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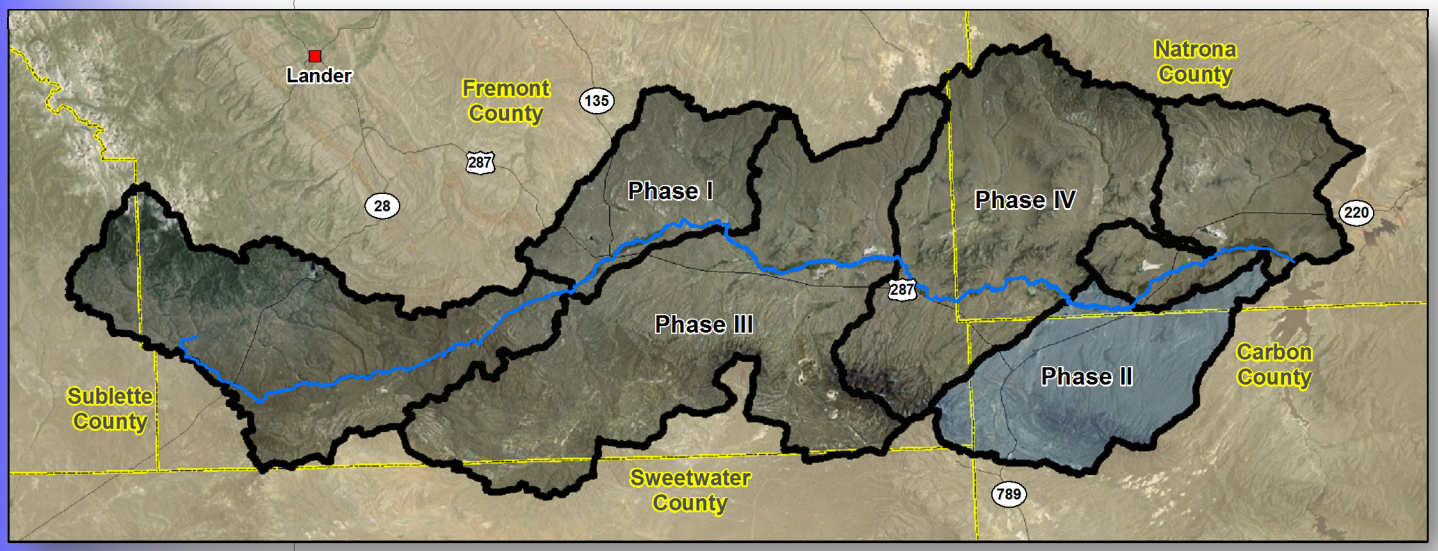
FINAL REPORT
FOR THE
SWEETWATER RIVER WATERSHED STUDY PHASE II
MUDDY CREEK AND HORSE CREEK
WATERSHED MANAGEMENT PLAN

Prepared For:

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, WY 82002



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(ACE Project No. WYWDC26)

ANDERSON CONSULTING ENGINEERS, INC.
Civil • Water Resources • Environmental

April 20, 2012

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I. INTRODUCTION AND OVERVIEW

I. INTRODUCTION AND OVERVIEW

In 2005 the Popo Agie Conservation District (PACD) requested funding from the Wyoming Water Development Commission (WWDC) for the completion of a watershed management plan for the Sweetwater River watershed. The intent was to have a comprehensive watershed inventory completed which identified issues related to land use and water resources and to then develop a plan addressing those issues. The WWDC approved funding for the project and Anderson Consulting Engineers, Inc. (ACE) was ultimately contracted in June, 2006 to complete the project.

Briefly, the overall objective of the watershed study is to generate a watershed management and irrigation rehabilitation plan for the Sweetwater River watershed that is not only technically sound, but also one that is practical and economically feasible.

Due to the vast extent of the Sweetwater watershed and the range of conditions found within it, as well as varying level of interest and willingness to participate among stakeholders, it was determined that ACE would focus upon the development of watershed management plans at the subwatershed level. This strategy was selected to promote stakeholder participation and the development of plans more detailed and practical than would be afforded at the larger scale.

Following a series of initial public meetings, landowners and stakeholders within the Long Creek basin expressed high levels of interest and participation. For these reasons, and at the direction of the Steering Committee, the Popo Agie Conservation District (PACD) and the Wyoming Water Development Office (WWDO), Long Creek watershed was selected for the first phase of this effort.

Four phases of the project were ultimately completed which focused a subwatershed approach that ranged in areal extent from one to three of the 10^{th} order Hydrologic Units defined by the United States Geologic Survey (USGS). (The hydrologic units delineated by the USGS are designated a hydrologic unit code, or HUC as discussed at the following website: http://water.usgs.gov/GIS/huc.html).

Upon completion of the four phases addressing subwatersheds within the Sweetwater River basin, a fifth phase entitled "Sweetwater River Watershed Study: Basinwide Summary" was completed which summarizes the results of the individual phases as well as providing a description of the entire Sweetwater River Watershed. Table 1.1 summarizes the various phases of the project and Figure 1.1 displays their locations. Each of the five phases have been published as separate and stand-alone documents.

This report presents the results of the Phase II investigation.

Table 1.1 Sweetwater River Watershed Investigation, Level I: Project Phases.

Phase	Hydrologic Unit Code	HUC Order	Watershed Name
Phase I:	HUC 1018000604	10th Order	Long Creek
Phase II:	**HUC 1018000609**	**10th Order**	**Muddy Creek**
	HUC 1018000611	**10th Order**	**Horse Creek (Arkansas Creek subbasin only)**
Phase III:	HUC 1018000603	10th Order	Alkali Creek
	HUC 1018000606	10th Order	Crooks Creek
	HUC 1018000605	10th Order	Buffalo Creek
Phase IV:	HUC 1018000607	10th Order	Sage Hen Creek
	HUC 1018000610	10th Order	Dry Creek
	HUC 1018000608	10th Order	Willow Creek
Basinwide	HUC 10180006	8th Order	Sweetwater River Watershed

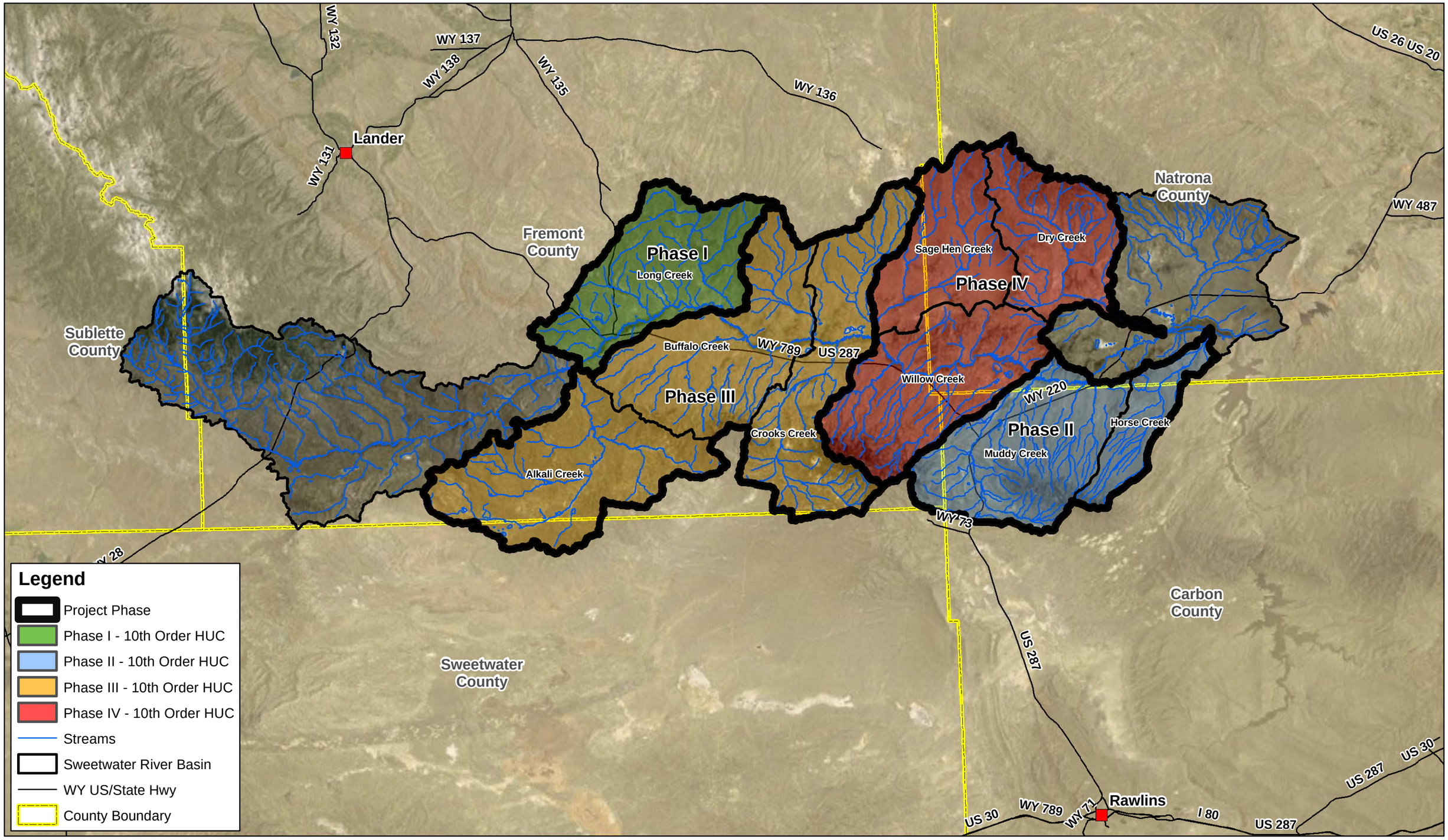


Figure 1.1 Sweetwater River Phase II: Location Map

II. WATERSHED DESCRIPTION AND INVENTORY

II. WATERSHED DESCRIPTION AND INVENTORY

2.1 Land Use and Management

The total land area within the Phase II study area is 216,150 acres (339.3 square miles). The distribution of land ownership within the watershed is shown on Figure 2.1. The bulk of the study area is federally owned; the BLM manages 79.0 percent of the area (170,758 acres). Of the remaining portion of the study area, 12.6 percent (27,234 acres) are privately owned, the State of Wyoming owns 8.2 percent (17,724 acres) and the United States Fish and Wildlife Service manages 0.2 percent (4,323 acres). As is evident in Figure 2.2, the privately owned lands are located primarily along the riparian corridors.

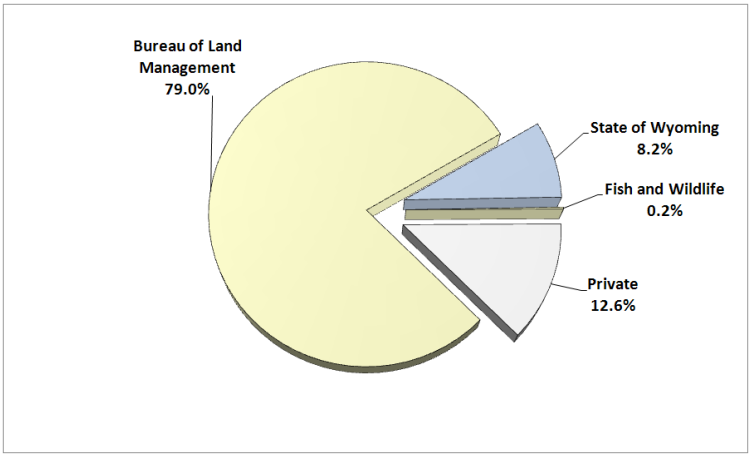


Figure 2.1 Distribution of Surface Ownership Within the Phase II Study Area.

The watershed spans the administrative boundaries of three BLM Field Offices as indicated in Figure 2.2. They include the Rawlins, Casper, and Lander Field Offices. The allotment boundaries do not typically coincide with the watershed boundaries, consequently allotments tend to span multiple watersheds. Allotment Management Plans (AMPs) have been prepared for several of the allotments in the study area. AMPs include, in addition to grazing management prescriptions, brief summaries of various allotment features and resources such as soils, geology, wildlife, etc. This information has been extracted, incorporated and referenced herein where pertinent.

2.2 Vegetation

2.2.1 Overview

Vegetative cover within the watershed was evaluated using data obtained through the LANDFIRE project (www.landfire.gov). LANDFIRE (Landscape Fire and Resource Management

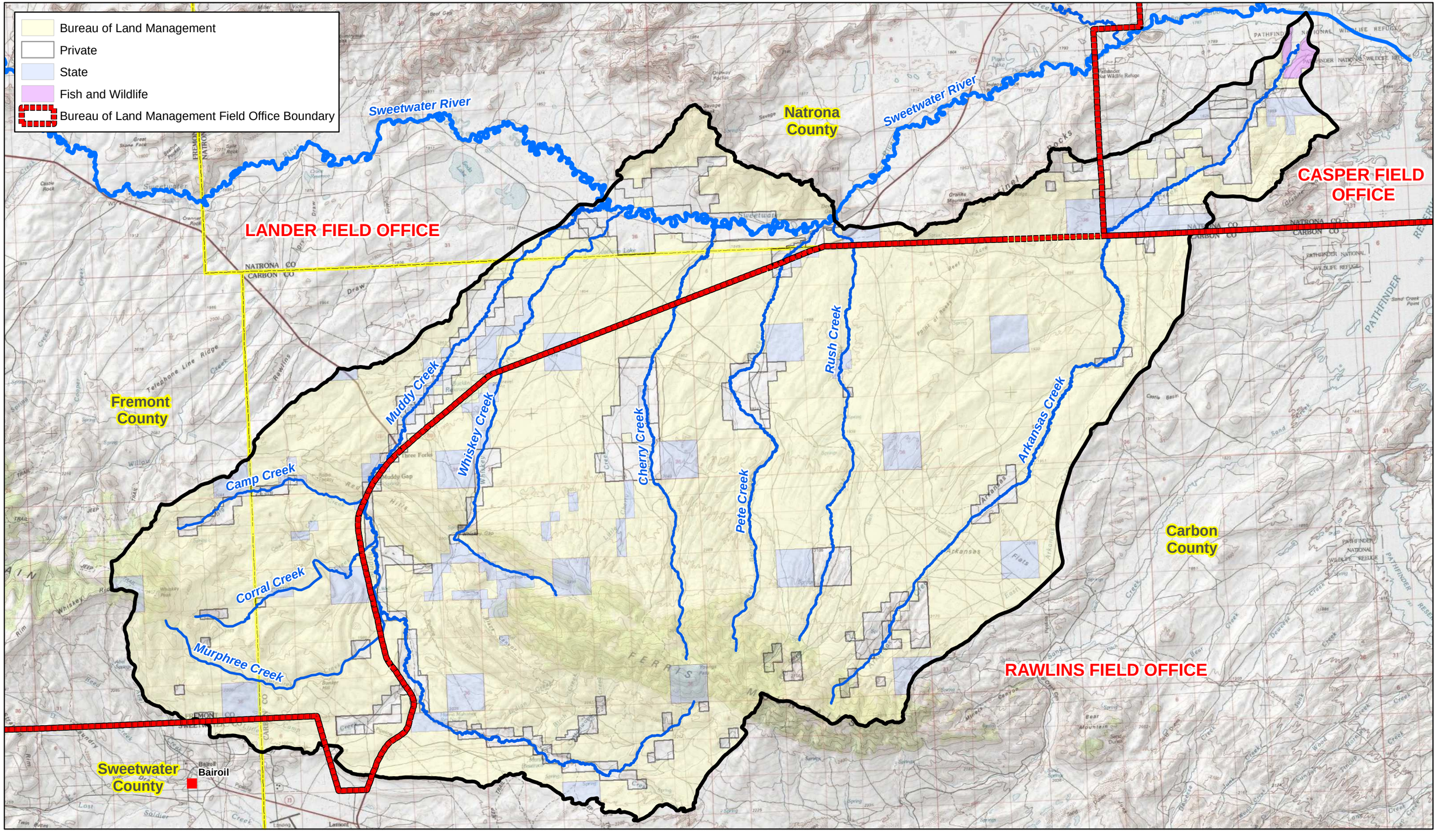


Figure 2.2 Sweetwater River Phase II: Land Ownership and Management

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 United States Forest Service (USFS) wildland fire management programs. The primary purpose of the LANDFIRE project is to collect the data necessary to develop wildland fire models. The data are generated using remote sensing techniques with on-the-ground truthing. Data products accessed for this project included 30-meter spatial resolution raster data sets describing vegetation type and cover. LANDFIRE vegetation map units are derived from NatureServe's Ecological Systems classification (Comer and others, 2003).

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

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

The LANDFIRE "existing vegetation type" (EVT) data were analyzed and summarized in Table 2.1. The LANDFIRE existing vegetation data indicate 42 different vegetation classes within the watershed. As is clearly indicated in this table, the three major sagebrush communities (Inter-Mountain Basins Big Sagebrush Shrubland, Inter-Mountain Basins Montane Sagebrush Steppe, and Artemisia tridentata ssp. vaseyana Shrubland Alliance) dominate coverage of the study area with a total of over 71% of the watershed acreage. While the fact that the majority of the study area is covered in sagebrush types comes as no surprise, the table presents valuable information pertaining to the vegetation types present to a much lesser extent. For instance, the LANDFIRE data indicates that 2.3 percent (4,991 acres) exist as some form of riparian vegetation (Rocky Mountain Subalpine/Upper Montane Riparian Systems, Rocky Mountain Montane Riparian Systems, plus Western Great Plains Depressional Wetland Systems).

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. For graphical purposes, data obtained through the Wyoming Gap Analysis program are shown on Figure 2.3. (http://www.wygisc.uwyo.edu/wbn/gap.html).

The 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 analyses, meaning that not every occurrence of habitat is mapped; only large, generalized distributions are mapped, based on the USGS 1:100,000

Table 2.1 Phase II Study Area: Tabulation of LANDFIRE Vegetation Type Data.

Rank	Existing Vegetation Type	Acres	Percent of Area	Cumulative Percent
1	Inter-Mountain Basins Big Sagebrush Shrubland	108,872	50.32%	50.32%
2	Inter-Mountain Basins Big Sagebrush Steppe	35,693	16.50%	66.81%
3	Artemisia tridentata ssp. vaseyana Shrubland Alliance	10,113	4.67%	71.49%
4	Rocky Mountain Lower Montane-Foothill Shrubland	9,752	4.51%	75.99%
5	Western Great Plains Floodplain Systems	8,250	3.81%	79.80%
6	Inter-Mountain Basins Montane Sagebrush Steppe	4,457	2.06%	81.86%
7	Wyoming Basins Low Sagebrush Shrubland	4,274	1.98%	83.84%
8	Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	3,745	1.73%	85.57%
9	Rocky Mountain Poor-Site Lodgepole Pine Forest	3,630	1.68%	87.25%
10	Rocky Mountain Foothill Limber Pine-Juniper Woodland	3,506	1.62%	88.87%
11	Rocky Mountain Subalpine/Upper Montane Riparian Systems	3,220	1.49%	90.36%
12	Inter-Mountain Basins Semi-Desert Grassland	3,084	1.43%	91.78%
13	Inter-Mountain Basins Mountain Mahogany Woodland and Shrubland	2,363	1.09%	92.87%
14	Inter-Mountain Basins Semi-Desert Shrub-Steppe	2,151	0.99%	93.87%
15	Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	1,484	0.69%	94.55%
16	Rocky Mountain Montane Riparian Systems	1,261	0.58%	95.14%
17	Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	1,200	0.55%	95.69%
18	Agriculture-Pasture/Hay	1,162	0.54%	96.23%
19	Developed-Open Space	1,149	0.53%	96.76%
20	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland	1,124	0.52%	97.28%
21	Inter-Mountain Basins Mat Saltbush Shrubland	898	0.42%	97.69%
22	Rocky Mountain Aspen Forest and Woodland	800	0.37%	98.06%
23	Middle Rocky Mountain Montane Douglas-fir Forest and Woodland	630	0.29%	98.35%
24	Northern Rocky Mountain Subalpine Woodland and Parkland	600	0.28%	98.63%
25	Inter-Mountain Basins Greasewood Flat	596	0.28%	98.91%
26	Introduced Upland Vegetation - Annual and Biennial Forbland	481	0.22%	99.13%
27	Inter-Mountain Basins Mixed Salt Desert Scrub	465	0.21%	99.34%
28	Southern Rocky Mountain Ponderosa Pine Woodland	263	0.12%	99.47%
29	Western Great Plains Depressional Wetland Systems	224	0.10%	99.57%
30	Open Water	155	0.07%	99.64%
31	Introduced Upland Vegetation - Annual Grassland	135	0.06%	99.70%
32	Inter-Mountain Basins Juniper Savanna	121	0.06%	99.76%
33	Rocky Mountain Subalpine-Montane Mesic Meadow	91	0.04%	99.80%
34	Developed-Low Intensity	86	0.04%	99.84%
35	Rocky Mountain Lodgepole Pine Forest	78	0.04%	99.88%
36	Barren	64	0.03%	99.91%
37	Southern Rocky Mountain Montane-Subalpine Grassland	63	0.03%	99.94%
38	Inter-Mountain Basins Sparsely Vegetated Systems	36	0.02%	99.95%
39	Colorado Plateau Pinyon-Juniper Woodland	35	0.02%	99.97%
40	Northern Rocky Mountain Subalpine-Upper Montane Grassland	25	0.01%	99.98%
41	Northwestern Great Plains Mixedgrass Prairie	24	0.01%	99.99%
42	Rocky Mountain Gambel Oak-Mixed Montane Shrubland	16	0.01%	100.00%

1 - Active sand dunes
2 - Basin exposed rock/soil
3 - Black sagebrush steppe
4 - Greasewood fans and flats
5 - Irrigated crops
6 - Lodgepole pine
7 - Mountain big sagebrush
8 - Saltbush fans and flats
9 - Vegetated dunes
10 - Wyoming big sagebrush

Sweetwater River
Natrona County
Fremont County
Carbon County
Sweetwater County
Bairoil
Muddy Creek
Whiskey Creek
Cherry Creek
Pete Creek
Rush Creek
Arkansas Creek
Camp Creek
Corral Creek
Murphree Creek
Telephone Line Ridge
Rawlins
Lamont
Three Forks
Muddy Gap
Point of Rocks
Granite Mountains
Bear Mountain
Sand Creek Point
PATHFINDER NATIONAL WILDLIFE REFUGE
NATRONA CO
CARBON CO
FREMONT CO
SWEETWATER CO

N
W E
S

Legend

Sweetwater River
Streams - Phase II Study Area
Phase II Study Area
Cities
County Boundary

0 12,500 25,000
Feet

Figure 2.3 Sweetwater River Phase II: Vegetative Cover 100K

mapping scale in both detail and precision. Therefore, this dataset can be used appropriately for coarse-scale (> 1:100,000) applications, or to provide context for finer-level maps or applications" (University of Wyoming, Spatial Data Visualization Center, 1996).

