estimated Project Cost	$21,972.50

L/W-011: Bales Stock Tank/Pipeline Project (Bales-001)

Purpose and Need: Additional source of water would provide greater flexibility to landowner with respect to grazing management, relieve grazing pressures in portions of pasture, and provide additional source of water for wildlife.

Proposed Project: Construct an infiltration gallery to fill a sump/pump vault made of corrugated metal pipe (CMP). Inside the pump vault, there will be a solar pump used to convey water to the new storage tank. From the storage tank, water will flow by gravity to a new stock tank.

Project components would include:

- Install infiltration gallery in Marquette Creek (perennial stream).
- Install new vertical CMP wet well.
- Install new solar pump in the CMP wet well.
- Install approximately 5,100 linear feet of 1.5-inch HDPE pipeline (does not need to provide winter water supplies).
- Install 5,000-gallon storage tank.
- Install 1,200-gallon rubber tire stock tank.

Project Location:
Township 50 North, Range 103 West, Section 3
44.3358 N, 109.2242 W

Owner/Operator: Bales, Steve

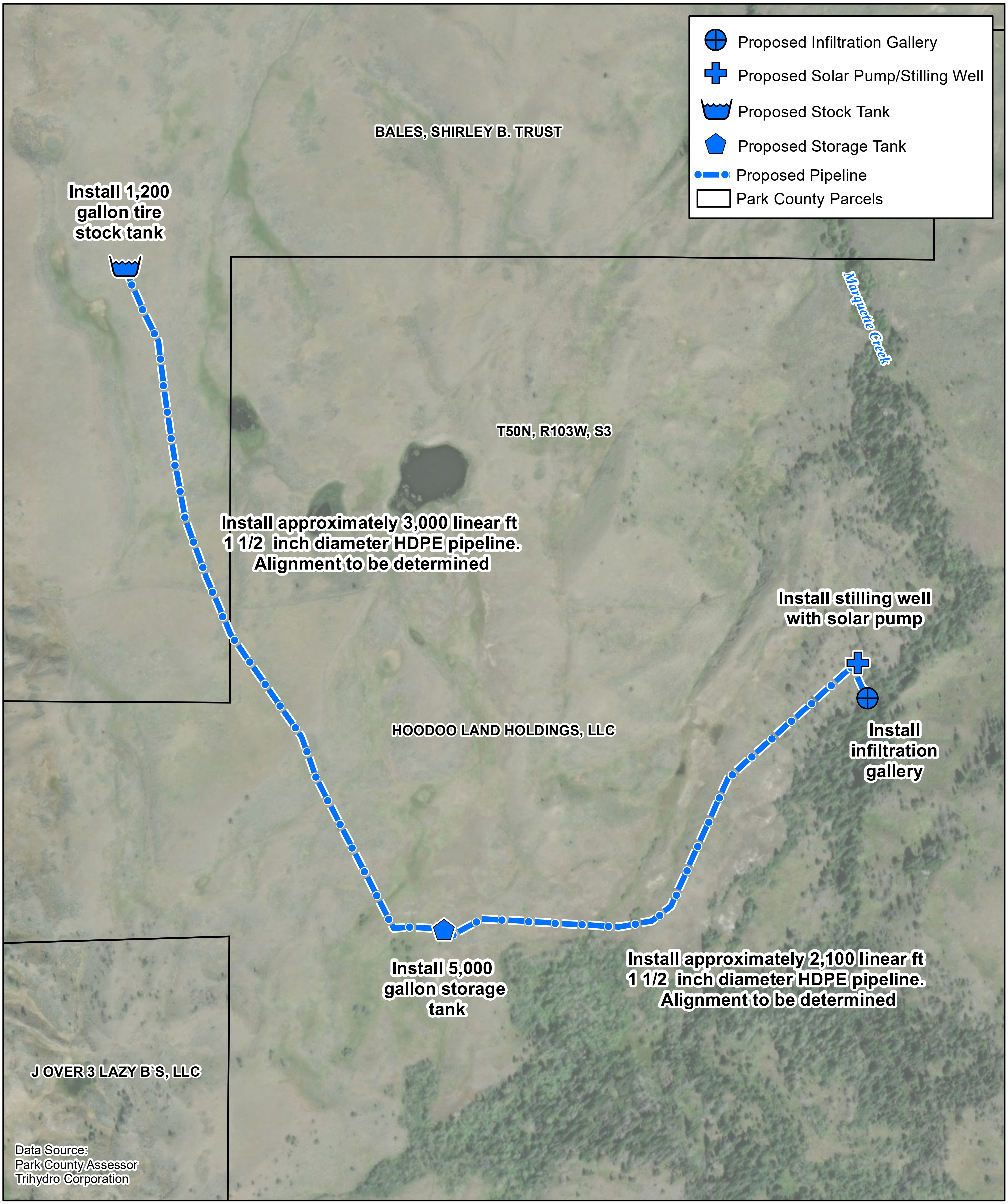
Land Ownership (Surface): Private

Water Source: Marquette Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. U.S. Army Corps of Engineers – 404 Permit



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L/W-011 (Bales-001) Bales Stock Tank/Pipeline Project
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/3/23	File: LW-011.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-011
Project Name: Bales Stock Tank/Pipeline Project
Sponsor Reference: Bales-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$4,604.70	$4,604.70
2	Irrigation Structure, Small	EA	1	$6,735.00	$6,735.00
3	24"CMP Wet Well	LF	6	$182.00	$1,092.00
4	Solar Pump System	EA	1	$8,300.00	$8,300.00
5	1.5" HDPE Pipe	LF	5,100	$4.00	$20,400.00
6	5,000 Gallon Plastic Storage Tank	EA	1	$5,500.00	$5,500.00
7	1,200 Gallon Rubber Tire Stock Tank	EA	1	$4,020.00	$4,020.00

Project Subtotal	$50,651.70
Contingencies (15% of subtotal)	$7,597.76
Engineering and Technical Assistance (10% of subtotal)	$5,065.17
Estimated Project Cost	$63,314.63

L/W-012: Well Construction (B4-001)