Review of this figure clearly indicates that with the exception of the higher elevations of Ferris Mountain, vegetation within the study area is dominated by the various sagebrush plant communities: big sagebrush, black sagebrush and black sagebrush. Coniferous forest (lodgepole) is found above elevations of approximately 7,500 feet and is consequently limited to the higher reaches of Ferris Mountain and Whiskey Peak.

The Wyoming Natural Diversity Database (WYNDD) lists several vegetation species within the Phase I study area which are apparent within the Phase II study area. Table 2.2 presents the results of a database query conducted by the WYNDD for the watershed.

Table 2.2 Wyoming Natural Diversity Database:
Vegetative Species in the Sweetwater River Watershed Phase II Study Area.

Scientific Name	Common Name	Listing Status	Tracked/ Watched
Plants			
Antennaria arcuata	Meadow pussytoes		Tracked
Cirsium pulcherrimum var. aridum	Cedar Rim thistle		Tracked
Yermo xanthocephalus	Desert yellowhead	Threatened	Tracked
Pyrrocoma clementis var. villosa	Hairy tranquil goldenweed		Tracked
Cryptantha stricta	Erect cryptantha		Watched
Boechera pendulina var. russeola	Daggett rockcress		Watched
Physaria eburniflora	Devil's Gate twinpod		Watched
Downingia laeta	Great basin downingia		Tracked
Oxytropis nana	Wyoming locoweed		Watched
Phlox pungens	Beaver Rim phlox		Tracked
Achnatherum nevadense	Nevada needlegrass		Tracked
Potamogeton illinoensis	Illinois pondweed		Tracked

2.2.2 Wetlands – Riparian Vegetation

Existing mapping of wetlands within the Phase II Study Area available for this study consisted of the National Wetlands Inventory (NWI) created by the US Fish and Wildlife Service (USFWS). The NWI mapping was completed using aerial photographs within the GIS environment and digitizing by analysts, however due to the relatively limited extent of mapped wetlands in relation to the size of the watershed, the data does not lend itself to presentation at this scale. Based upon the NWI mapping, approximately 2,363 acres (including 226 acres classified as open water) of wetlands exist within the watershed. It is generally understood by users of the NWI mapping that the data are suitable for broadscale 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.

In addition to the NWI mapping, the LANDFIRE data includes limited determination of wetlands as well. Based upon the LANDFIRE data analysis, there are approximately 224 acres of Western Great Plains Depressional Wetlands with the watershed. Other types of wetlands are not included in the LANDFIRE data, however, two riparian vegetation categories are found within the watershed: Rocky Mountain Subalpine/Upper Montane Riparian Systems (3,220 acres) and Rocky Mountain Montane Riparian Systems (1,261 acres as stated previously) 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. Figure 2.4 displays the available wetlands mapping data. Note that due to the limited extent of wetland mapping units, presentation of a background topographic map as is present in other figures, is not feasible.

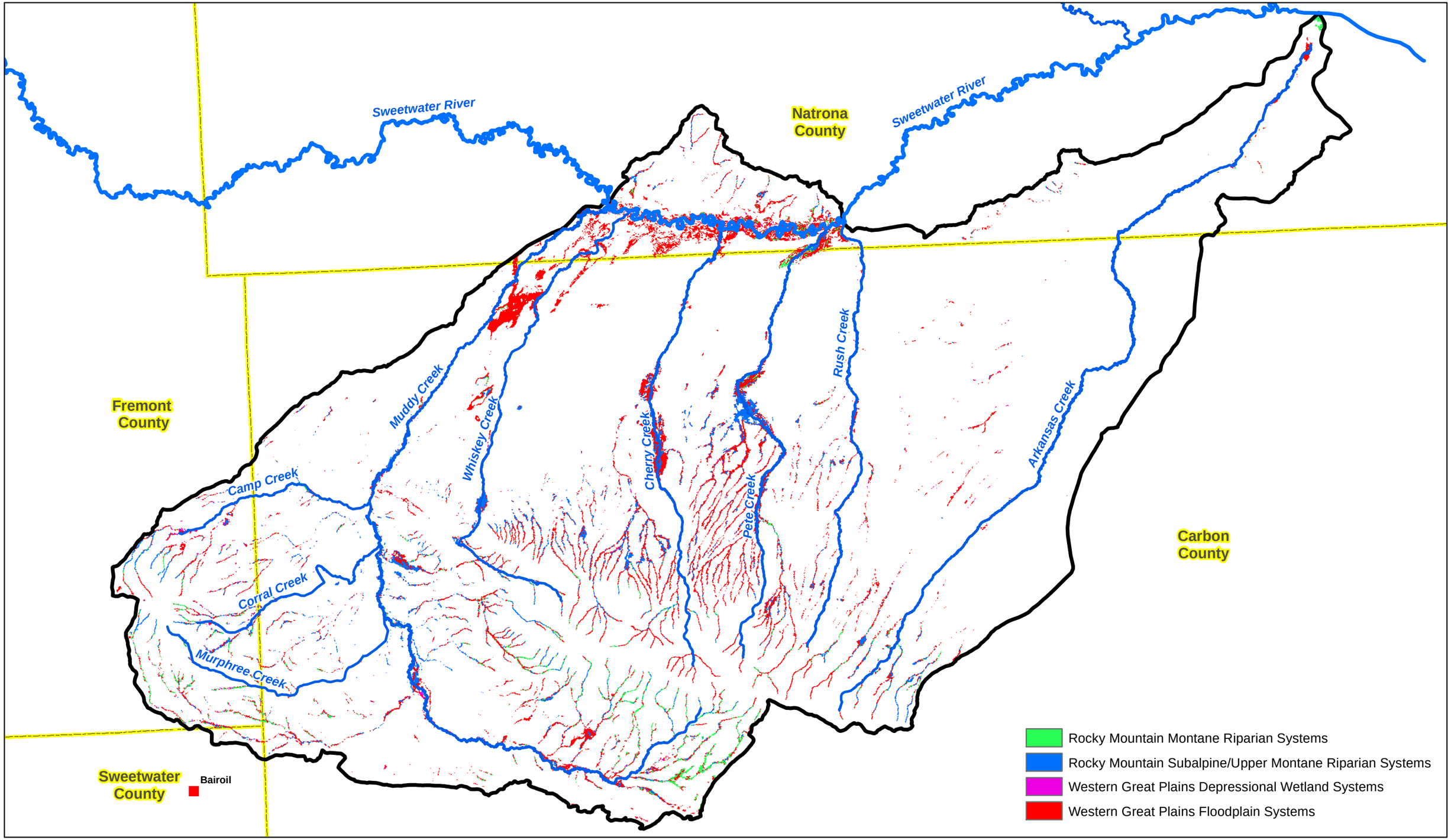
2.2.3 Vegetation Issues

According to field reconnaissance, the BLM and local landowners, tamarisk and Russian Olive are not heavily established within the study area. However, other invasive species (e.g., spotted knapweed, Russian knapweed, etc.) threaten to become established although according to the BLM (BLM, 2003), these areas are not currently extensive.

Fire suppression has resulted in undesirable vegetative conditions in the study area. Also according to the BLM (BLM, 2003), the "forested systems on the Ferris Mountains are in poor health in some areas and have high fuel loading since there have not been any major fires on the Ferris Mountains since the 1940's".

2.3 Wildlife

Much of the watershed has been mapped by the Wyoming Game and Fish Department (WGFD) as crucial habitat for big game species. Specifically, the entire study area has been identified as seasonal habitat for mule deer, and antelope, and extensive portions of the area are seasonal habitat for elk and moose. In addition, crucial habitat has been mapped for antelope (52,650 acres), elk (29,256 acres), and mule deer (20,165 acres). The WGFD maps the seasonal ranges by herd unit for each big game species and makes special note of areas listed



N
W E
S

Legend

- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.4 Sweetwater River Phase II: Landfire Riparian areas

as crucial habitat and parturition (birthing areas). Crucial habitat or range is defined as those seasonal ranges or habitats (mostly winter range) that have been documented as the determining factor in a population's ability to maintain itself at a certain level over a long period of time. Figures 2.5 through 2.8 display the seasonal range, crucial range, parturition range, and migration corridors for big game species in the study area: antelope, elk, moose, and mule deer.

The Wyoming Natural Diversity Database (WYNDD) lists numerous non-game species of concern within the watershed, including amphibians, birds, fish, mammals, mollusks, and reptiles. Table 2.3 presents the results of a database query conducted by the WYNDD for the watershed. Included in this list are all species of concern or species of potential concern which have been documented in the study area. Review of the list shows that the only endangered species known to have been observed within the study area is the black-footed ferret (*Mustela nigripes*) and the only threatened species is the grey wolf (*Canis lupus*).

The potential exists for some of these species to occur within appropriate habitats within the watershed. For example, areas of known greater sage grouse (*Centrocercus urophasianus*) leks are displayed in Figure 2.9. The sage grouse does not receive federal or state protection at this time; however, it is recognized as a sensitive species / species of concern by the BLM and a species of concern by WGFD. In August 2008, Executive Order 2008-2 was signed by the Governor which stresses additional management consideration to sage grouse and sage grouse habitat statewide. The Order includes requirements of state agencies to encourage development outside of the Core areas and to focus management to the greatest extent possible on the maintenance and enhancements of habitat within them. The Core Sage Grouse Population Areas and known leks within the Phase II Study Area are delineated in Figure 2.9.

The BLM definition of a sensitive species is as follows: species that could easily become endangered or extinct in the state, including: (a) species under status review by the FWS/National Marine and Fisheries Service; (b) species whose numbers are declining so rapidly that Federal listing may become necessary; (c) species with typically small or fragmented populations; and (d) species inhabiting specialized refuge or other unique habitats.

WGFD lists the greater sage grouse as: species that are widely distributed, with population status or trends unknown but suspected to be stable; habitat restricted or vulnerable but no recent or on-going significant loss; species likely sensitive to human disturbance. *The sage grouse are not listed as a Threatened or Endangered species and does not receive any protections from the Endangered Species Act; however, BLM and WGFD have developed restrictions/recommendations to help protect the sage grouse.*

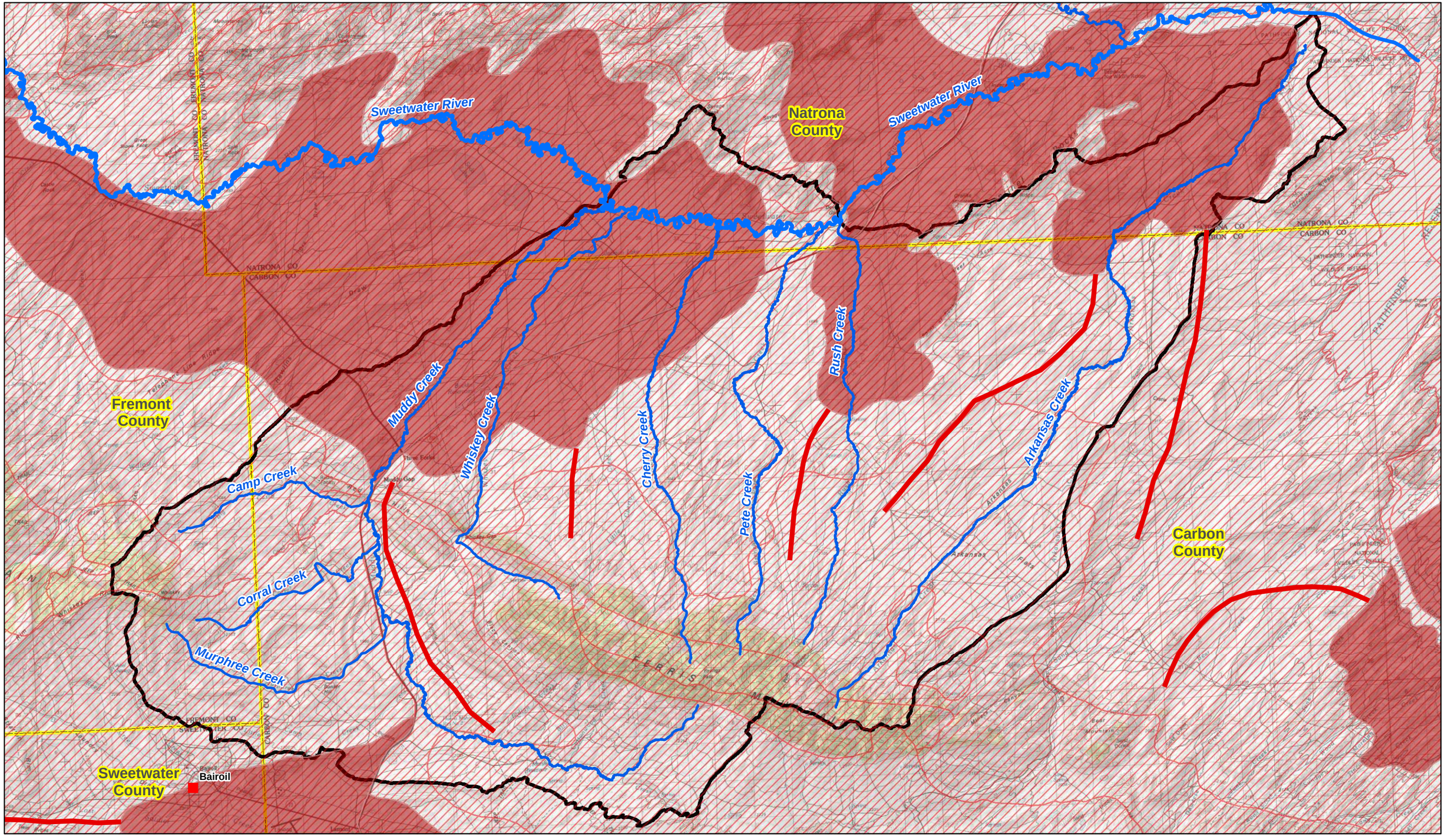
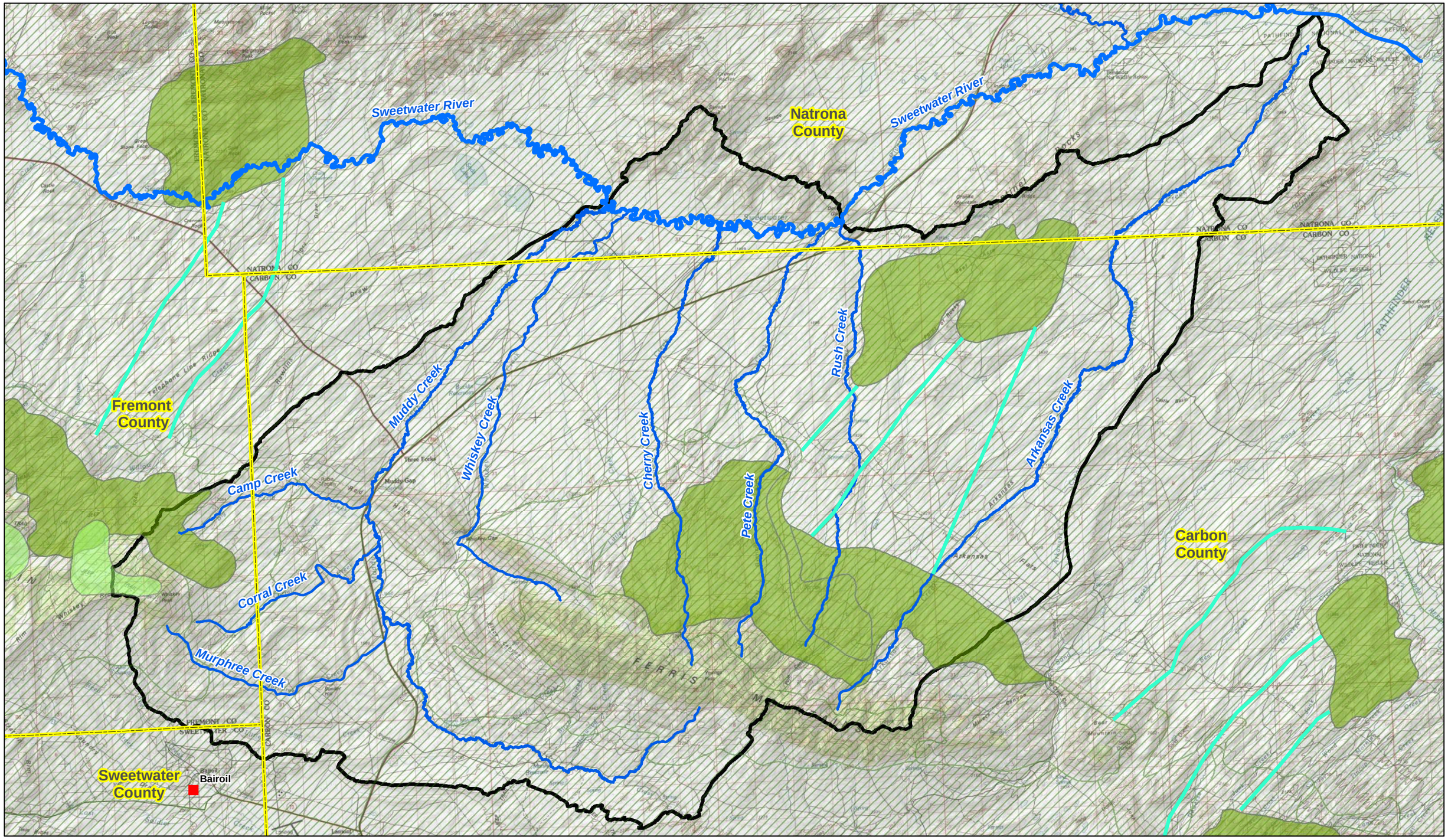


Figure 2.5 Sweetwater River Phase II: Antelope Habitat



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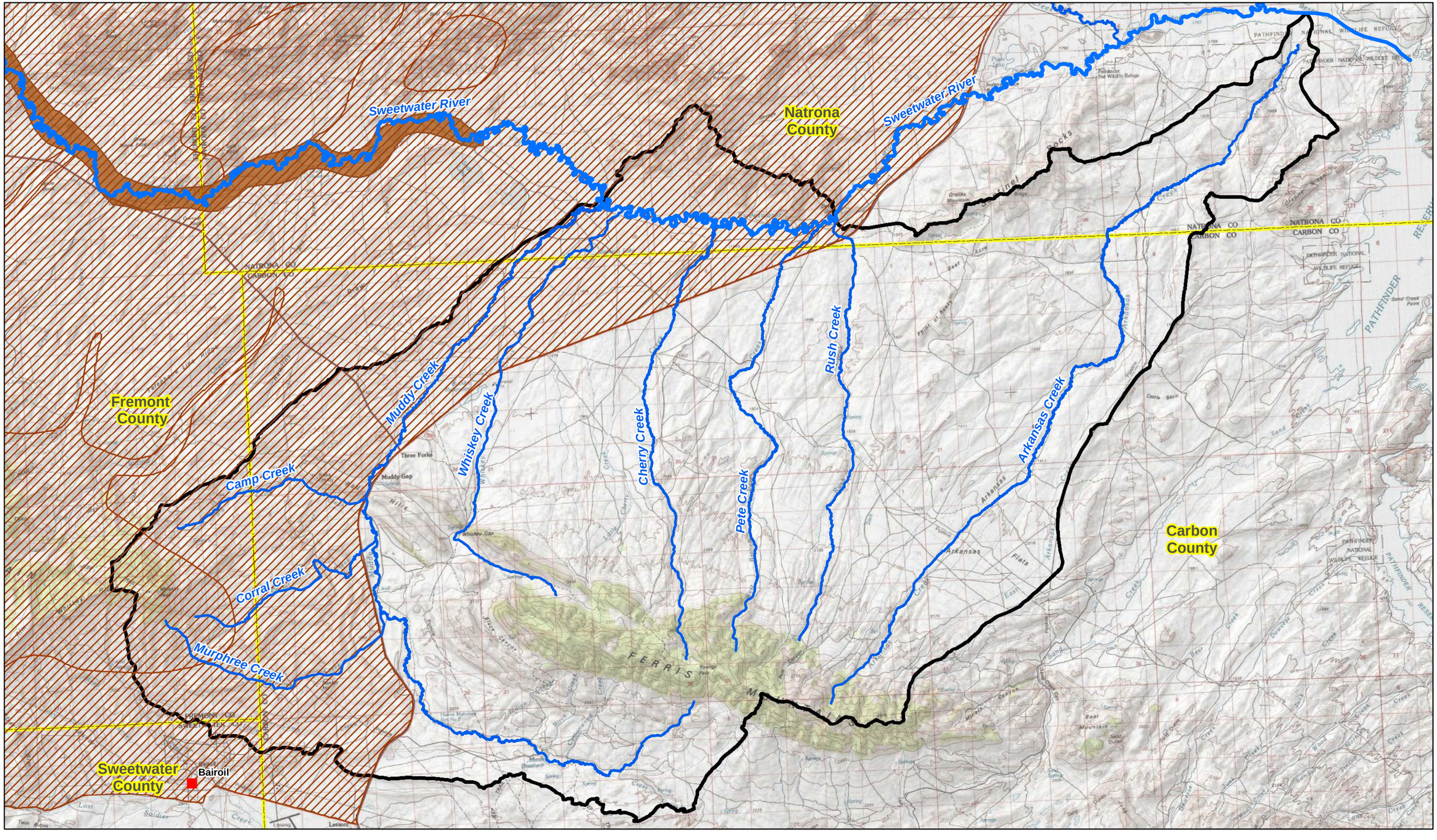
Legend

- Migration Routes
- Parturition Area
- Crucial Range
- Seasonal Range
- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.6 Sweetwater River Phase II: Elk Habitat



N
W E
S

Legend

- Crucial Range
- Seasonal Range
- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.7 Sweetwater River Phase II: Moose Habitat

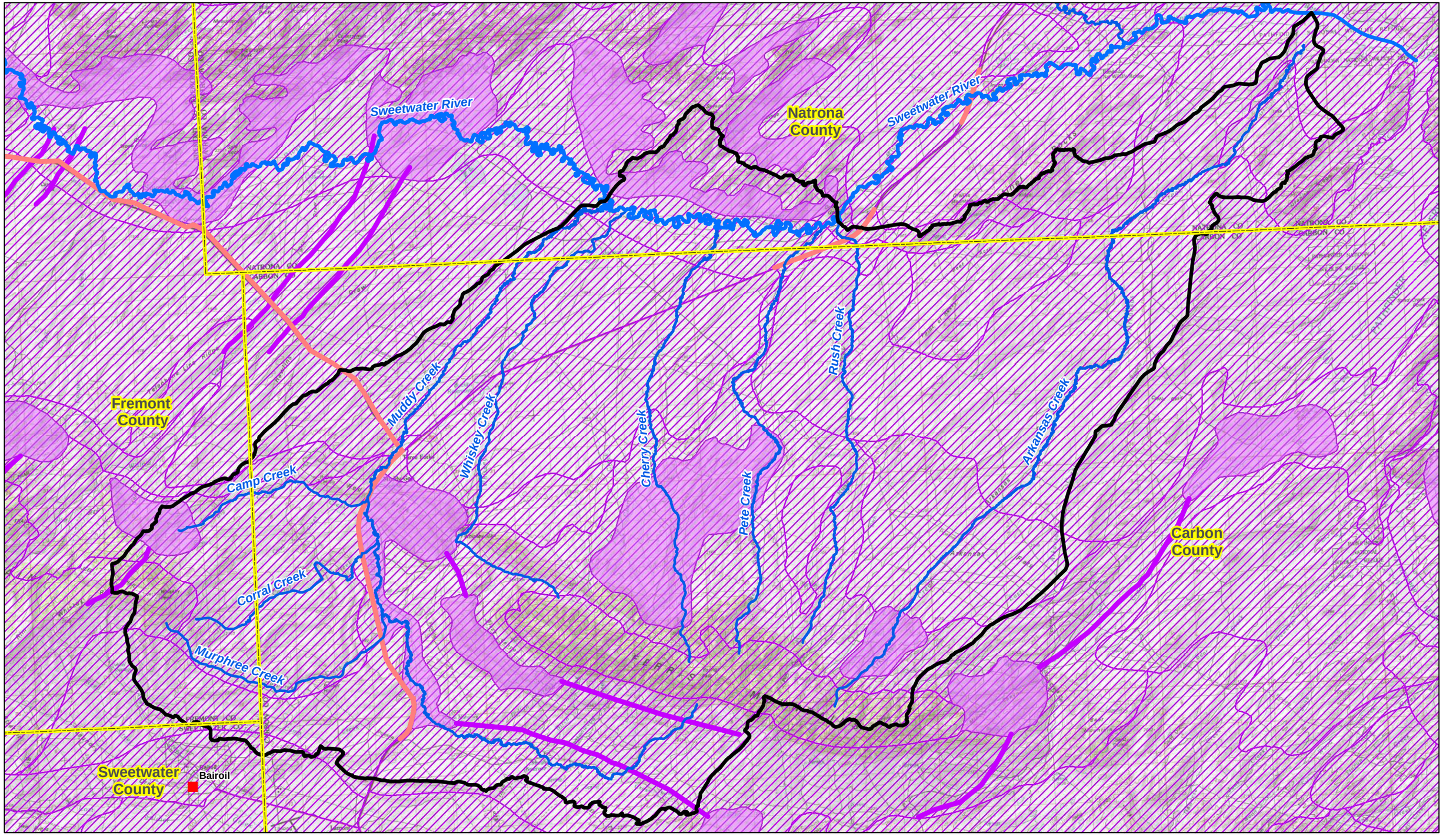


Figure 2.8 Sweetwater River Phase II: Mule Deer Habitat

Table 2.3 Wyoming Natural Diversity Database: Wildlife Species in the Phase II Study Area.

Scientific Name	Common Name	Listing Status	Tracked/ Watched
Amphibians			
Ambystoma tigrinum	Tiger Salamander		Watched
Rana pipiens	Northern Leopard Frog	Petitioned	Tracked
Birds			
Gavia immer	Common Loon		Tracked
Pelecanus erythrorhynchos	American White Pelican (Breeding Colonies)		Tracked
Botaurus lentiginosus	American Bittern		Tracked
Egretta thula	Snowy Egret		Watched
Nycticorax nycticorax	Black-crowned Night-Heron		Watched
Plegadis chihi	White-faced Ibis		Tracked
Cygnus columbianus	Tundra Swan		Watched
Aythya collaris	Ring-necked Duck		Watched
Bucephala clangula	Common Goldeneye		Watched
Bucephala albeola	Bufflehead		Watched
Haliaeetus leucocephalus	Bald Eagle	Delisted	Tracked
Accipiter gentilis	Northern Goshawk	Listing Denied	Tracked
Buteo regalis	Ferruginous Hawk		Tracked
Aquila chrysaetos	Golden Eagle		Watched
Falco peregrinus anatum	American Peregrine Falcon	Delisted	Tracked
Lagopus leucurus	White-tailed Ptarmigan		Tracked
Centrocercus urophasianus	Greater Sage Grouse	Candidate	Tracked
Rallus limicola	Virginia Rail		Watched
Grus canadensis	Sandhill Crane		Watched
Charadrius alexandrinus	Snowy Plover		Tracked
Charadrius montanus	Mountain Plover	Listing Denied	Tracked
Recurvirostra americana	American Avocet		Watched
Numenius americanus	Long-billed Curlew		Tracked
Larus californicus	California Gull (Breeding Colonies)		Watched
Sterna caspia	Caspian Tern		Tracked
Athene cunicularia	Burrowing Owl		Tracked
Stellula calliope	Calliope Hummingbird		Tracked
Melanerpes lewis	Lewis' Woodpecker		Tracked
Oreoscoptes montanus	Sage Thrasher		Watched
Lanius ludovicianus	Loggerhead Shrike		Tracked
Dendroica townsendi	Townsend's Warbler		Watched
Spizella breweri	Brewer's Sparrow		Watched
Amphispiza belli	Sage Sparrow		Tracked
Calcarius mccownii	Mccown's Longspur		Tracked
Mammals			
Corynorhinus townsendii	Townsend's Big-eared Bat		Tracked
Sylvilagus floridanus	Eastern Cottontail		Watched
Brachylagus idahoensis	Pygmy Rabbit	Petitioned	Tracked
Spermophilus elegans	Wyoming Ground Squirrel		Watched
Cynomys leucurus	White-tailed Prairie Dog	Petitioned	Tracked
Perognathus fasciatus	Olive-backed Pocket Mouse		Watched
Canis lupus	Gray Wolf	Threatened	Tracked
Mustela nigripes	Black-footed Ferret	Endangered	Tracked
Ovis canadensis	Bighorn Sheep		Watched
Reptiles			
Trionyx spiniferus	Spiny Softshell Turtle		Watched
Coluber constrictor flaviventris	Eastern Yellowbelly Racer		Watched

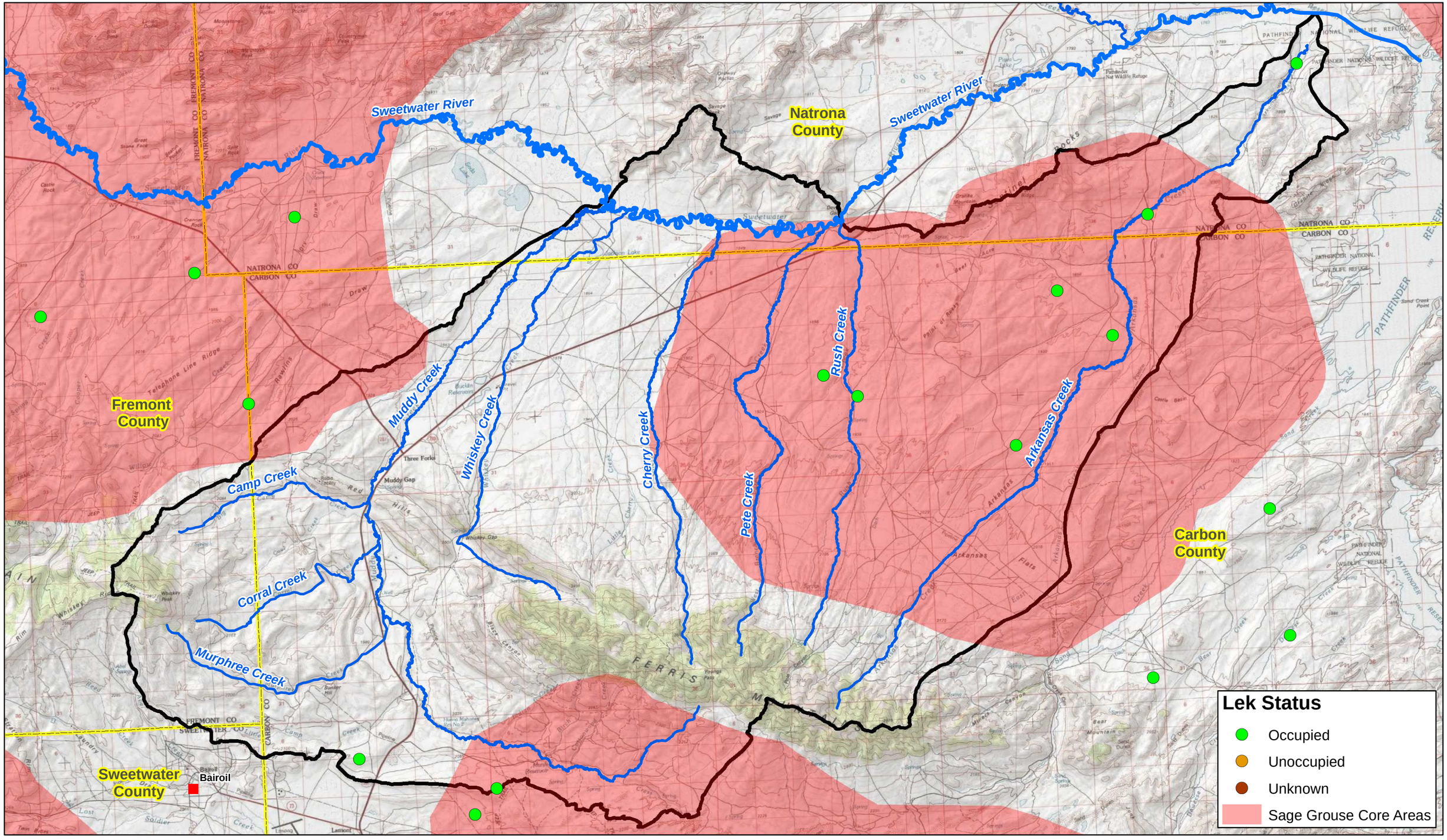


Figure 2.9 Sweetwater River Phase II: Sage Grouse Leks

The study area also lies within the Green Mountain Wild Horse Herd Area (Figure 2.10). According the Lander BLM Field Office's website, *"the AML for this HMA is 300 horses. A full range of colors is present. Most horses are solid in color, but a noticeable number of tobiano paints are present. The horses range from 11 to 15 hands and 750-1000 pounds mature weight. Health is good with few apparent problems. Domestic cattle and sheep utilize the area in all seasons with summer cattle use predominating. Vegetation around the mountain is dominated by various sage, grass, woodland, and riparian species. The area supports significant wildlife populations of elk, deer, antelope, and moose. "*

2.4 Geology and Soils

Surface geology mapping completed by the United States Geologic Survey was obtained from the Wyoming Geographic Information and Science Center (WyGISC) and incorporated into the project GIS. The distribution of surficial geologic deposits within the watershed is displayed in Figure 2.11. This figure shows that the majority of the study area is covered with alluvial deposits, or stream deposits. Alluvial formations include floodplains of active stream channels, alluvial terraces associated with historic stream floodplains, alluvial fans, and dissected alluvial fans. Residuum (materials formed in place) or colluvium (transported and deposited by gravity) comprise the bulk of the remainder of the study area. Limited areas of landslides were mapped in the vicinity of Whiskey Peak. Exposed bedrock is limited in extent and is found primarily in the vicinity of Ferris Mountain and Sentinel Rocks.

Mapping of bedrock geology was also completed by the USGS and obtained through WyGISC. Figure 2.12 shows the distribution of outcropping or near surface bedrock (and the major surficial geologic units) within the watershed.

Within the Phase II Study Area, detailed soils mapping was not available for the majority of the area. The NRCS assigns its detailed soils mapping (1:24,000 scale) pertinent attributes, including the ESD. The 1:24,000 scale mapping was available only for Fremont and Natrona Counties which span approximately 12.6 percent of the study area. Consequently, the broader scale general soils mapping (1:250,000) is presented in Figure 2.13.

Wild Horse Management Area within basin

Wild Horse Management Area outside of basin

Sweetwater River

Natrona County

Sweetwater River

Fremont County

Muddy Creek

Whiskey Creek

Cherry Creek

Rush Creek

Pete Creek

Arkansas Creek

Camp Creek

Green Mountain

Corral Creek

Murphree Creek

Carbon County

Sweetwater County

Bairoil

Stewart Creek

N

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Legend

Sweetwater River

Streams - Phase II Study Area

Phase II Study Area

Cities

County Boundary

0 12,500 25,000

Feet

Figure 2.10 Sweetwater River Phase II: Wild Horse Management Areas

1 - Alluvial fan
2 - Alluvium
3 - Bedrock
4 - Bench
5 - Dissected alluvial fan
6 - Dissected bench
7 - Dissected terrace
8 - Eolian mixed
9 - Landslide mixed
10 - Residuum
11 - Slopewash and colluvium
12 - Terrace deposits

Sweetwater River

Natrona County

Sweetwater River

Fremont County

Muddy Creek

Whiskey Creek

Cherry Creek

Rush Creek

Pete Creek

Arkansas Creek

Camp Creek

Corral Creek

Murphree Creek

Carbon County

Sweetwater County

Bairoil

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S

Legend

Sweetwater River

Streams - Phase II Study Area

Phase II Study Area

Cities

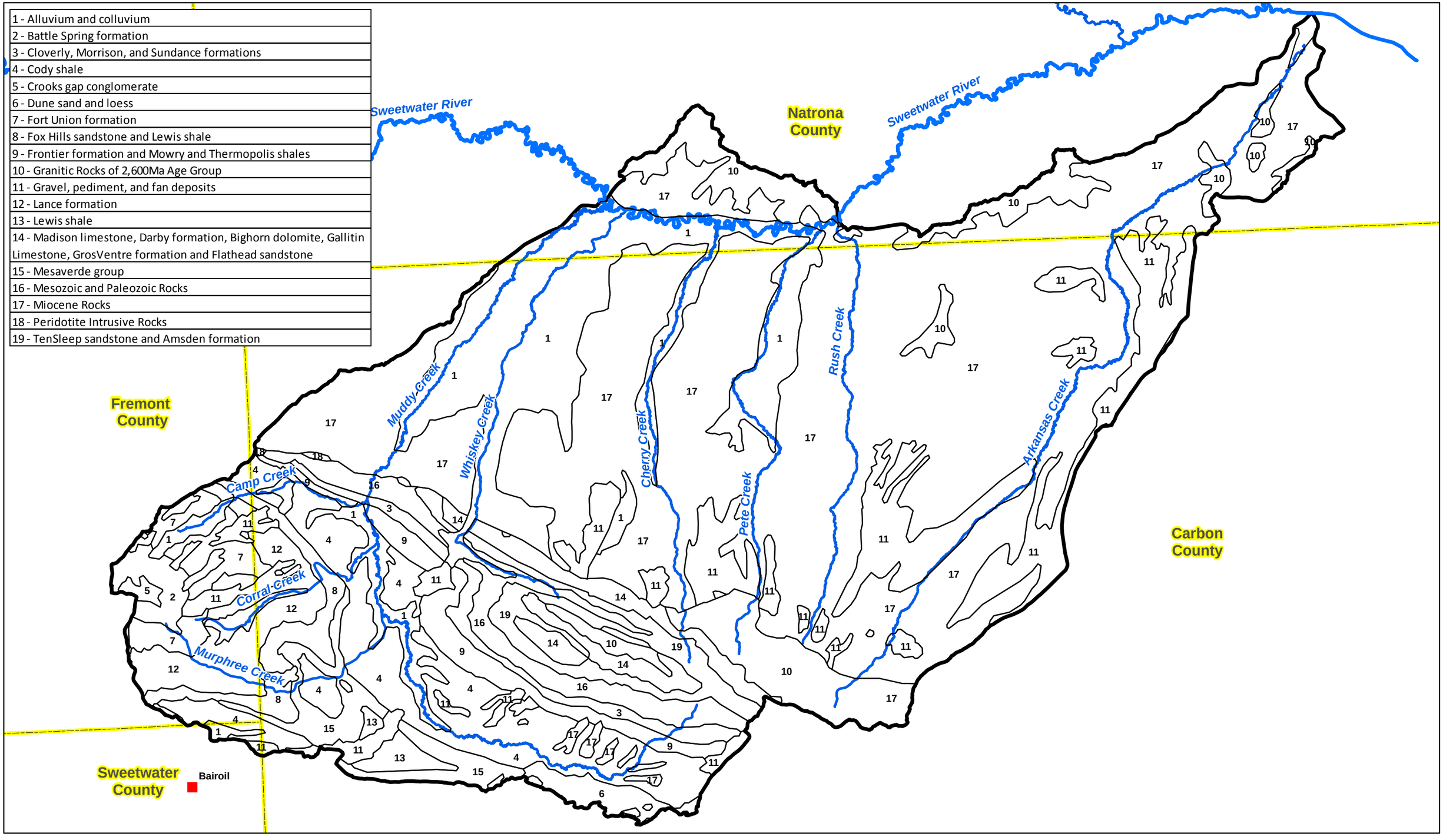
County Boundary

0 12,500 25,000

Feet

Figure 2.11 Sweetwater River Phase II: Surficial Geology

1 - Alluvium and colluvium
2 - Battle Spring formation
3 - Cloverly, Morrison, and Sundance formations
4 - Cody shale
5 - Crooks gap conglomerate
6 - Dune sand and loess
7 - Fort Union formation
8 - Fox Hills sandstone and Lewis shale
9 - Frontier formation and Mowry and Thermopolis shales
10 - Granitic Rocks of 2,600Ma Age Group
11 - Gravel, pediment, and fan deposits
12 - Lance formation
13 - Lewis shale
14 - Madison limestone, Darby formation, Bighorn dolomite, Gallitin Limestone, GrosVentre formation and Flathead sandstone
15 - Mesaverde group
16 - Mesozoic and Paleozoic Rocks
17 - Miocene Rocks
18 - Peridotite Intrusive Rocks
19 - TenSleep sandstone and Amsden formation



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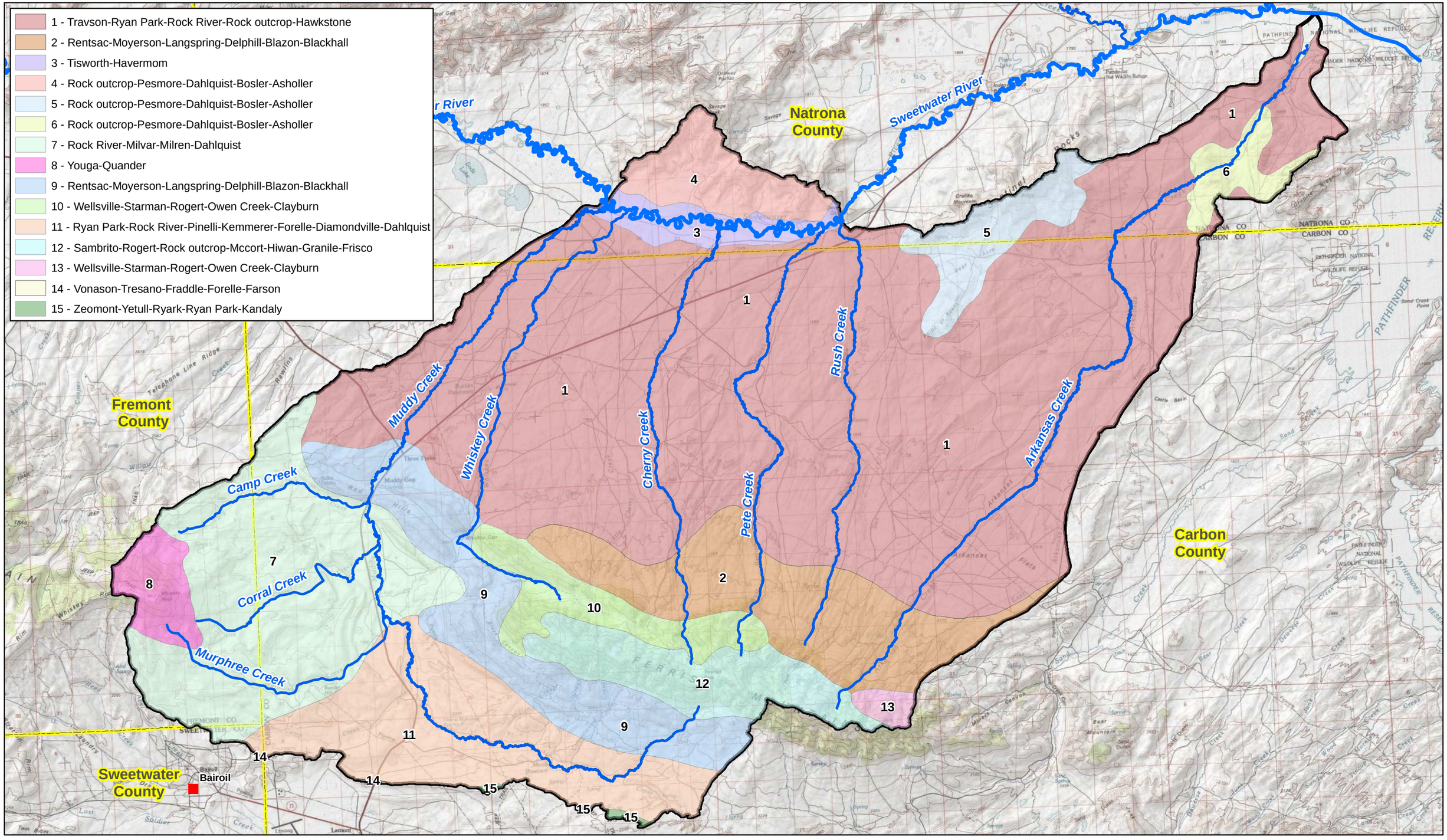
Legend

- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.12 Sweetwater River Phase II: Bedrock Geology



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- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.13 Sweetwater River Phase II: Soils Mapping at 1:250,000

2.5 Hydrology

2.5.1 Surface Water Hydrology

The location and extent of the watershed, the mainstem streams, significant tributaries, and existing reservoirs are shown on Figure 2.14. As indicated in this figure, the study area consists of the watersheds of six separate and roughly parallel tributaries to the Sweetwater River. From west to east they are: Muddy Creek, Whiskey Creek, Cherry Creek, Pete Creek, Rush Creek and Arkansas Creek. All of these streams tend to have perennial reaches in their upper basins. Springs in upper watershed and the vicinity of the wilderness study area provide year-round local sources of water and provide supplemental flow to surface waters. These streams generally flow for portions of the year, generally drying up during drier summer / fall months (August / September). Peak runoff typically occurs in May.