Purpose and Need: Construction of a new well would provide the ranch with greater opportunities for grazing rotation, provide a source of water for livestock, and provide an additional source of water for wildlife. Domestic supply would also be provided.

Proposed Project: Conduct geologic investigation and review previous studies to assess well feasibility. Drill, construct, and develop groundwater well. Install solar-powered pump.

Project components would include:

- Investigate geologic formation and review available data.
- Install/construct groundwater well, assume 100 linear feet, and install solar-powered pump.

Project Location:
Township 57 North, Range 107 West, Section 10
44.9400 N, 109.7811 W

Owner/Operator: Multiple

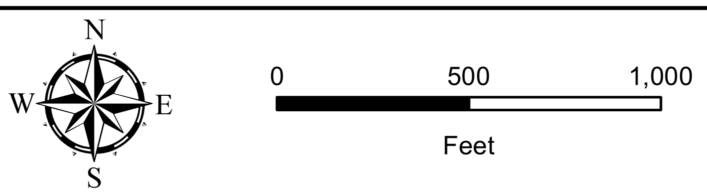
Land Ownership (Surface): Private

Water Source: Groundwater (well)

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office



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L/W-012 (B4-001) Well Construction Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 7/6/23	File: LW-012.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID:	L/W-012
Project Name:	Well Construction
Sponsor Reference:	B4-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,990.00	$1,990.00
3	Well-Drill, Case, and Develop Well	LF	100	$116.00	$11,600.00
5	Solar Pump System - Less than 250' TDH	EA	1	$8,300.00	$8,300.00

Project Subtotal	$21,890.00
Contingencies (15% of subtotal)	$3,283.50
Engineering and Technical Assistance (10% of subtotal)	$2,189.00
Estimated Project Cost	$27,362.50

L/W-013 through L/W-018: Trout Creek Ranch (TCR) Spring Developments (TCR-004 to TCR-009)

Purpose and Need: The property owner has six existing springs, which could provide additional water sources to livestock and wildlife if fully developed. Each spring developed will also increase flexibility for livestock grazing and reduce livestock/wildlife grazing along the banks of Trout Creek.

Proposed Project: Identify springs to develop on the facility that will provide the most improvement for grazing management in the surrounding area. Work with landowner to select optimal placements for stock tanks. For each spring developed, follow NRCS standards and install HDPE pipe to a rubber tire stock tank.