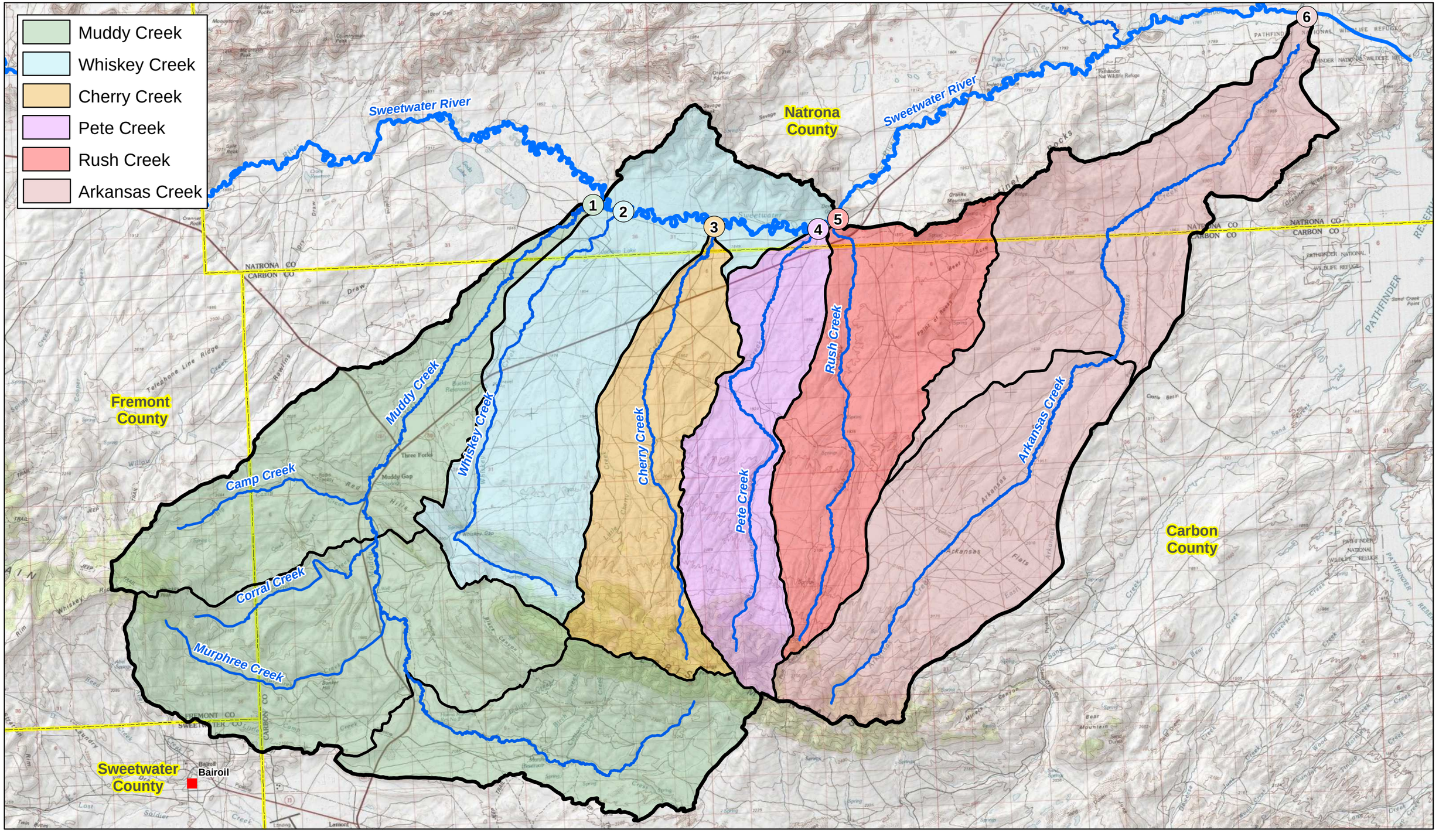
There are no stream gages located within the watershed nor have there been any gages reported in the past. Regional hydrologic methods exist which rely upon regressional relationships between measured discharge and basin physical characteristics (area, slope, precipitation, etc). Using these techniques, the mean annual discharge for each of the subbasins within the Phase II Study Area was estimated and the results tabulated in Table 2.4. It must be recognized that these estimates do not include spring-derived flows and are provided as an approximation only.

Table 2.4 Mean Annual Runoff.

Stream	Area		Mean Annual Runoff	
	Acre	Square Miles	cfs	acre-feet
Pete Creek	17,364	27.1	1.55	1,119.7
Cherry Creek	18,343	28.7	1.60	1,154.6
Rush Creek	23,045	36.0	1.82	1,312.0
Whiskey Creek	32,098	50.2	2.19	1,579.5
Arkansas Creek	53,426	83.5	2.91	2,101.0
Muddy Creek	72,075	112.6	3.44	2,484.5

2.5.2 Groundwater Hydrology

Several springs are located within the watershed as indicated in Figure 2.15. Several of these springs have sufficient yield to provide supplemental supply to surface waters. Others consist of “wet spots” and support local vegetation and livestock usage.



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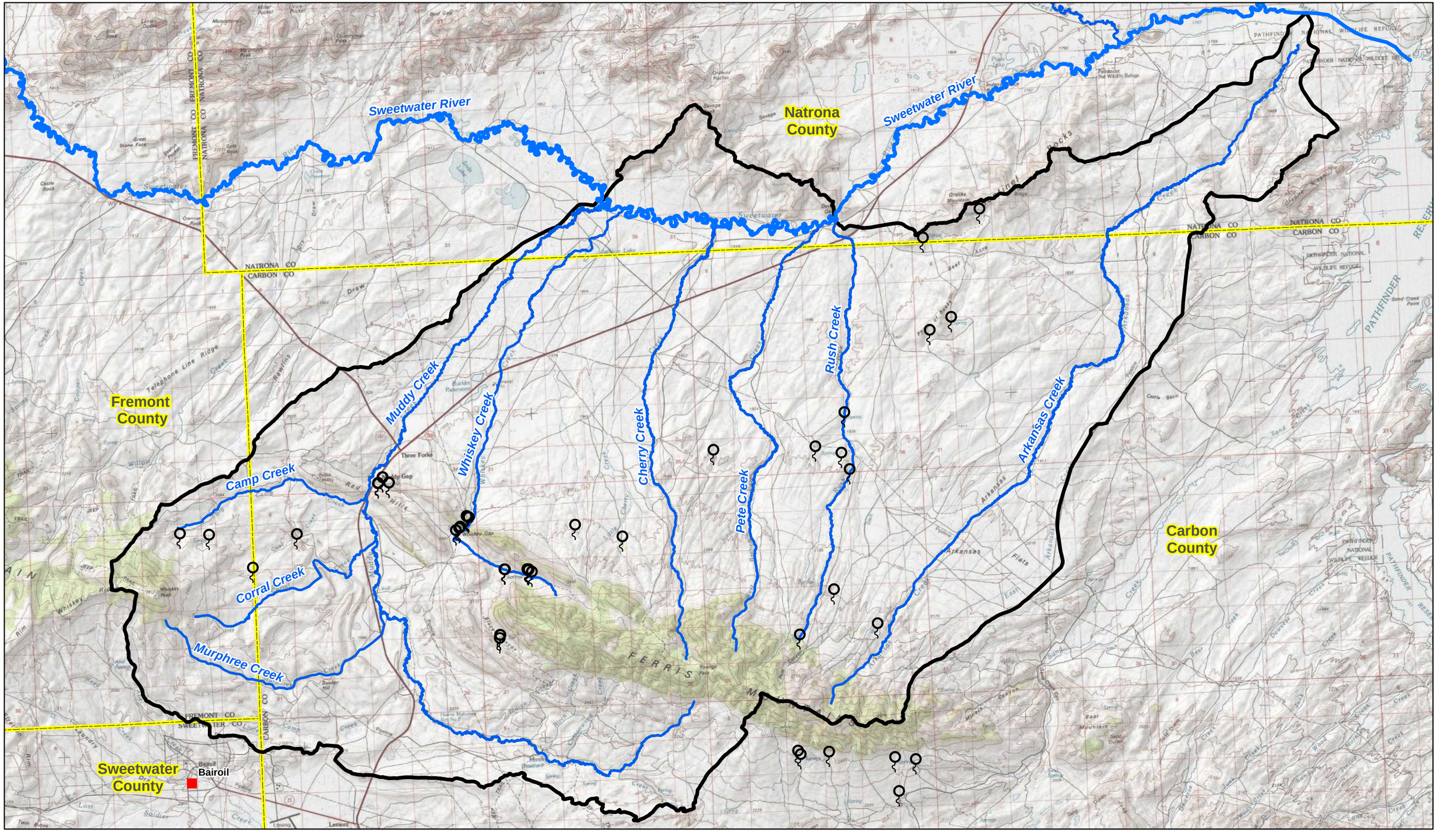
Phase II Study Area
Sweetwater River
Cities
Streams - Phase II Study Area
County Boundary

0 12,500 25,000
Feet

Figure 2.14 Sweetwater River Phase II: Hydrologic Features



N
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Legend

- Springs
- Cities
- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- County Boundary

0 12,500 25,000

Feet

Figure 2.15 Sweetwater River Phase II: Spring Locations

Groundwater in the Phase II Study Area occurs in both shallow (alluvial) and deeper (bedrock) aquifers. According to records provided by the Wyoming State Engineers Office (WYSEO), there are approximately ninety six (96) permitted wells within the study area. This number includes springs for which water rights permits have been granted. Well depths range from less than ten feet to a maximum of 6,851 feet for an industrial on the watershed divide near Bairoil. Most wells in the study area are approximately 100 feet to 250 feet deep with yields between 10 gpm and 25 gpm. Depth to water is typically from ten (10) to two hundred (200) feet. Figure 2.16 displays the location of wells within the WYSEO database. Appendix A summarizes pertinent information on the wells.

2.6 Stream Channel Conditions

2.6.1 Rosgen Level I Classification

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

Table 2.5 presents a tabulation of geomorphic parameters quantified within the GIS environment. Figure 2.17 displays the results of the Rosgen Level I classification effort. Brief descriptions of the various stream types encountered in the watershed are presented in the following paragraphs. In addition, results of previous channel assessments conducted by the BLM using the Proper Functioning Condition (PFC) methods have been incorporated into the evaluation of stream channel conditions.

Downstream reaches of the mainstem channels within the study area were predominately classified as Type C stream channels. These channels are typically characterized by relatively low slopes, meandering planforms (i.e., the shape one would see if viewing from above, as in a map or aerial photo), and pool/riffle sequences. C-type channels tend to occur in broad alluvial valleys, and they are typically associated with broad floodplain areas. C-type channels tend to be relatively sinuous, as they follow a meandering course within a single channel thread. As a result, the channels are laterally stable, and geomorphically resilient.

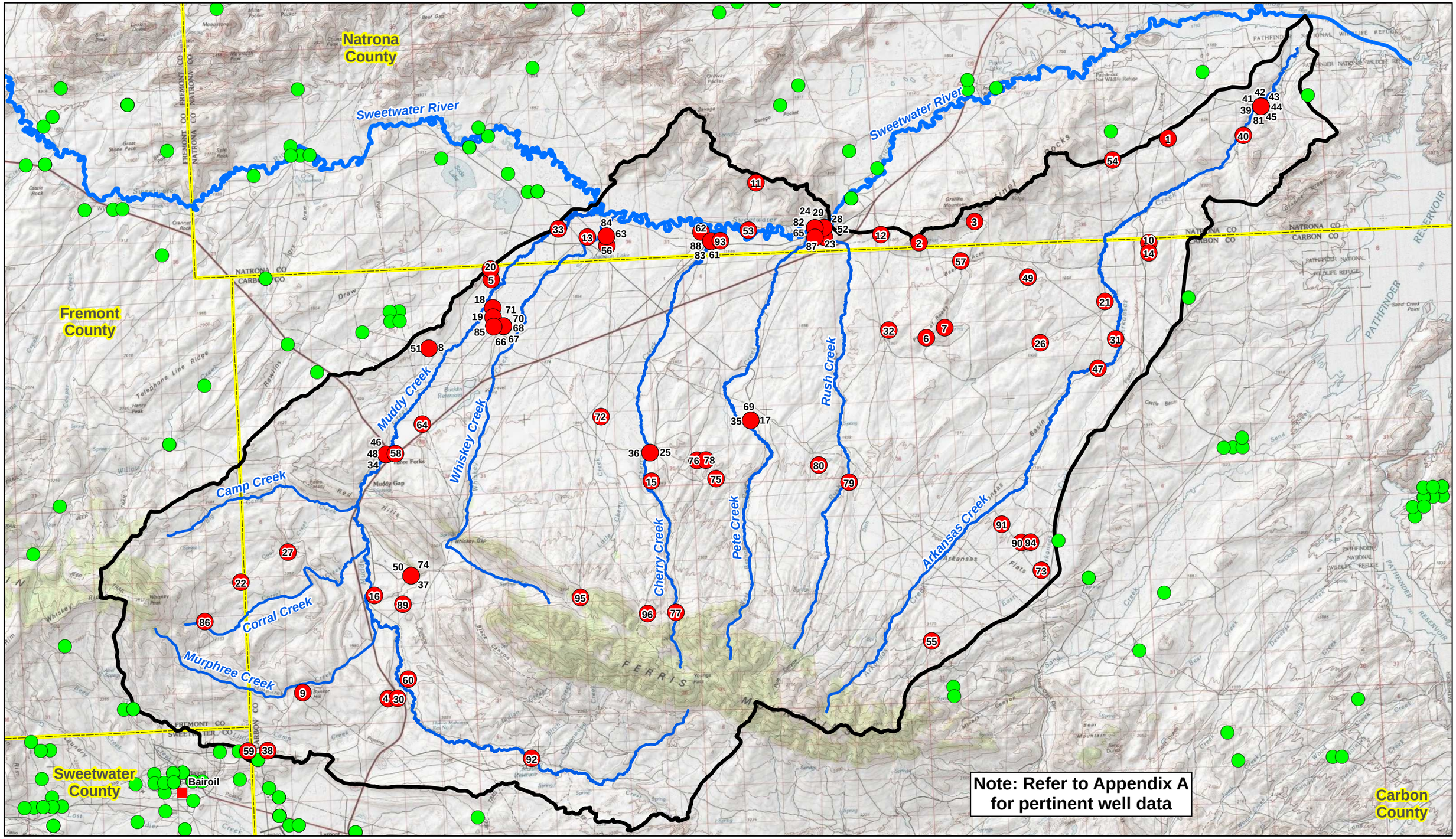


Figure 2.16 Sweetwater River Phase II: Permitted Groundwater Wells

Table 2.5 Summary of Rosgen Level I Classification Results.

Stream	Reach Number	Station (Distance from Mouth)		Reach Length (ft)	Sinuosity	Slope	Rosgen
		Station Start (ft)	Station End (ft)				
Arkansas Creek	1	0	16,400	16,400	1.45	0.0038	C
	2	16,400	32,100	15,700	1.15	0.0063	C
	3	32,100	135,100	103,000	1.75	0.0041	C
	4	135,100	174,500	39,400	1.17	0.0251	B
	5	174,500	184,800	10,300	1.05	0.1202	B
Cherry Creek	1	0	12,500	12,500	2.15	0.0053	C
	2	12,500	32,100	19,600	1.31	0.0062	C
	3	32,100	63,600	31,500	1.32	0.0182	B
	4	63,600	86,300	22,700	1.07	0.0730	B
Muddy Creek	1	0	30,800	30,800	2.16	0.0016	C
	2	30,800	88,600	57,800	1.31	0.0042	C
	3	88,600	150,200	61,600	1.62	0.0056	C
	4	150,200	190,900	40,700	1.67	0.0081	C
	5	190,900	211,000	20,100	1.15	0.0474	B
Pete Creek	1	0	3,900	3,900	1.89	0.0042	C
	2	3,900	27,600	23,700	1.24	0.0072	C
	3	27,600	44,000	16,400	1.68	0.0078	C
	4	44,000	49,900	5,900	1.26	0.0139	C
	5	49,900	70,800	20,900	1.66	0.0127	B
	6	70,800	95,000	24,200	1.09	0.0870	B
Rush Creek	1	0	40,700	40,700	1.36	0.0089	C
	2	40,700	80,500	39,800	1.16	0.0346	B
Whiskey Creek	1	0	12,500	12,500	1.12	0.0032	C
	2	12,500	33,500	21,000	1.49	0.0030	C
	3	33,500	53,100	19,600	1.09	0.0090	C
	4	53,100	60,400	7,300	1.15	0.0136	B
	5	60,400	87,400	27,000	1.09	0.0529	B

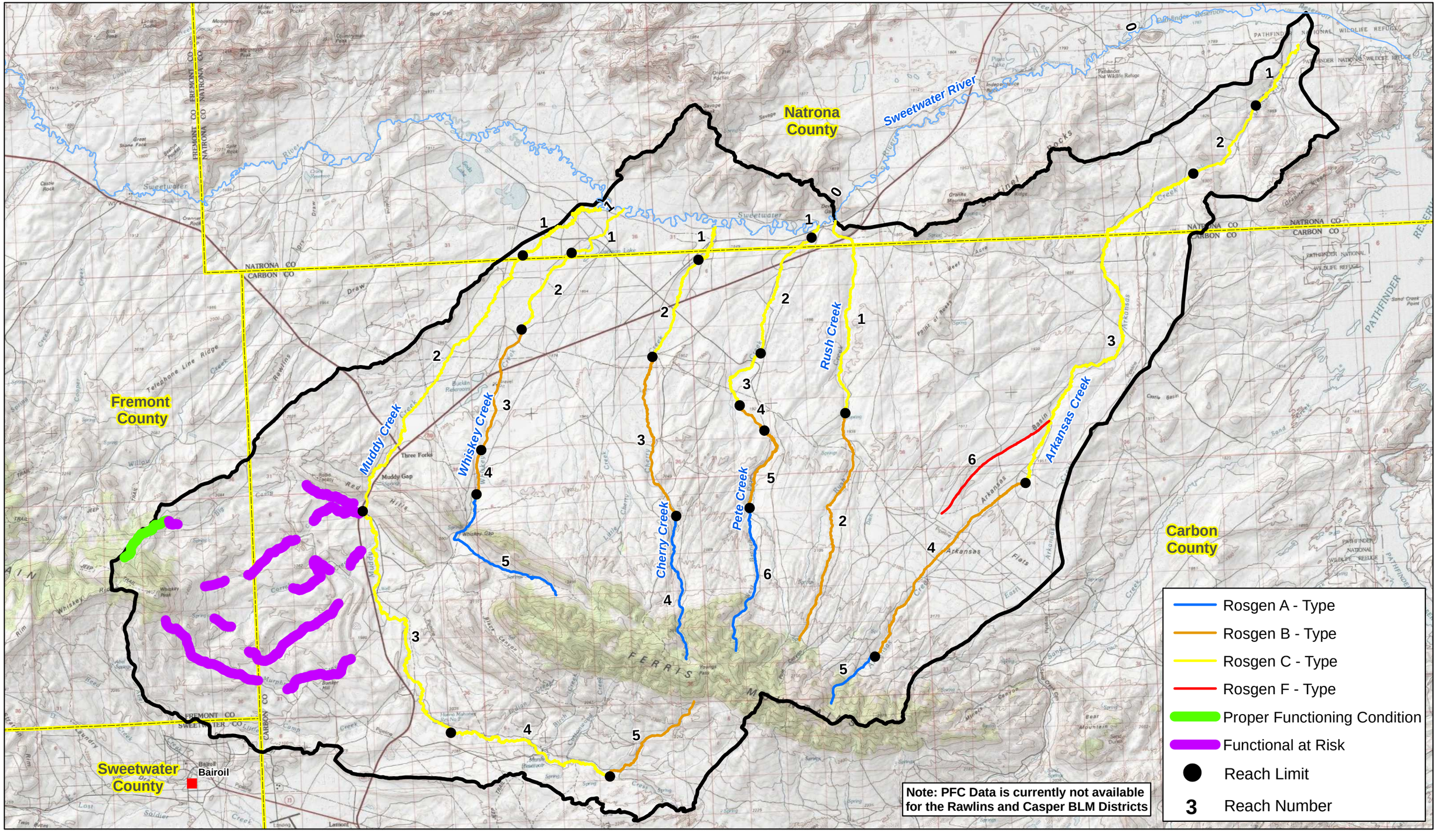


Figure 2.17 Sweetwater River Phase II: Geomorphic Stream Classifications

Figure 2.18 displays a photo of Muddy Creek near the Highway 287 crossing. This reach of Muddy Creek is unentrenched, and appears to be relatively stable. Bed material is relatively fine and would be classified as sand to gravel in size.