Project components per spring would include:

- Construct an NRCS spring development.
- Install approximately 200 linear feet of 1 ½ inch diameter HDPE pipeline.
- Install 1,200-gallon rubber tire stock tank.

Locations:

Spring	Project ID	Township, Range, Section	Latitude, Longitude
Four Bear Spring	L/W-013	T52N, R104W, S10	44.4892 N, 109.3657 W
Four Bear Spring #2	L/W-014	T52N, R104W, S8	44.4900 N, 109.3869 W
Logan Mountain Spring	L/W-015	T52N, R104W, S11	44.4989 N, 109.3311 W
Trout Creek Spring	L/W-016	T52N, R104W, S4	44.5144 N, 109.3719 W
Trout Creek Spring #2	L/W-017	T52N, R104W, S3	44.5041 N, 109.3569 W
Murray Creek Spring	L/W-018	T52N, R104W, S4	44.5142 N, 109.3719 W

Owner/Operator: Williams, Cory

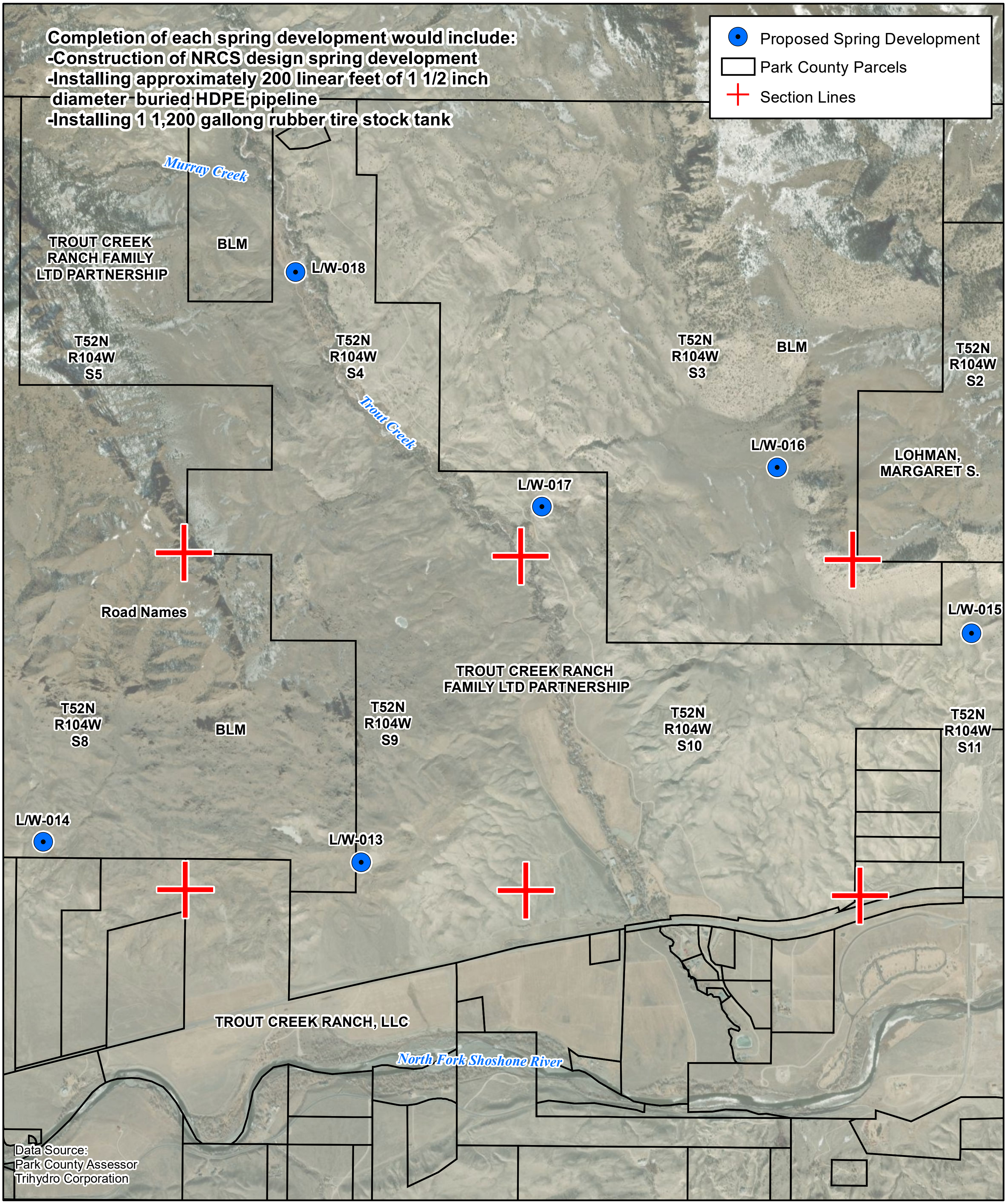
Land Ownership (Surface, varies between locations): Private, Bureau of Land Management

Water Source (varies between locations): Groundwater, Trout Creek

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office
2. Bureau of Land Management – Authorization



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L/W-013 thru L/W-018 (Trout Creek Ranch-004 thru 009)
Trout Creek Ranch Spring Developments
Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/13/23	File: troutcreek.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-013 through L/W-018
Project Name: Trout Creek Ranch Spring Developments
Sponsor Reference: Trout Creek Ranch-004 through Trout Creek Ranch-009

PROJECT COSTS (COST PER EACH SPRING DEVELOPMENT)

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,074.20	$1,074.20
2	Spring Development	EA	1	$5,922.00	$5,922.00
3	1.5" HDPE Pipe	LF	200	$4.00	$800.00
4	1,200 Gal Rubber Tire Stock Tank	EA	1	$4,020.00	$4,020.00

Project Subtotal	$11,816.20
Contingencies (15% of subtotal)	$1,772.43
Engineering and Technical Assistance (10% of subtotal)	$1,181.62
Estimated Project Cost	$14,770.25

L/W-019: Friends of a Legacy (FOAL) Project Generic (FOAL-001)

Purpose and Need: Generic rehabilitation efforts needed around existing stock reservoirs inside the McCollough Peaks Horse Management Unit. This volunteer group attempts to rehabilitate existing stock reservoirs which have filled with sediment and are no longer viable.

Proposed Project: Assess existing stock reservoirs for sediment accumulation and damage to embankment. Implement appropriate rehabilitation measures as needed, i.e., sediment removal, install outlet control structures.

Project components would include:

- Stock pond observation/evaluation.
- Construct a new earthen embankment with native soils or excavate accumulated sediment. Assume approximately 500 CY.
- Install Agri Drain stock reservoir outlet and PVC outlet pipe (optional).

Project Location: Unspecified

Owner/Operator: Friends of a Legacy (FOAL)

Land Ownership (Surface): Bureau of Land Management

Water Source: Surface water

Grazing Allotment: To be determined after location selected

Sage Grouse Core Area: To be determined after location selected

Potential Permitting:

1. Wyoming State Engineer's Office
2. Wyoming Department of Environmental Quality – Small Construction General Permit
3. Bureau of Land Management – Authorization

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-019
Project Name: FOAL Project Generic
Sponsor Reference: FOAL-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,598.00	$1,598.00
2	Excavation	CY	500	$25.00	$12,500.00
3	Embankment (N)	CY	500	--	--
4	15" Agri Drain Water Level Control Structure	EA	1	$2,200.00	$2,200.00
5	15" Plastic Irrigation Pipe (PIP 80)	LF	40	$32.00	$1,280.00

(N) Not a separate pay item. Cost included in excavation item.

Project Subtotal	$17,578.00
Contingencies (15% of subtotal)	$2,636.70
Engineering and Technical Assistance (10% of subtotal)	$1,757.80
Estimated Project Cost	$21,972.50

L/W-020: Roberts Drainage System and Pond (Roberts-001)

Purpose and Need: Landowner is losing use of productive land due to uncontrolled seepage from the Cody Canal. Water from the canal needs redirecting to keep use of productive land.

Proposed Project: Construct an underdrain to drain the area and route water into a manmade pond. Investigate water losses and/or seepage related to new pond and pipes on neighboring parcel. Engineer's estimates for quantities are provided in the attached cost estimate.