Figure 2.18 Example Type C Channel: Lower Muddy.

Upper reaches of most channels were classified as Type B stream channels. For example, upper Whiskey Creek was classified as a B-type channel (Figure 2.19). *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. B-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 disturbance, 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 2.19 Example Type B Channel: Lower Whiskey Creek.

Portions of Arkansas Creek are affected by transbasin diversions which take water from Rush Creek and add it to the Upper Arkansas drainage. The additional streamflows have resulted in degradation of a reach of Arkansas Creek (Figure 2.20). This reach was classified as an F-Type channel due to its entrenched condition. F-Type Channels typically have relatively low slopes (<2%), similar to C and E channel types. The slope of this reach lies outside of the typical classification limits, however, the natural flow regime has been altered and the resulting configuration has formed. 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 an historic downcutting event.

Figure 2.20 Example Type F Channel: Arkansas Creek.

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. The bed of the channel is armored with gravel/cobble bed material and it appears the channel has adjusted to the impacts of changes to the streamflow regime and has stabilized. Bank angles appear to be reduced and erosion appears to be inactive and vegetation is encroaching. Likewise, the channel has formed alternate point bars within its incised floodplain and the bed did not exhibit active headcutting which would indicate the channel is actively downcutting.

Several smaller tributaries were observed in an effort to provide input to management of tributaries within the upper reaches of the watershed. Several tributaries originating on Whiskey Peak, including Murphrey Creek, Camp Creek, and Corral Creek, displayed signs of active channel incision and would consequently be classified as G-Type channels. G-Type Channels are narrow, steep entrenched gullies. G-Type channels typically have high bank erosion rates and a high sediment supply. Channel degradation and sideslope rejuvenation processes are typical. Figure 2.21 displays a typical G-Type channel within the watershed.

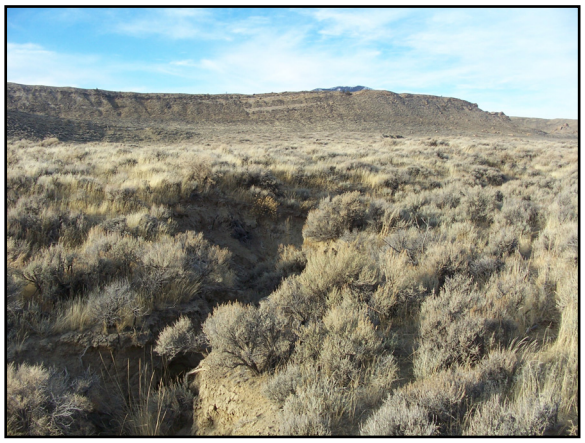


Figure 2.21 Example Type G Channel: Tributary to Murphrey Creek.

2.6.2 Proper Functioning Condition

The BLM utilizes a procedure for assessing the health of a stream called Proper Functioning Condition assessment or PFC. PFC is described by the BLM as:

> *"A qualitative method for assessing the condition of riparian-wetland areas. The term PFC is used to describe both the assessment process, and a defined, on the-ground condition of a riparian-wetland area. The PFC assessment refers to a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas. A checklist is used for the PFC assessment, which*

synthesizes information that is foundational to determining the overall health of a riparian-wetland system" (BLM, 1998).

The PFC assessment terminates with the definition of one of three classes for a given stream segment as described below.

Proper Functioning Condition: A stream is said to be functioning properly when adequate vegetation, landform, or debris is present to:

- dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality;
- filter sediment and aid floodplain development;
- improve flood water retention and groundwater recharge;
- develop root masses that stabilize islands and shoreline features against cutting action;
- restrict water percolation;
- develop diverse ponding characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, water bird breeding, and other uses; and
- support greater biodiversity.

Functional At Risk: Riparian/wetland areas are classified as *functioning-at-risk* when they are in functioning condition but an existing soil, water, or vegetation attribute makes them susceptible to degradation. These areas are further distinguished based on whether or not they demonstrate an *upward*, *not apparent*, or *downward* trend.

Nonfunctioning: Riparian/wetland areas are classified as *nonfunctioning* when they clearly are not providing adequate riparian vegetation, physical structure, or large woody debris to dissipate stream energy associated with high flows.

Within the Phase II Study Area, the BLM conducted PFC assessments on selected stream segments intermittently since 1995 (Figure 2.17). A qualitative review of the field data forms completed by BLM personnel indicates a considerable amount of variability exists in channel condition throughout the study area. At the time of the field inspections, BLM observers classified the majority of the reaches as being either Proper Function Condition (PFC) or

Functional At Risk (FAR). There were very few reaches classified as being Nonfunctional (NF). Observer notes indicate the predominate factors contributing to a reach being classified as anything other than PFC were degradation of riparian vegetation or stream channel and bank degradation / erosion.

It should be noted that the PFC assessment results in evaluation of specific and frequently isolated stream reaches, generally on federal lands. Without a comprehensive collation of PFC data, system-wide conclusions are difficult to ascertain.

2.6.3 Impairments

Current impairments to stream channels within the study area appear to fall into two broad and interrelated categories:

- Riparian Vegetation Degradation: Impaired riparian condition and habitat, and
- Riparian Degradation: Generally bank erosion and physical disturbance of stream banks.

It should be noted however, that channels throughout the study area appear to be improved in relation to the BLM's PFC assessments conducted in the mid to late 1990's. In several locations, evidence was observed of historic channel degradation which appears to have recovered and generally stable conditions are now evident. For example, Figure 2.22 displays a photo of upper Arkansas Creek where a series of small headcuts appear to have been stabilized and vegetation has re-established itself along the channel bed and banks.

Figure 2.22 Stabilized Reach: Upper Arkansas Creek.

Changes in grazing management resulting in rest/rotation in lieu of season long grazing appear to have had positive impacts upon channel conditions. Many reaches within the Phase II Study Area continue to exhibit degraded riparian vegetation. However, it appears that riparian species are re-establishing themselves and the channels, on the whole, are on an upward trend.

2.7 Ecological Site Descriptions

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

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

Ecological Site Descriptions (ESDs) are reports available from the NRCS that describe the following for each Ecological Site:

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

More information regarding ESDs and their application is available at: http://esis.sc.egov.usda.gov/ESIS/About.aspx.

The ESDs can be used to compare what is growing on the rangeland with what each site is capable of growing. By comparing the present vegetative composition to the potential compositions, the relative health of the range resource can be evaluated. Production of each site is closely related to the ecological condition of the site. Ecological Sites are defined based upon their location within defined Ecological Precipitation Zones and soil characteristics. Figure 2.23 displays the ecological precipitation zones found in the Phase II Study Area and the State of Wyoming.

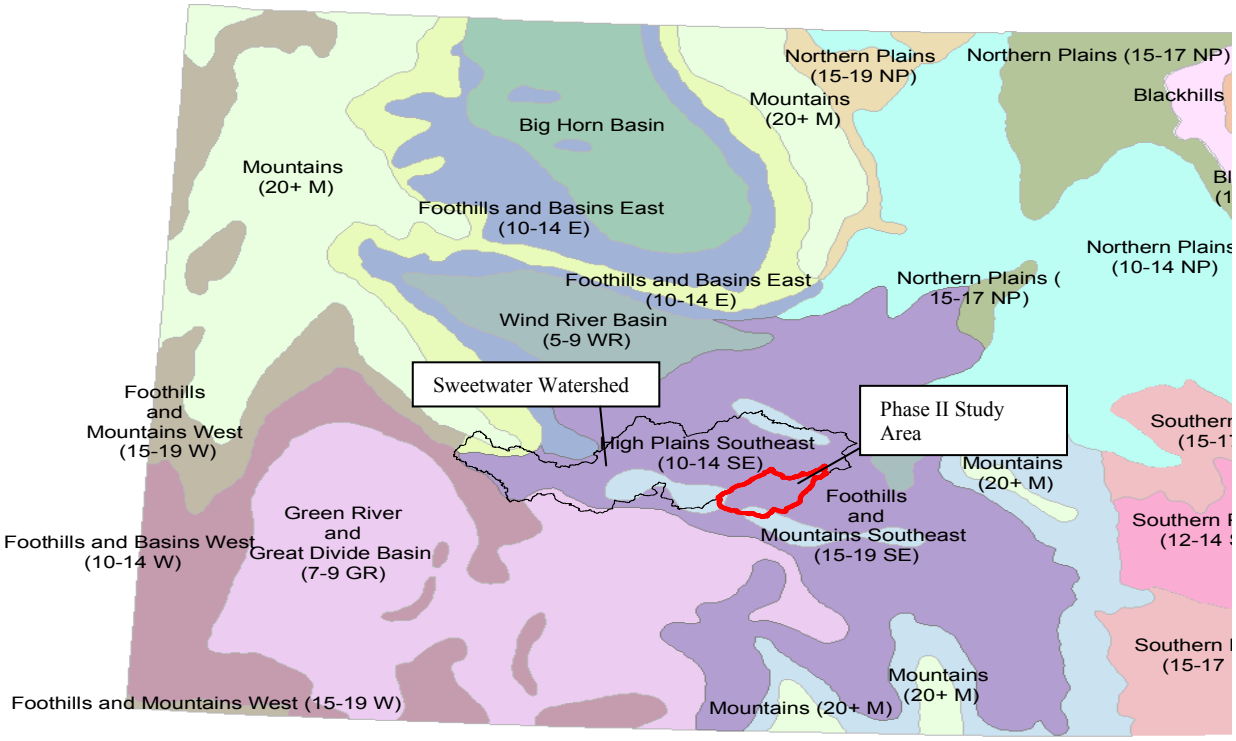


Figure 2.23 Wyoming Ecological Precipitation Zones.

Using database tools provided by the NRCS, the available soils mapping was evaluated and Ecological Sites defined within the study area. Within the Phase II Study Area, detailed soils mapping was not available for the majority of the area. The NRCS assigns its detailed soils mapping (1:24,000 scale) pertinent attributes, including the ESD. The 1:24,000 scale mapping was available only for Fremont and Natrona Counties which span approximately 12.6 percent of the study area. Consequently, the broader scale general soils mapping (1:250,000) was attributed with anticipated ESDs based upon soils encountered.

Table 2.6 contains a list of the sites which would likely be encountered within the study area and their relative distribution. Figure 2.24 displays their location within the study area.

The relative distribution of the sites is displayed in Figure 2.25. As is evident in this figure, the Sandy 1 – 14 inch precipitation zone, High Plains Southeast ecological site potentially comprises over 50 percent of the area.

Table 2.6 Analysis of Ecological Site Distribution in the Phase II Study Area.

Number	ESD Code	ESD Description	Area (ac)	Percent
1	R034AY350WY	Sandy (Sy) 10-14 P.Z., High Plains Southeast	110,120	50.94%
2	R034AY366WY	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast	25,236	11.67%
3	R049XA162WY	Shallow Loamy (SwLy) 10-14 P.Z., Foothills and Mountains Southeast	17,519	8.10%
4	R034AY366WY	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast	15,216	7.04%
5	R034AY366WY	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast	13,816	6.39%
6	R034AY350WY	Sandy (Sy) 10-14 P.Z., High Plains Southeast	7,981	3.69%
7	R034AY362WY	Shallow Loamy (SwLy) 15-19 P.Z., High Plains Southeast	5,843	2.70%
8	R034AY362WY	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast	5,151	2.38%
9	R034AY362WY	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast	5,105	2.36%
10	R034AY350WY	Sandy (Sy) 10-14 P.Z., High Plains Southeast	3,325	1.54%
11	R049XA122WY	Loamy (Ly) 15-19 P.Z., Foothills and Mountains Southeast	3,071	1.42%
12	R034AY362WY	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast	2,736	1.27%
13	R034AY362WY	Shallow Loamy (SwLy) 15-19 P.Z., High Plains Southeast	811	0.38%
14	R034AY362WY	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast	209	0.10%
15	R034AY322WY	Loamy (Ly) 10-14 P.Z., High Plains Southeast	26	0.01%

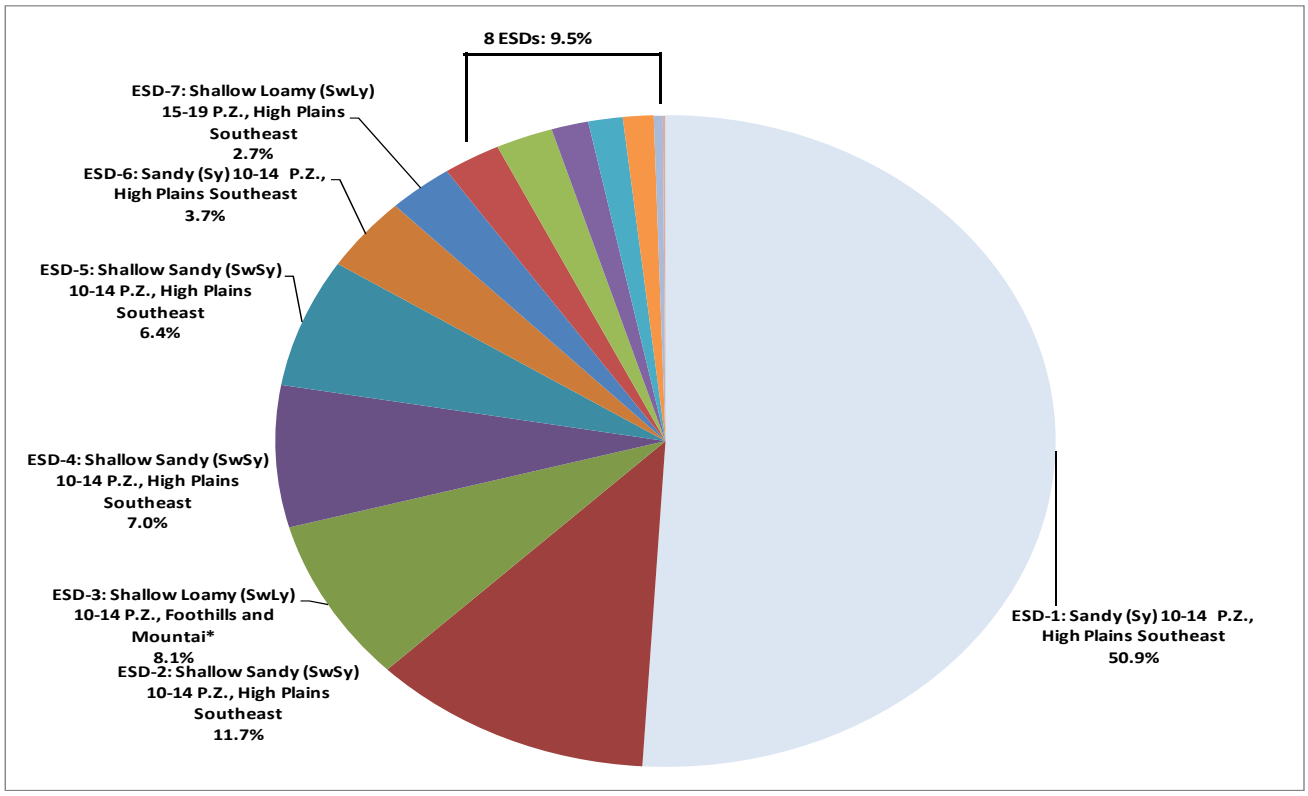
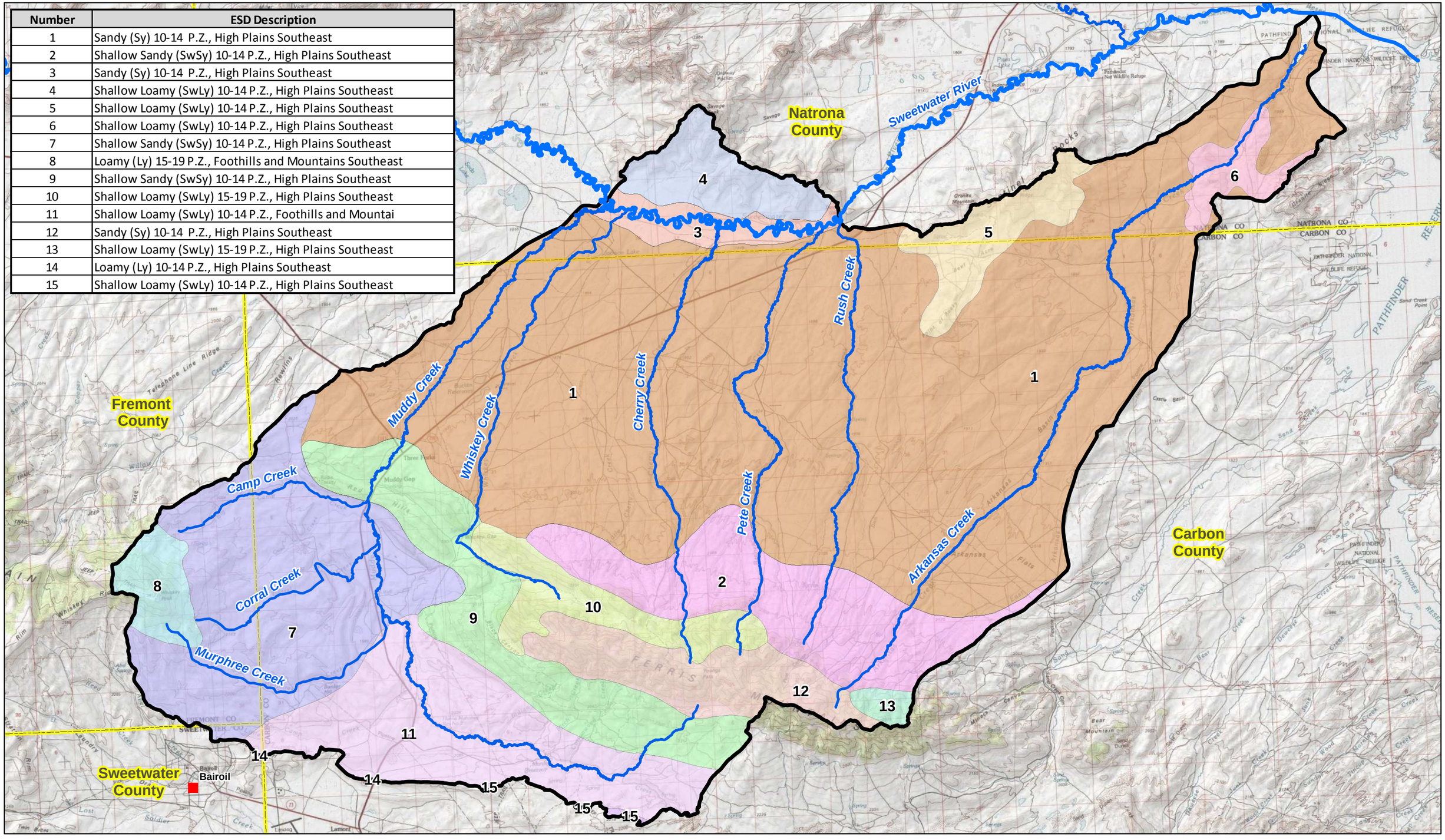


Figure 2.25 Distribution of Ecological Sites Within the Phase II Study Area.

Number	ESD Description
1	Sandy (Sy) 10-14 P.Z., High Plains Southeast
2	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast
3	Sandy (Sy) 10-14 P.Z., High Plains Southeast
4	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast
5	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast
6	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast
7	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast
8	Loamy (Ly) 15-19 P.Z., Foothills and Mountains Southeast
9	Shallow Sandy (SwSy) 10-14 P.Z., High Plains Southeast
10	Shallow Loamy (SwLy) 15-19 P.Z., High Plains Southeast
11	Shallow Loamy (SwLy) 10-14 P.Z., Foothills and Mountai
12	Sandy (Sy) 10-14 P.Z., High Plains Southeast
13	Shallow Loamy (SwLy) 15-19 P.Z., High Plains Southeast
14	Loamy (Ly) 10-14 P.Z., High Plains Southeast
15	Shallow Loamy (SwLy) 10-14 P.Z., High Plains Southeast



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- Sweetwater River
- Phase II Study Area
- County Boundary
- Streams- Phase II Study Area
- Cities

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Feet

Figure 2.24 Sweetwater River Phase II: Ecological Sites

The following description of the Historic Climax Plant Community (HCPC) associated with this ESD was extracted from the NRCS descriptions (NRCS, 2008).

Sandy (Sy) 10 – 14 Inch PZ High Plains Southeast:

The interpretive plant community for this site is the Historic Climax Plant Community. Potential vegetation is estimated at 75% grasses or grass-like plants, 10% forbs and 15% woody plants. The major grasses include needleandthread, Indian ricegrass, and rhizomatous wheatgrass. Big and silver sagebrush are the major woody plants.

A typical plant composition for this state consists of needleandthread 20-50%, rhizomatous wheatgrass 15-25%, Indian ricegrass 10-20%, perennial forbs 5-10%,and shrubs 5-10%. Ground cover, by ocular estimate, varies from 35-45%.

The total annual production (air-dry weight) of this state is about 1200 pounds per acre, but it can range from about 700 lbs/acre in unfavorable years to about 1500 lbs/acre in above average years.
This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

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

- *Moderate Continuous Season-long Grazing will convert the plant community to the Big Sagebrush/Shortgrass Plant Community if big sagebrush is present at 5-10%.*
- *Moderate Continuous Season-long Grazing or Continuous Spring Grazing with Brush*
- *Management (chemical) will convert the plant community to the Threadleaf Sedge/Blue grama Plant Community.*

2.8 Grazing

2.8.1 Grazing Administration

Grazing on federal lands within the study area is administered by the Bureau of Land Management. The BLM-administered allotments typically include intermingled private, state, and federally-administered lands used for grazing. All lands within the watershed with the

exception of the higher portions of Ferris Mountain, are used for grazing. Figure 2.26 displays the grazing allotments found within the study area.

Under the umbrella of the Lander Resource Management Plan, management of grazing allotments are prioritized based on the classification of the allotments into one of three management categories: Improve (I), Maintain (M), and Custodial (C). These categories broadly define management objectives of the BLM administered public lands in the allotment (BLM, 2008).

Livestock grazing is managed is accordance with the principles of multiple use and sustained yield embodied in the Federal Land Policy and Management Act (1976) and the Taylor Grazing Act (1934). BLM's specific objectives and procedures for managing livestock grazing are contained in the agency's grazing regulations. BLM's grazing regulations were revised in 1995 to ensure that livestock grazing is conducted in a manner that will sustain or improve the fundamental ecological health of public rangelands.

Grazing on BLM lands to meet these requirements is managed under the Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands Administered by the BLM in the State of Wyoming (BLM, 2007). Among the full suite of grazing management guidelines, those most applicable to this watershed study are summarized as follows:

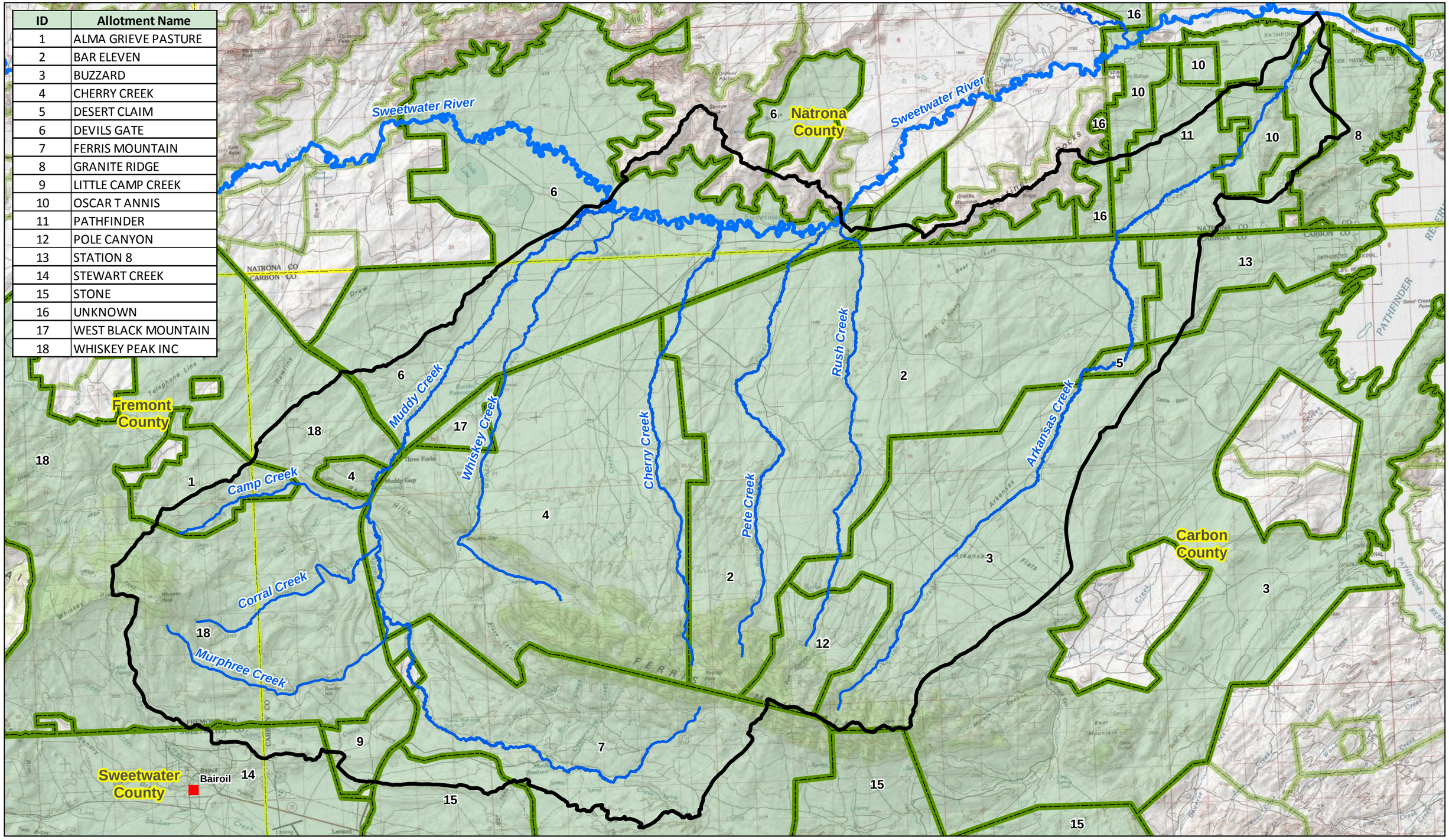
- Ensure that conditions after grazing use will support infiltration, maintain soil moisture storage, stabilize soils, release sufficient water to maintain overall system function, and maintain soil permeability rates and other appropriate processes.

- Restore, maintain, or improve riparian plant communities to sustain adequate residual plant cover for sediment capture and groundwater recharge.

- Implement riparian improvements (e.g., instream structures, water troughs, etc.) to maintain or enhance appropriate stream channel morphology; develop springs, seeps, reservoirs, wells or other water development projects in a manner protective of watershed ecological and hydrological functions; and implement range improvements away from riparian areas to avoid conflicts in achieving or maintaining riparian function.

- Adopt management practices and implement range improvements that protect vegetative cover and thereby maintain, restore or enhance water quality. A set of six standards have been established to meet the above guidelines (BLM, 2007). Each standard sets a specific objective, explains the function and importance of the objective, and provides indicators to assess the attainment of the objective.

ID	Allotment Name
1	ALMA GRIEVE PASTURE
2	BAR ELEVEN
3	BUZZARD
4	CHERRY CREEK
5	DESERT CLAIM
6	DEVILS GATE
7	FERRIS MOUNTAIN
8	GRANITE RIDGE
9	LITTLE CAMP CREEK
10	OSCAR T ANNIS
11	PATHFINDER
12	POLE CANYON
13	STATION 8
14	STEWART CREEK
15	STONE
16	UNKNOWN
17	WEST BLACK MOUNTAIN
18	WHISKEY PEAK INC



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Legend

- Grazing Allotments
- Phase II Study Area
- Sweetwater River
- Streams - Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 2.26 Sweetwater River Phase II: Grazing Allotments

Implementation of appropriate range management practices and/or improvements is carried out under an activity or implementation plan, including allotment management plans (AMPs).

2.8.2 Existing Water Supply

The Phase II Study Area has the good fortune of possessing several reliable water sources for livestock and wildlife. These sources include:

- Perennial and intermittent streams,
- Springs,
- Ponds, and
- Stock tanks, reservoirs, etc.

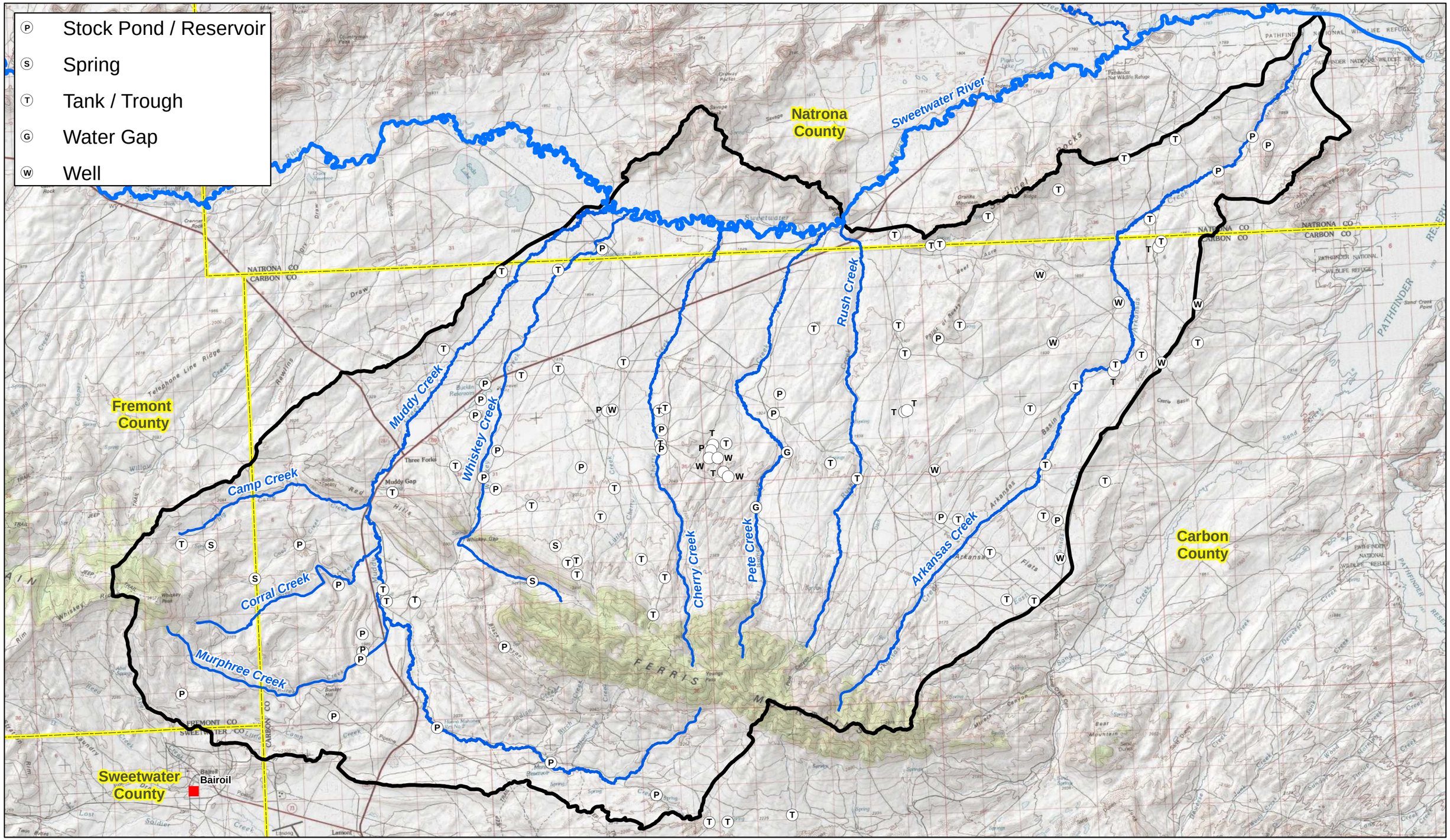
Figure 2.27 displays the general location of these sources.

Perennial and intermittent streams (when flowing) have historically served as reliable sources of water for both livestock and wildlife. Based upon a preliminary review of hydrologic conditions, perennial reaches appear to include the upper portions of the study area mainstems; including Muddy Creek, Rush Creek, Whiskey Creek, Pete Creek, Rush Creek, and Arkansas Creek. Lower reaches of the mainstems are intermittent, flowing for only portions of the year. The remainder of the watershed appears to be ephemeral and flows in response to precipitation events. Throughout most of the area, riparian conditions are in fair condition and appear to be in an 'upward' trend.

Several springs are located within the study area. These sources tend to be more isolated in comparison to the perennial streams, and are subjected to higher intensity use. Previous projects completed by the BLM and local landowners have included creation of livestock exclusions at springs experiencing heavy use.

2.8.3 Range Conditions and Needs

The majority of the Phase II Study Area has been grazed by domestic livestock (both cattle and sheep) since the late 1800's. Generally, range conditions are in "high fair" to "good" ecological condition. Range trends are generally stable to slightly upward overall.



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Legend

- Sweetwater River
- Streams- Phase II Study Area
- Cities
- Phase II Study Area
- County Boundary

0 12,500 25,000

Feet

Figure 2.27 Sweetwater River Phase II: Existing Wildlife / Livestock Water Sources

Riparian areas continue to be heavily relied upon for their wildlife and livestock water, feed values, and cover. This inhibits recovery of many of these ecologically important areas, including contributing at least locally to geomorphic stream instability.

An important factor needed to facilitate improved grazing management and thereby achieve the associated benefits to the watershed is well distributed, reliable water. Despite the relative ample water supplies within the watershed, good grazing systems control both the time (amount of time spent in an area), and the timing (the time of the year) that the livestock spend in a pasture. Grasses and other plants need to recover from the last grazing event before being grazed again. This is because food reserves in the roots must be utilized for new plant growth. If they do not get to replace these root reserves, the plants are weakened and may eventually die. Less desirable plants eventually take over and plant densities decrease. Without well distributed livestock water, areas near water (frequently riparian areas) are grazed heavily while many other areas are under utilized. Livestock water must also be reliable so that each pasture can be used as needed in a grazing rotation. Otherwise, the same pastures with reliable water get grazed repeatedly at the same crucial time of the year.

Because plants grow rapidly during the growing season, re-growth is frequently grazed multiple times during each grazing period. This results in depleted root reserves. Because of this, it is often desirable to combine herds so livestock can spend shorter time periods in one pasture. This requires adequate quantities of water to accommodate larger herds.

In addition to restoration of more healthy conditions in currently impacted riparian areas, continuing adjustments in overall range management will contribute to the maintenance, recovery or improvement of a variety of interrelated aspects of watershed function, including but not necessarily limited to:

- Improved infiltration of snowmelt and rainfall;
- Retention of soil moisture;
- Groundwater recharge;
- Sustained release of soil moisture and groundwater as seeps/springs; and
- Stabilization of soils against erosion into streams.

In general, most range improvement practices which improve watershed and livestock values also improve wildlife habitat values. With important and sensitive species such as sage grouse, care must be taken to ensure that practices are beneficial rather than detrimental to their habitat values. Examples of this include the need for mixed age stands of sagebrush,

adequate vegetative residues, wildlife escape ramps from livestock tanks, and provisions for wildlife water.

Alternatives to address the need for additional wildlife/livestock watering sites are presented in Section 3.5. Potential management practices and improvements to address other rangeland/grazing related issues are included in Section 3.6. It is important to consider that to be cost-effective any range improvement practices/facilities that may be implemented must be followed up with a good grazing system. Otherwise, any short term gains will be lost, and often made worse. Since the key to any good grazing system is usually a good, reliable livestock water system, this usually is the most cost-effective practice to initiate the process. The best value for the investment of resources usually occurs on the more productive land. Land that is too steep or shallow can only show limited returns on investments. Finally, to work in the long run, any change in range management must be supported by the land user.

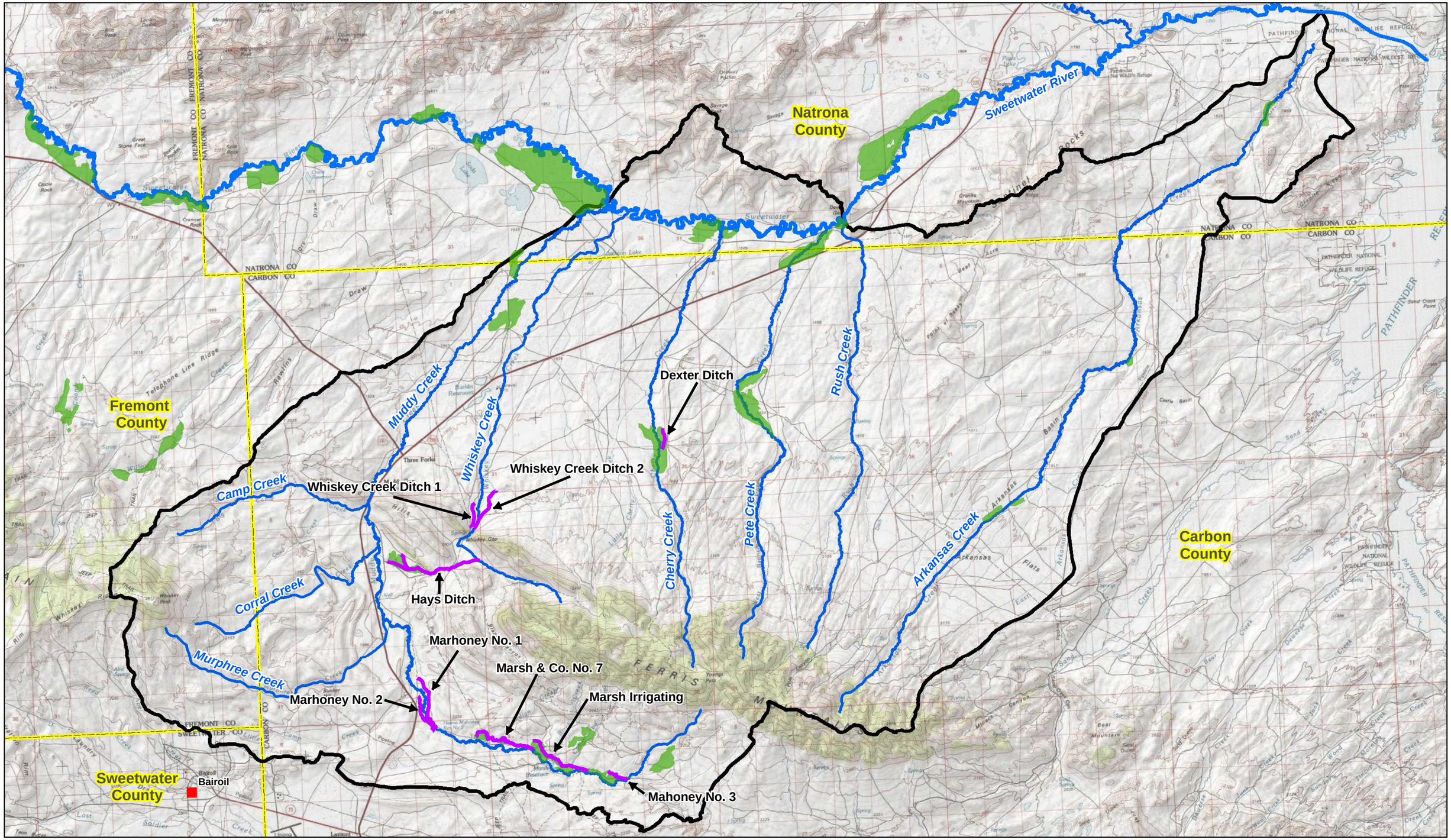
2.9 Irrigation

2.9.1 Irrigation Overview

Irrigation systems within the Phase II Study Area are limited to a handful of small privately owned ditches. Total irrigated acres within the watershed were determined to be approximately 1,603 acres based upon spatial data available through the WWDO. Appendix B summarizes the water rights information available from the WSEO. Figure 2.28 displays the extent of irrigated lands and the ditch systems inventoried.

Ditch owners were contacted and invited to participate in the irrigation system inventory phase of the project. Ditch systems were then evaluated in an effort to assess system integrity and determine rehabilitation improvements that would:

- increase the longevity of the irrigation facilities,
- provide water conservation, and
- facilitate greater irrigation efficiency.



Legend

- Inventoried Irrigation Ditches
- Irrigated Land
- Sweetwater River
- Streams- Phase II Study Area
- Cities
- Phase II Study Area
- County Boundary

N W E S

0 12,500 25,000

Feet

Figure 2.28 Sweetwater River Phase II: Inventoried Irrigation Ditches and Irrigated Lands

The inventory effort consisted of:

- Interviewing landowners;
- Field inventory of hydraulic structures;
- Inventory of ditch conditions;
- Assessment of the hydraulic efficiency of the structures;
- Photographic documentation of the structures and their condition;
- Location of the structures using GPS technology, and
- Incorporation of data into the project GIS.

The landowners requesting an inventory of existing irrigation facilities included:

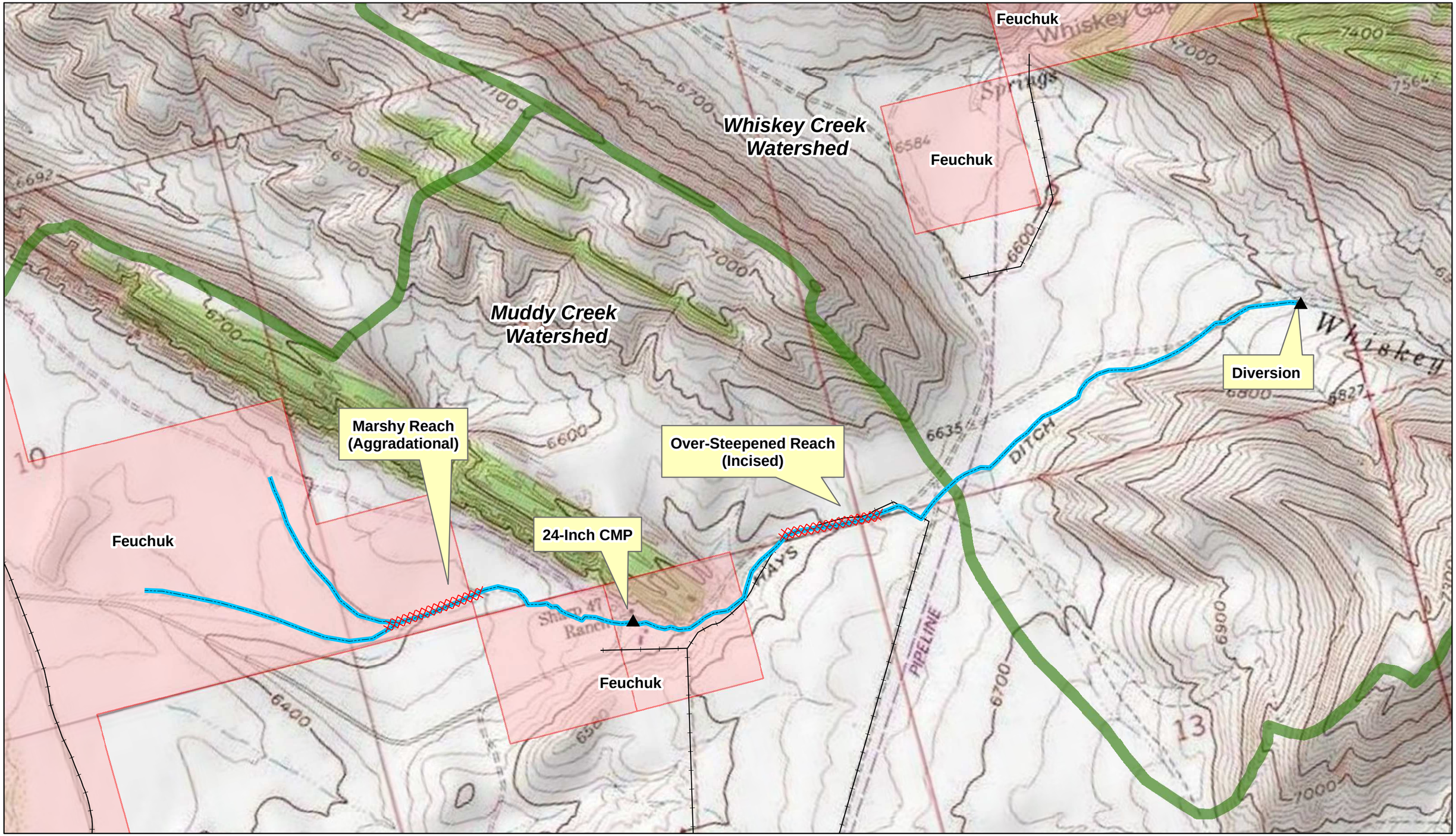
- Hays Ditch
- Mahoney / Marsh Ditches
- Whiskey Creek Ditches
- Dexter Ditch

2.9.2 Hays Ditch Inventory (Feuchuk)

The Hays Ditch diverts water from Whiskey Creek under Permit Number P2121D with a priority date of May 19, 1899. The permit has an appropriation of 1.28 cubic feet per second for a total of eighty-five (85) acres. The water right is held by Ellen Feuchuk who irrigates property in Section 10, T. 27 N., R. 89 W. The total length of the ditch is approximately 2.9 miles. The system was inventoried in October, 2008. Figure 2.29 displays a map of the system and location of features discussed below. The following observations pertaining to the Hay Ditch were recorded:

- There is currently no physical diversion structure on Whiskey Creek. Presently, flows are diverted from the creek by manipulating two 12-inch diameter CMPs within the creek. The system appears functional, however, modification of diversions is problematic (Figure 2.30). There is no measurement device in the vicinity of the diversion.