Project components would include:

- Construct an underdrain (French drain) comprised of perforated pipe located at the bottom of a trench filled with permeable material (rock) wrapped in filter fabric. The depth of trench is to be determined.
- Install solid HDPE pipe connecting the underdrain to a manmade pond. The pipe dimensions and alignment are to be determined. For cost estimate purposes, 6-inch pipe is assumed.
- Excavate new pond and install Agri Drain water level control structure and PVC outlet pipe. Pond capacity to be determined. For cost estimate purposes, assume 2 acre-feet of storage capacity.

Project Location:
Township 52 North, Range 101 West, Section 8
44.5025 N, 109.0242 W

Owner/Operator: Roberts, Shauna

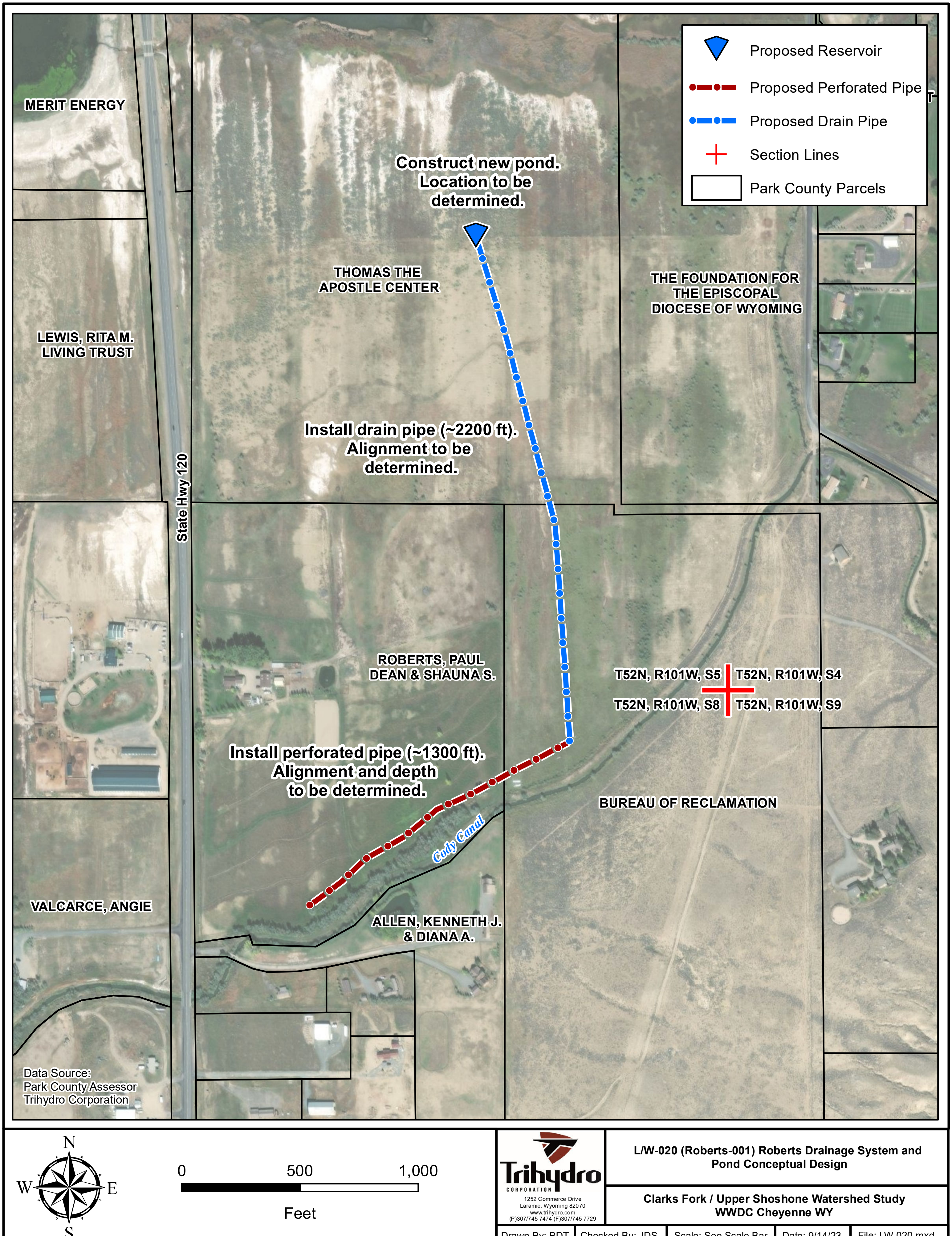
Land Ownership (Surface): Private

Water Source: Cody Canal

Sage Grouse Core Area: Not Applicable

Potential Permitting:

1. Wyoming State Engineer's Office



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Laramie, Wyoming 82070
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L/W-020 (Roberts-001) Roberts Drainage System and Pond Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/14/23	File: LW-020.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-020
Project Name: Roberts Drainage System and Pond
Sponsor Reference: Roberts-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$19,018.00	$19,018.00
2	Excavation	CY	3,300	$15.00	$49,500.00
3	Permeable Material	CY	200	$100.00	$20,000.00
4	6" Perforated HDPE Pipe	LF	1,300	$24.00	$31,200.00
5	6" HDPE Pipe	LF	2,200	$35.00	$77,000.00
6	Geotextile, Drainage and Filtration	SY	1,800	$5.00	$9,000.00
7	15" Agri Drain Water Level Control Structure	EA	1	$2,200.00	$2,200.00
8	15" Plastic Irrigation Pipe (PIP 80)	LF	40	$32.00	$1,280.00

Project Subtotal	$209,198.00
Contingencies (15% of subtotal)	$31,379.70
Engineering and Technical Assistance (10% of subtotal)	$20,919.80
Estimated Project Cost	$261,497.50

L/W-021: Tippecanoe Reservoir Rehabilitation (Corbett-001)

Purpose and Need: The existing reservoir low-level outlet structure (inlet box) and sluice gate are in poor condition and no longer capable of closing and seating properly. Water is being lost continuously. Replacement is required to restore proper function and promote water conservation.

Proposed Project: Replace the reinforced concrete low-level outlet structure (inlet box), sluice gate, gate stem, and operator wheel. The owner received an estimate in November 2022 from a local contractor to complete this work. It is recommended to perform a video inspection of the existing 12-inch corrugated metal pipe (CMP) (outlet pipe) prior to performing this work, as outlet pipe deterioration may also be a concern.

Project components would include:

- Remove existing concrete low-level outlet structure (inlet box), sluice gate, gate stem, and operator wheel.
- Construct new reinforced concrete low-level outlet structure (inlet box) and install a new sluice gate with gate stem and operator wheel.
- Perform a video inspection of the existing 12-inch CMP outlet pipe (optional).

Project Location:
Township 56 North, Range 103 West, Section 24
44.8181 N, 109.2189 W