Figure 2.30 Hays Ditch Diversion on Whiskey Creek.



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Feet

Legend

- Private Land
- Watershed Boundary
- Hays Ditch - Existing
- Fence
- Irrigation Structure
- Unstable Reach

Figure 2.29 Sweetwater River Phase II: Hays Ditch Irrigation Inventory

- The ditch is entirely earthen; there are no lined or piped sections. It initially is aligned along the contour and appears to be relatively stable. Approximately 0.8 miles downstream of the diversion, the ditch slope increases where it joins a native drainage. This reach appears to be incising, however, considering the age of the ditch (>100 years), the incision does not appear severe (Figure 2.31).

Figure 2.31 Hays Ditch Incised Reach.

- Sediment derived in the erosive reach may exacerbate conveyance limitations downstream. Downstream of the Feuchuk Ranch, the ditch enters a marshy area (Figure 2.32). Evidence of the ditch is lost in this area and it is our understanding that conveyance to the ditches downstream is problematic.

Figure 2.32 Hays Ditch Marshy Reach.

2.9.3 Mahoney / Marsh Ditches (Raymond)

The Raymond system inventory included inventory of irrigation system components of five separate ditches: Marsh Irrigating Ditch (Territorial Permit), Marsh & Co. No. 7 Ditch (Permit No. 1966), Mahoney No. 1 Ditch (Permit No. 1889), Mahoney No. 2 Ditch (Permit No. 1888), and the Mahoney No. 3 Ditch (Permit Nos. 1951 and 1965). Water rights associated with these ditches are included in Appendix B. The water rights are held by Gary Raymond who irrigates property within the Muddy Creek floodplain. Reservoirs associated with the ditches include the Hanna Mahoney Reservoir (Permit No. 824R) and the Marsh & Co. Reservoir (Permit No. 825R). The system was inventoried in October, 2008. Figure 2.33 displays a map of the Marsh Irrigating, Marsh & Co. No. 7, and Mahoney No. 3 Ditches. Figure 2.34 displays a figure of the Mahoney Nos. 1 and 2 Ditches. The following observations were recorded for these systems:

- The diversion structure for the Mahoney No. 3 ditch on Muddy Creek appeared functional but was classified as being in 'poor' condition. The structure lacks the ability to easily regulate flows diverted into the ditch (Figure 2.35).

FERRIS MOUNTAIN RANCH, INC.

FERRIS MOUNTAIN RANCH, INC.

FERRIS MOUNTAIN RANCH, INC.

FERRIS MOUNTAIN RANCH, INC.

FERRIS MOUNTAIN RANCH, INC.

Marsh & Co. No. 7

Diversion

Marsh Reservoir

18-inch CMP

24-inch CMP

12-inch Parshall Flume

Marsh Irrigating

Diversion

Vegetation

Mahoney No. 3 Diversion

Mahoney No. 3

N

W E

S

0 1,500 3,000

Feet

Legend

Private Land

Watershed Boundary

Irrigation Structure

Irrigation Ditch

Fence

Figure 2.33 Sweetwater River Phase II: Ferris Mountain Ranch Irrigation Ditches Inventory (Upper)

Dense Vegetation in Ditch

Spillway - Failed

18-in CMP

Degraded Channel

Mahoney No. 1

Seep

24-in CMP

FERRIS MOUNTAIN RANCH, INC.

Mahoney No. 2

24-in CMP

TULLY, GEORGE E.

TULLY, GEORGE E.

N E S W

0 800 1,600

Feet

Legend

Irrigation Ditches

Watershed Boundary

Irrigation Structure

Fence

Private Land

Figure 2.34 Sweetwater River Phase II: Mahoney Irrigation Ditches Inventory (Lower)

- The Marsh Irrigating Ditch headgate appears to be relatively new, however, the diversion structure in Muddy Creek is in poor condition. The structure appears to be functional but requiring frequent reconstruction and reconfiguration. It consists of loosely fabricated metal fence posts and plastic tarps (Figure 2.36).

Figure 2.35 Mahoney No. 3 Headgate.

- With the exception of the Marsh Irrigating Ditch, measurement devices were not observed on any of the ditch systems.

- The spillway from the Hanna Mahoney Reservoir had recently been reconstructed and subsequently failed. According to Mr. Raymond, the structure was in the process of being redesigned and reconstructed.

Figure2.36 Marsh Irrigating Ditch Diversion on Muddy Creek.

- The reach of the Mahoney No. 1 ditch extending from its origin at the Hanna Mahoney Reservoir and extending approximately 500 feet is heavily choked with vegetation which appears to impede ditch flow and likely contributes to conveyance losses (Figure 2.37).

- Minor seepage was noted on the Mahoney No. 2 ditch.

Figure 2.37 Heavily Vegetated Reach of Mahoney No. 1 Ditch.

2.9.4 Whiskey Creek Ditches Nos. 1 and 2 / Dexter Ditch Inventory

The Whiskey Creek Ditches and Dexter Ditch are small ditches located on Whiskey Creek and Cherry Creek, respectively. Figure 2.38 displays the locations of the Whiskey Creek ditches and the Dexter Ditch, respectively. The ditches divert flows under the following permits:

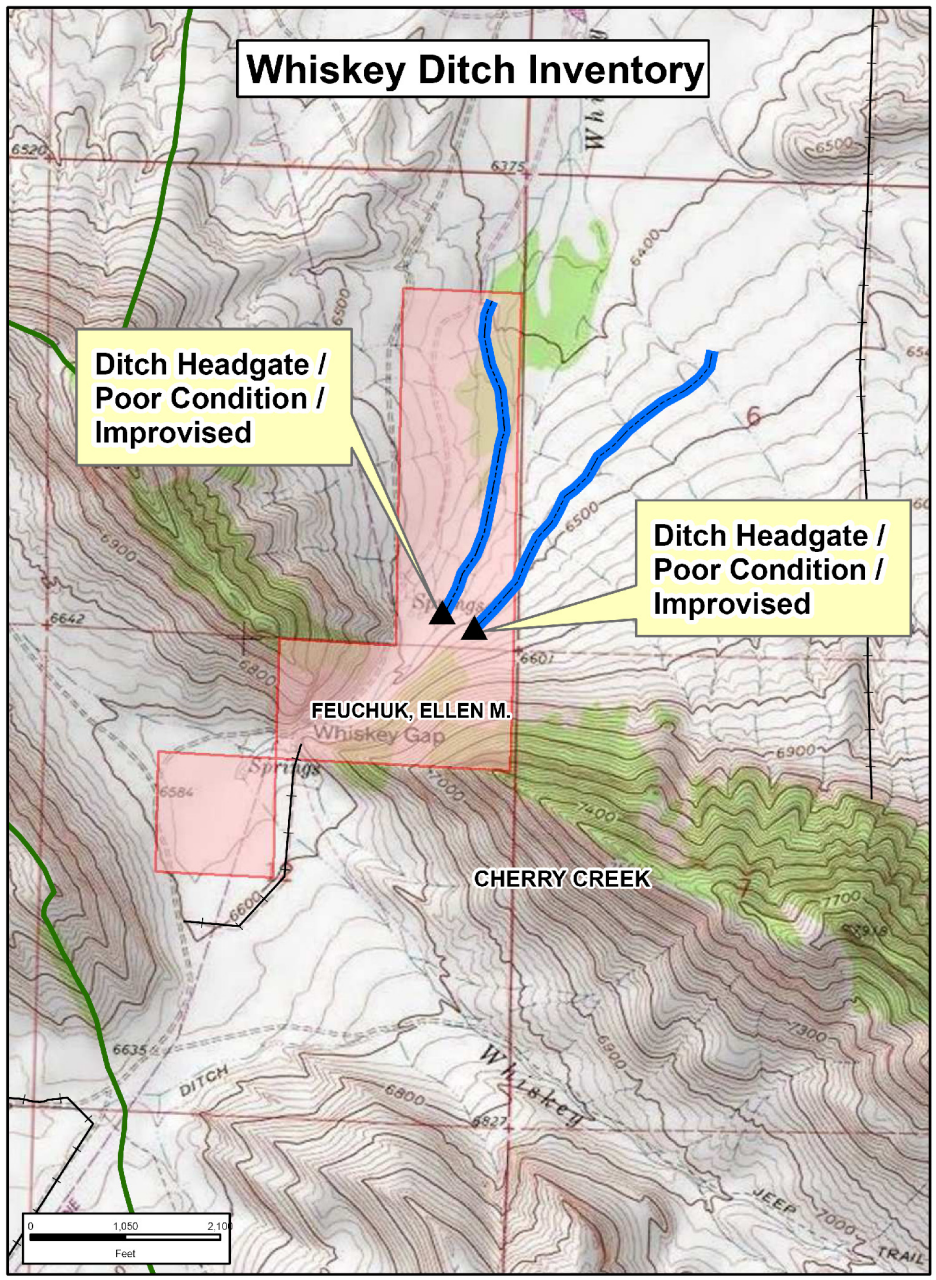
- Whiskey Creek Ditch No. 1 diverts under permit No. 1251 with a priority date of May 9, 1896.

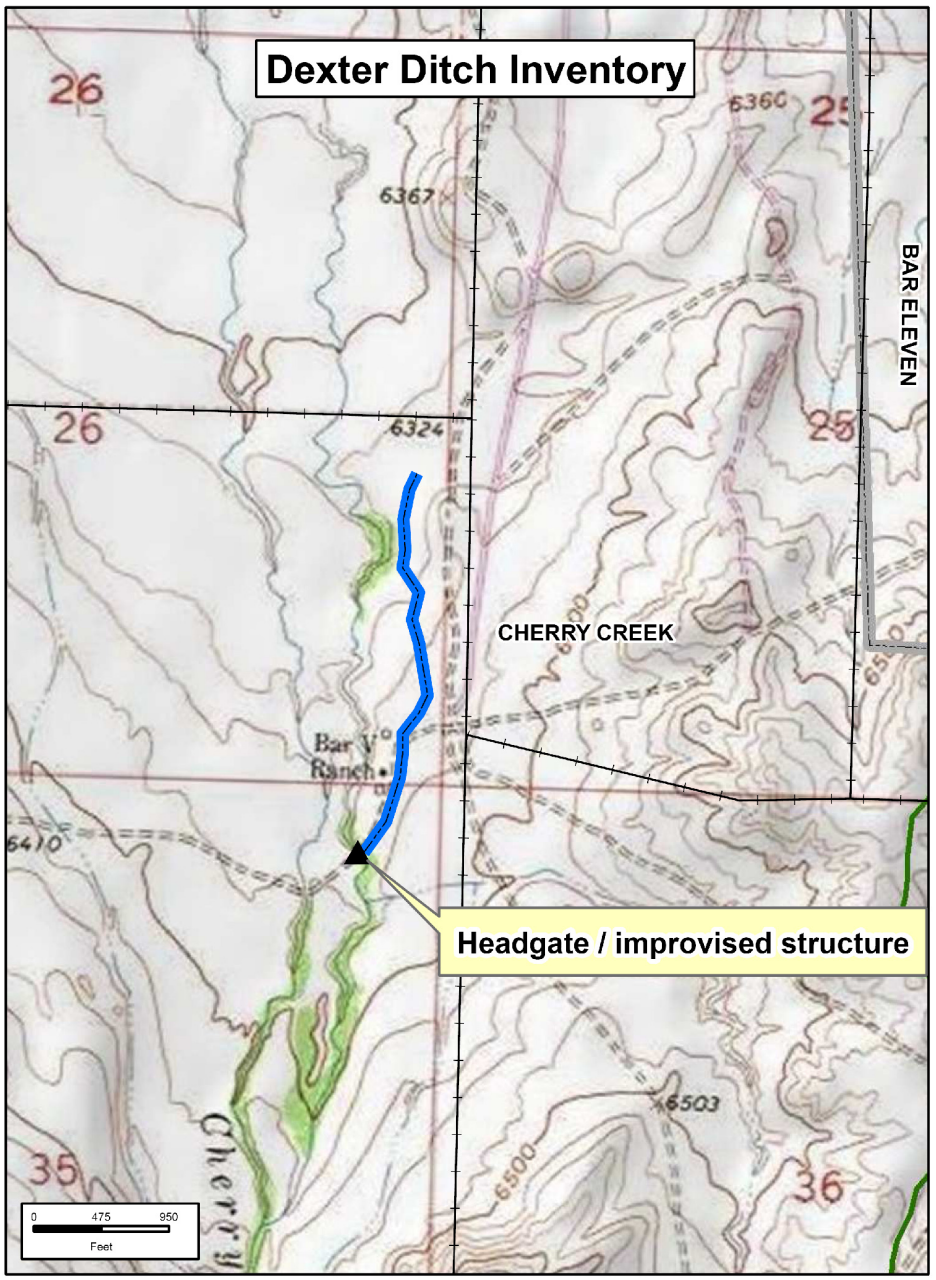
- Whiskey Creek Ditch No. 2 diverts under permit No. 1252 with a priority date of May 9, 1896.

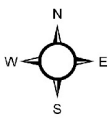
- Dexter Ditch diverts under a territorial permit with a priority date of April 24, 1885.

- At the request of the ditch representative, only the ditch headgate was evaluated; there are no other structures needing rehabilitation or replacement on these ditches. Consequently, no reference nor implications regarding the condition of the remaining ditch or associated infrastructure are made. The following observation was made regarding the ditch headgates:

- The headgate structures of each ditch were in poor condition and consisted of loosely fabricated post and tarp structures that lack the ability to adequately control diversions and require frequent reconstruction.







Legend

- Private Land
- Allotment Boundary
- Watershed Boundary
- Fence
- Irrigation Ditch
- Irrigation Structure

Figure 2.38 Sweetwater River Phase II: Whiskey Ditch and Dexter Ditch Irrigation Inventory

III. WATERSHED MANAGEMENT AND REHABILITATION PLAN

III. WATERSHED MANAGEMENT AND REHABILITATION PLAN

3.1 Overview

As stated previously, the objective of this study is to generate a watershed management plan that is not only technically sound, but also one that is practical and economically feasible. In conjunction with the development of a database for the watershed, the investigative phase of this study focused on an assessment of the watershed and the identification and evaluation of improvements to address those issues/problems described in Chapter 2. Potential improvements were developed and categorized into the following:

- Irrigation System Conservation and Rehabilitation. The inventory and evaluation of the existing infrastructure was completed and improvements identified for the rehabilitation or replacement of existing structures.

- Stream Channel Condition and Stability. Stream channels within the watershed were characterized with respect to their condition and stability. Impaired channels were identified for further evaluation and alternative improvements developed.

- Livestock / Wildlife Watering Opportunities. Based upon an evaluation of existing water sources and the condition of upland grazing resources, potential upland water source development projects were identified.

- Grazing Management Opportunities. Based upon a review of the pertinent Ecological Site Descriptions (ESDs) and the ambient vegetation and soil conditions, grazing management strategies are presented.

- Other Upland Management Opportunities. Additional watershed management alternatives were identified.

Watershed or irrigation rehabilitation plans have been developed for each category, and are presented in the following portions of this chapter. These plans have been prepared to provide an overview of potential improvements that can partially or fully address the key issues/problems identified within the watershed.

In the remainder of this chapter, the individual plans developed within each discipline are described and evaluated with respect to providing benefits to range conditions and utilization, improvement of riparian conditions, and improving the existing water supply through conservation. The results of the geomorphic assessment are further refined to identify those impaired reaches that merit more immediate attention. With respect to irrigation

rehabilitation, the plans prepared for irrigation systems are further prioritized to identify those improvements that provide the most benefit. In summary, this chapter provides the PACD with a plan that can be used to guide future efforts to enhance the water and range resources within the Phase II Study Area.

3.2 Irrigation System Conservation and Rehabilitation

In this section, a conceptual rehabilitation plan is presented for the inventoried irrigation ditches. The rehabilitation plan represents the integration of individual measures to mitigate problems identified in the inventory phase of the project. Specifically, the improvements that comprise the rehabilitation plan focus on:

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

The plan is intended to provide the ditch owners an assessment of conditions associated with the ditch and its associated hydraulic structures. The irrigator can use the plan as a "resource or wish list" from which they can select projects for potential future funding assistance from sources such as the WWDC Small Water Project Program or NRCS EQIP.

In an effort to assist the ditch owner in prioritizing potential improvements to each ditch, relative priorities were defined as follows:

Priority 1: Install, replace, or rehabilitate aging infrastructure critical to the diversion and delivery of water.

Priority 2: Install, replace, or rehabilitate aging infrastructure critical to the operation, measurement, and management of the irrigation diversions.

Priority 3: Install, replace, or rehabilitate aging infrastructure to provide improvements in on-farm efficiency and conservation.

3.2.1 Hays Ditch Rehabilitation Plan

Based upon the results of the field inventory, the conceptual rehabilitation plan was developed and is presented in Table 3.1 and graphically in Figure 3.1

Table 3.1 Conceptual-Level Rehabilitation Plan: Hays Ditch.

Hays Ditch			
Rehabilitation Item Number	**Description**	**Station (feet from headgate)**	**Priority**
1	Install diversion structure in Whiskey Creek	0.0	1
2	Install 2-ft Parshall flume at diversion structure	100	2
3	Install approx. 1,000 ft of 12-inch PIP	To Be Determined	2
4	Realign laterals around marsh area (approx. 5,000 feet total)	103+00 to lateral ends	2
5	Install 12-inch farm turnout headgate	To Be Determined	2
6	Install 3-ft wide check structure	Varies	2
7	Install 8-inch gated pipe (app. 3,000 LF)	To Be Determined	3

The following improvements are included in the plan:

- A permanent diversion structure should be constructed on Whiskey Creek. The structure should include controllable gate (e.g, Waterman 18-inch Canal Gate) and a rock sill across Whiskey Creek to facilitate diversion.
- A Parshall Flume (24-inch) is recommended for placement in the vicinity of the diversion.
- In an effort to reduce incision and downstream sedimentation, a 12-diameter pipe is recommended for placement within the steepened reach. The pipe would be approximately 1,000 feet long and include inlet and outlet structures.
- Upstream of the marsh area, the ditch could be split into two lateral ditches. Each lateral could be aligned as indicated on Figure 3.1.
- A canal headgate (e.g, Waterman 18-inch) would be placed on the northern lateral and a check structure would be located immediately downstream of the split.
- Gated pipe should be installed at selected locations within irrigated parcels under each ditch in an effort to increase efficiency on the irrigated parcel, particularly during periods of low flow when existing flood irrigation methods may not result in efficient delivery of irrigation water.