Owner/Operator: Corbett, Harriet

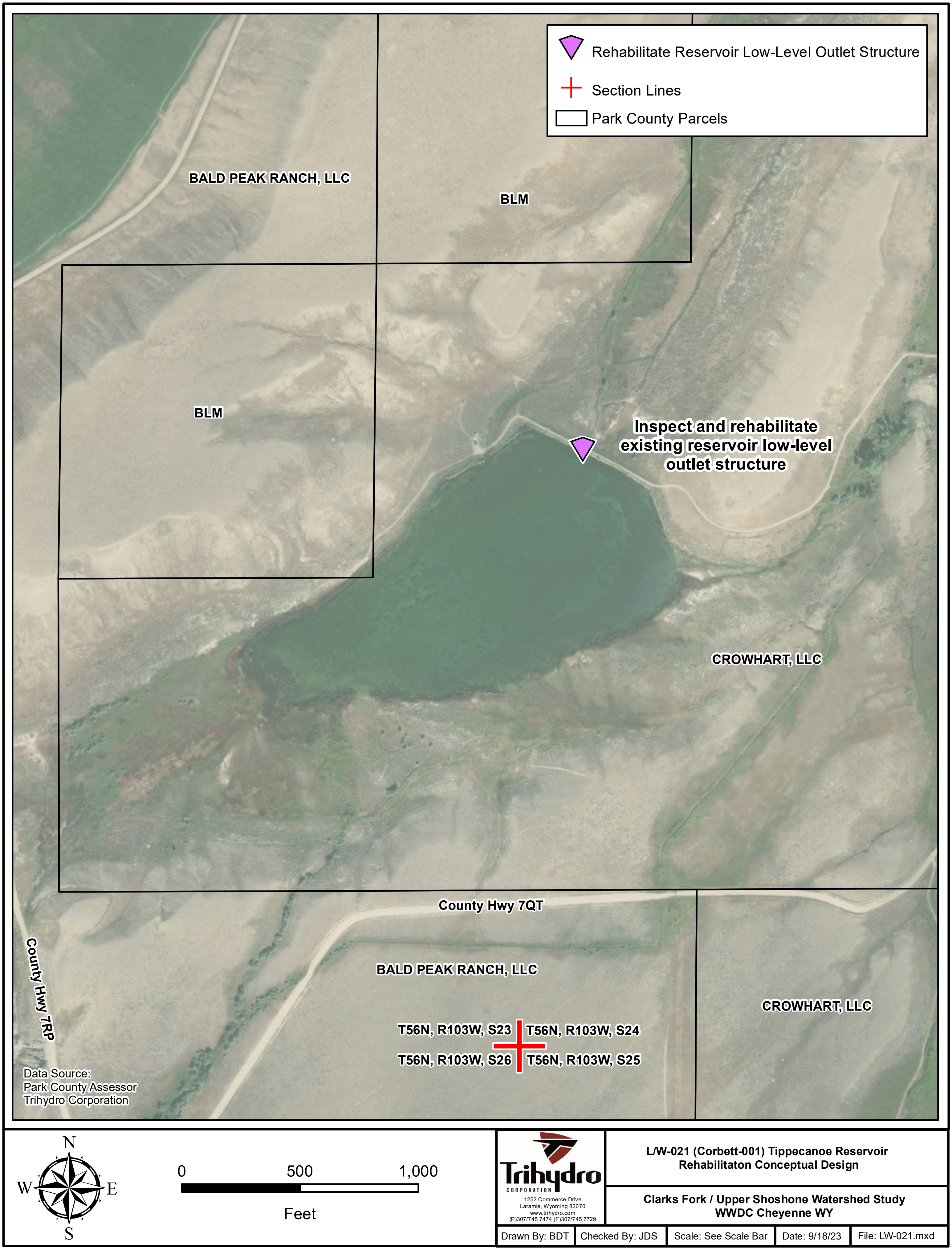
Land Ownership (Surface): Private

Water Source: Tippecanoe Reservoir

Sage Grouse Core Area: Core Management Area

Potential Permitting:

1. Wyoming State Engineer's Office



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L/W-021 (Corbett-001) Tippecanoe Reservoir
Rehabilitaton Conceptual Design

Clarks Fork / Upper Shoshone Watershed Study
WWDC Cheyenne WY

Drawn By: BDT	Checked By: JDS	Scale: See Scale Bar	Date: 9/18/23	File: LW-021.mxd

Clarks Fork/Upper Shoshone Watershed Study
Watershed Improvement Project
Engineer's Preliminary Estimate of Project Costs

Project ID: L/W-021
Project Name: Tippecanoe Reservoir Rehabilitation
Sponsor Reference: Corbett-001

PROJECT COSTS

Item #	Description	Unit	Quantity	Unit Cost	Total Cost
1	Mobilization	LS	LS	$1,680.00	$1,680.00
2	Remove Existing Stucture, Gate, and Stem	LS	LS	$5,000.00	$5,000.00
3	Miscellaneous Structure, Small	EA	1	$7,000.00	$7,000.00
4	12" Slide Gate	EA	1	$1,800.00	$1,800.00
5	Gate Stem and Wheel	EA	1	$3,000.00	$3,000.00

Project Subtotal	$18,480.00
Contingencies (15% of subtotal)	$2,772.00
Engineering and Technical Assistance (10% of subtotal)	$1,848.00
Estimated Project Cost	$23,100.00

Notes:
1. The estimate above is conceptual and based on limited information.
2. The owner received a quote in November 2022 from a local contractor for $46,946.00, which may be more accurate.