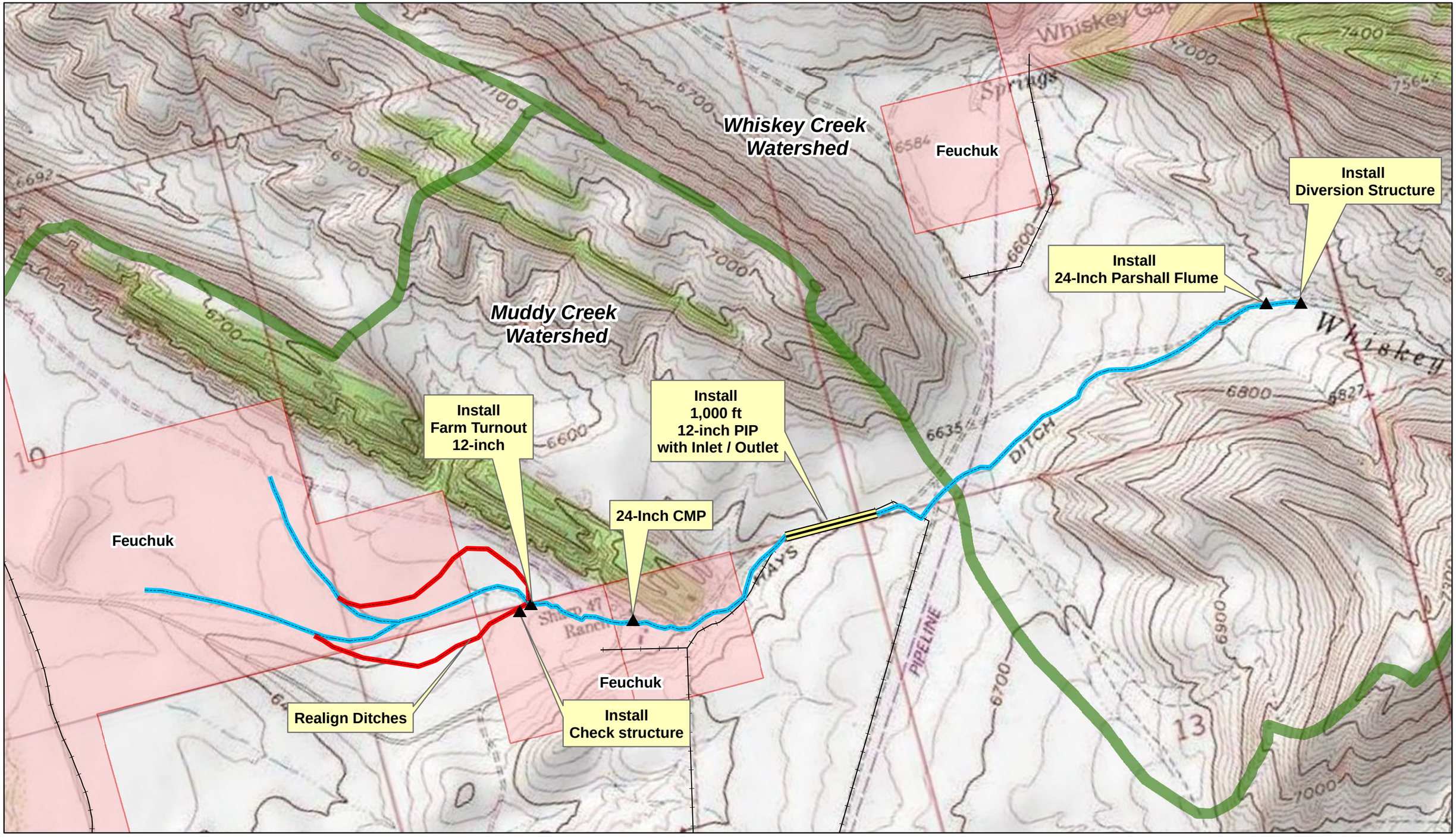


Figure 3.1 Sweetwater River Phase II: Feuchuk Irrigation Rehabilitation Plan: Hays Ditch

3.2.2 Mahoney / Marsh Ditches Rehabilitation Plan

According to the ditch owner (Raymond), the ditches are functional and there are no issues concerning operation and delivery of irrigation water. Based upon the results of the field inventory, the conceptual rehabilitation plan was developed and is presented in Table 3.2 and graphically in Figures 3.2 and 3.3. As indicated in the figures, recommendations regarding these ditches.

Table 3.2 Conceptual-Level Rehabilitation Plan: Mahoney / Marsh Irrigation Ditches.

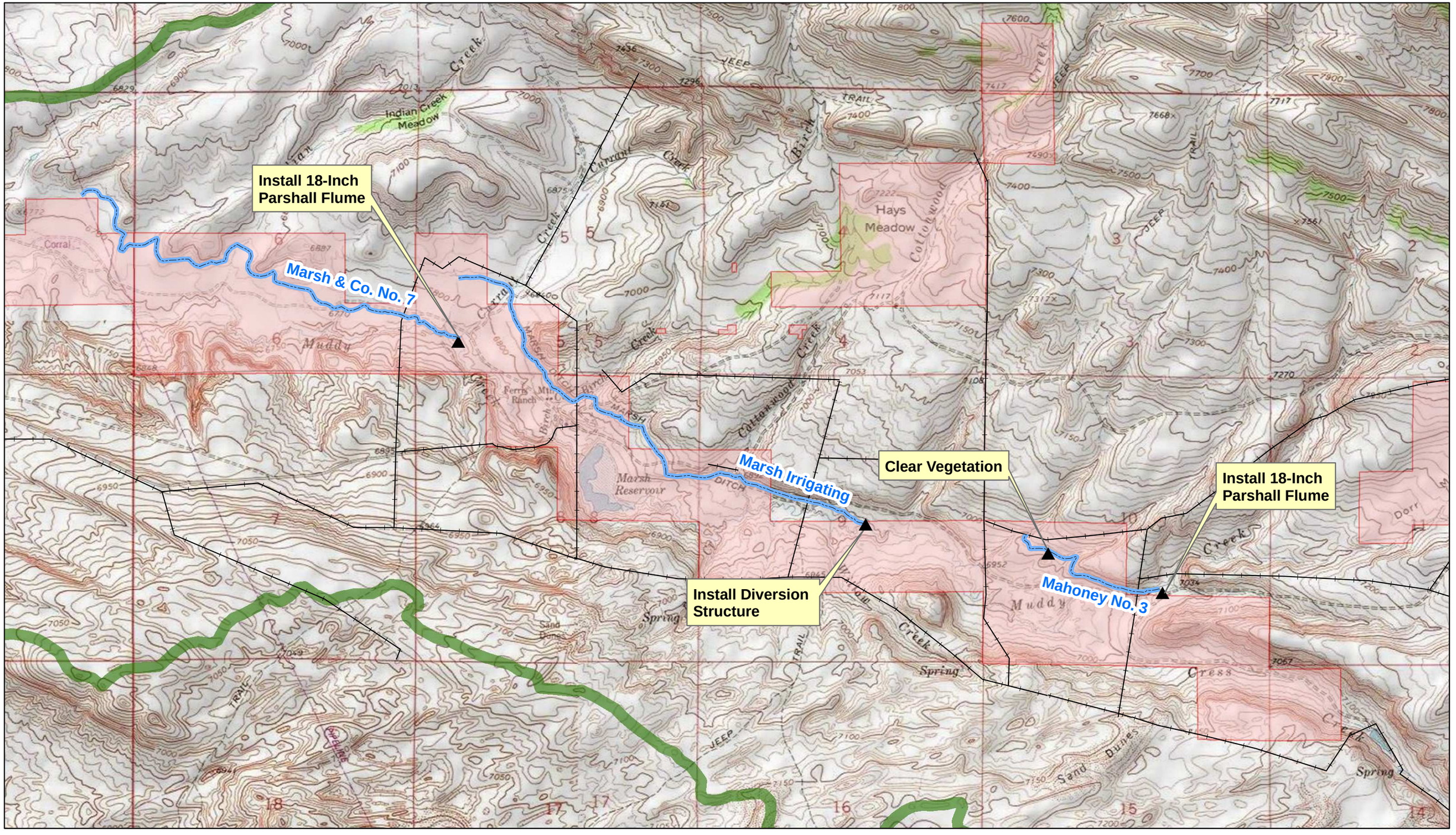
Mahoney / Marsh Irrigation Ditches			
Rehabilitation Item Number	**Description**	**Station (feet from headgate)**	**Priority**
1	Marsh Irrigating Ditch: Install diversion structure in Muddy Ck.	0.0	1
2	Install three Parshall Flumes (18-inch) on ungaged ditches	varies	2
3	Monitor rebuilt spillway	NA	1
4	Clear vegetation from selected ditch reaches	varies	1

The following improvements are included in the plan:

- For the Marsh Irrigating Ditch, a permanent diversion structure should be constructed on Muddy Creek. The structure should include controllable gate (e.g, Waterman 18-inch Canal Gate) and a rock sill across Muddy Creek to facilitate diversion.
- With the exception of the Marsh Irrigating Ditch which is equipped with a Parshall flume, measurement devices should be installed on each ditch.
- The reconstructed spillway for the Hanna Mahoney Reservoir should be monitored and inspected at regular intervals and particular following large events.
- Reaches of all ditches where vegetation has encroached should be cleared in order to improve flow conditions and to reduce evapotranspiration losses.

3.2.3 Whiskey Creek / Dexter Ditches Rehabilitation Plan

Based upon the results of the field inventory, the conceptual rehabilitation plan was developed. (Due to the simplicity of the recommendations, a figure displaying a rehabilitation plan is not included). Table 3.3 summarizes the rehabilitation plan.



N
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Feet

Legend

- Private Land
- Watershed Boundary
- Irrigation Structure
- Irrigation Ditch
- Fence

Figure 3.2 Sweetwater River Phase II: Ferris Mountain Ranch Irrigation Ditches: REHAB (Upper)

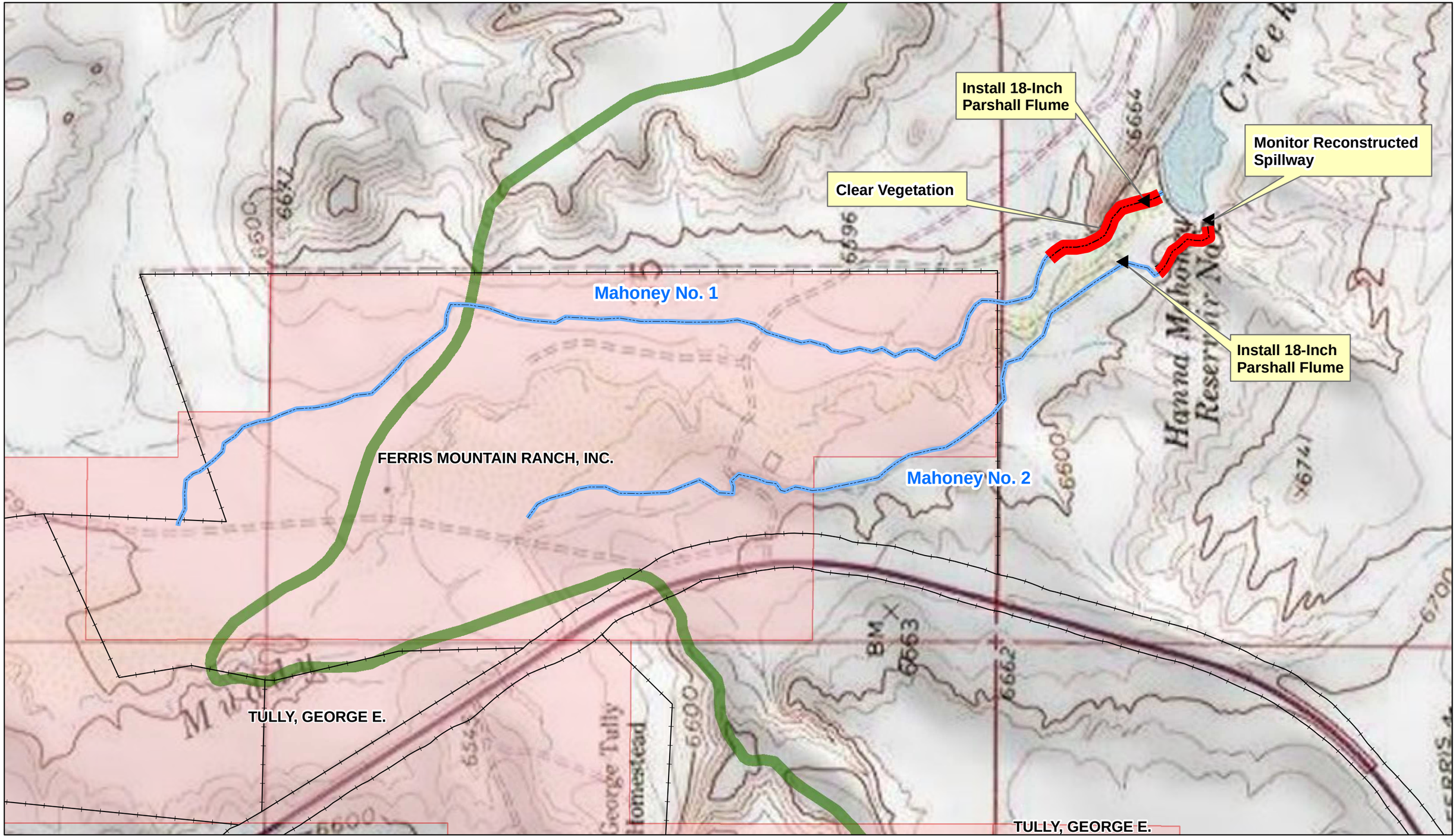


Figure 3.3 Sweetwater River Phase II: Mahoney Irrigation Ditches: REHAB (LOWER)

Table 3.3 Conceptual-Level Rehabilitation Plan: Whiskey Creek / Dexter Ditches.

Whiskey / Dexter Ditches			
Rehabilitation Item Number	**Description**	**Station (feet from headgate)**	**Priority**
1	Dexter Ditch: Install headgate	0.0	1
2	Whiskey Ditch No. 1: Install headgate	0.0	1
3	Whiskey Ditch No. 2: Install headgate	0.0	1

The following improvements are included in the plan:

- Headgate structures should be installed on each of the three ditches. The structures should include concrete headwalls and 18-inch diameter slide gates (Waterman).

3.2.4 Cost Estimates: Irrigation System Components

Conceptual level cost estimates for the irrigation system improvements are provided in Table 3.4.

3.3 Stream Channel Condition and Stability

3.3.1 Stream Channel Restoration Strategies

The general condition of the principal stream channels and primary tributaries were evaluated during the geomorphic investigation presented in Chapter 2. During the evaluation of existing channel conditions, several impaired reaches were identified and two general classes of impairments noted. The general two categories of impairments were classified as indicated below:

- Channel degradation/incision; and
- Riparian degradation (vegetation loss).

Various approaches can be taken during channel restoration and stabilization efforts, including both "hard" engineering and "soft" approaches and combinations of the two. Examples of "hard" approaches would include construction of channel structures or reconstruction of channels themselves. The selection of the appropriate mitigation/restoration

Table 3.4 Conceptual Costs: Irrigation System Improvements.

Rehabilitation Item Number	Description	Construction Cost	Engineering (10%)	Subtotal	Contingency (15%)	Total Construction Cost	Final Plans and Specs	Permitting / Legal / Access	Total Project Cost
	Hays Ditch								
1	Install diversion structure	$ 12,000	$ 1,200	$ 13,200	$ 1,980	$ 15,180	$ 2,500	$ 2,000	$ 19,680
2	Install 2-ft Parshall flume	$ 3,000	$ 300	$ 3,300	$ 495	$ 3,795	$ 500	$ -	$ 4,295
3	Install approx. 1,000 ft 12-inch PIP	$ 7,000	$ 700	$ 7,700	$ 1,155	$ 8,855	$ 2,000	$ -	$ 10,855
4	Realign Ditch	$ 4,000	$ 400	$ 4,400	$ 660	$ 5,060	$ 500	$ -	$ 5,560
5	Install 12-inch farm turnout headgate	$ 2,000	$ 200	$ 2,200	$ 330	$ 2,530	$ 500	$ -	$ 3,030
6	Install 3-ft wide check structure	$ 2,000	$ 200	$ 2,200	$ 330	$ 2,530	$ 500	$ -	$ 3,030
7	Install 8-inch gated pipe (app. 3,000 LF)	$ 10,000	$ 1,000	$ 11,000	$ 1,650	$ 12,650	$ 1,000	$ -	$ 13,650
	Mahoney / Marsh Ditches								
1	Marsh Irrigating Ditch: Install diversion structure in Muddy Ck.	$ 12,000	$ 1,200	$ 13,200	$ 1,980	$ 15,180	$ 2,500	$ -	$ 17,680
2	Install three Parshall Flumes (18-inch) on ungaged ditches	$ 9,000	$ 900	$ 9,900	$ 1,485	$ 11,385	$ 500	$ -	$ 11,885
3	Monitor rebuilt spillway	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
4	Clear vegetation from selected ditch reaches	$ 3,000	$ 300	$ 3,300	$ 495	$ 3,795	$ -	$ -	$ 3,795
	Whiskey Creek / Dexter Ditches								
1	Dexter Ditch: Install headgate	$ 4,000	$ 400	$ 4,400	$ 660	$ 5,060	$ 250	$ -	$ 5,310
2	Whiskey Ditch No. 1: Install headgate	$ 4,000	$ 400	$ 4,400	$ 660	$ 5,060	$ -	$ -	$ 5,060
3	Whiskey Ditch No. 2: Install headgate	$ 4,000	$ 400	$ 4,400	$ 660	$ 5,060	$ -	$ -	$ 5,060

technique depends upon site-specific information and critical review of hydrologic and hydraulic data. Installation of an inappropriate type of structure or improper installation could exacerbate conditions.

For instance, methods of restoring incised channels may include construction of gradient restoration facilities (i.e., drop structures, check structures) within the incised channel. Figure 3.4 displays a diagram of a typical stream channel stabilization strategy for a small channel experiencing minor downcutting. Log check dams are placed in series within a problematic reach. Figure 3.5 shows an alternative form of stream stabilization: the rock filled gabion.

Figure 3.5 Stream Stabilization Structure: Rock Filled Gabion.

Examples of "soft" approaches include a variety of Best Management Practices (BMPs). Examples of potentially applicable BMPs designed for channel restoration activities include those that result in reducing or, at least temporarily excluding wildlife and livestock from accessing designated riparian zones, establishment of riparian buffers, etc. The proposed wildlife/livestock water developments discussed previously (and others that may be identified in the future) can be considered elements of a range management BMP that will help restore over time those areas of channel impairment that have resulted from overutilization of riparian areas or adjacent upland range. Figure 3.6 displays a photo of willow fascine installation. This strategy could be employed on many of the perennial channels or intermittent where sufficient flow exists to support the vegetation, in an effort to restore riparian habitat and stabilize streambanks.

Figure 3.6 Stream Stabilization Measure: Willow Fascine Installation.

These examples of "hard" and "soft" approaches represent both extremes of the continuum of channel restoration strategies that exist. In practice, it must be kept in mind that it is generally a combination of strategies,

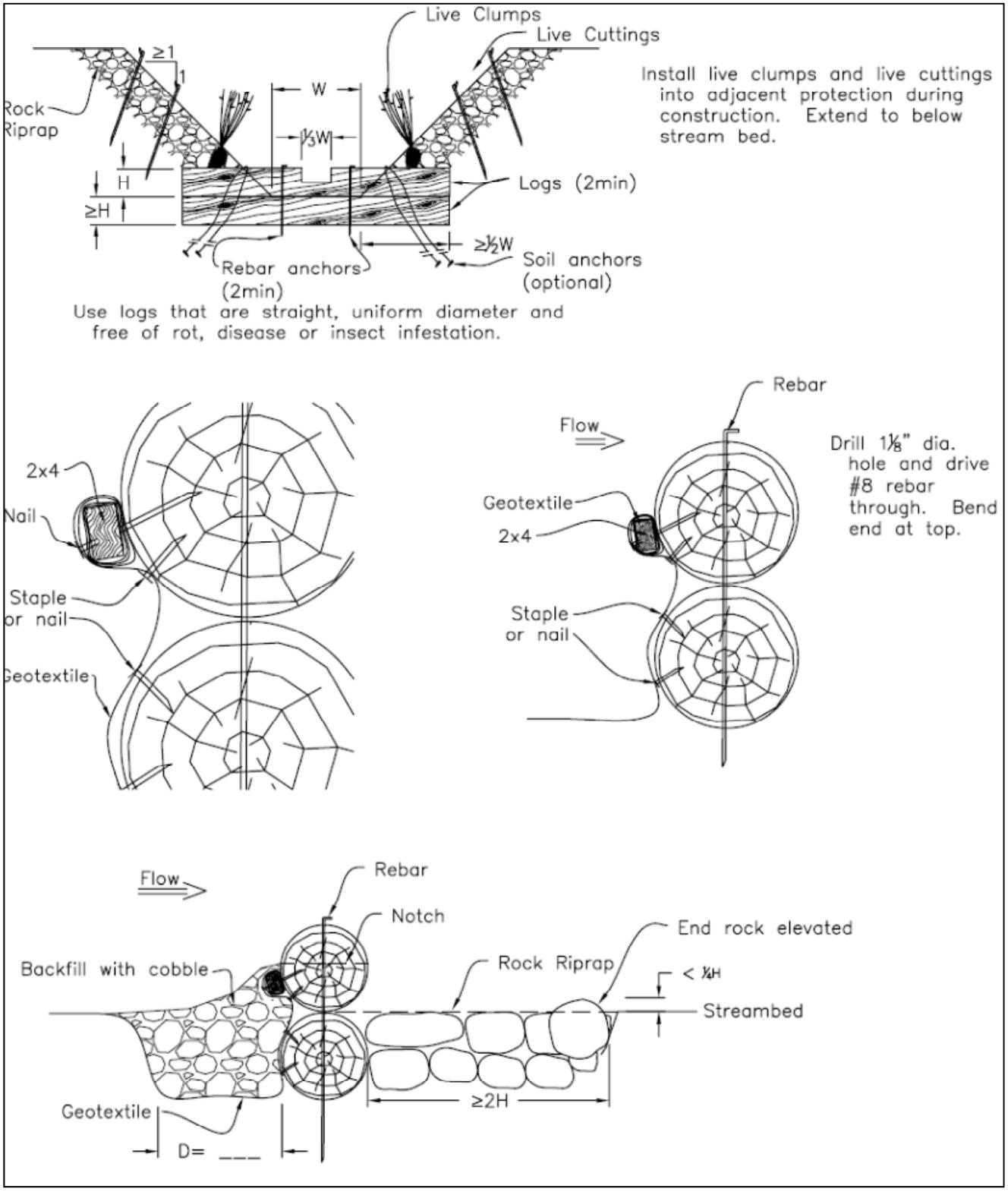


Figure 3.4 Conceptual Design: Log Check Dam.

integrated into a cohesive plan that provides the most effective solution. Table 3.5 presents a summary of some of these channel restoration strategies which can be employed during future restoration efforts. Development of more specific projects and BMPs was beyond the scope of this Level I study. Such projects can be identified and developed on the basis of more detailed geomorphic analysis of impaired stream reaches.

Table 3.5 Summary of Potential Stream Channel Stabilization/Restoration Techniques.

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

3.3.2 Stream Channel Components of the Watershed Management Plan

Based on the information presented above, the following items are presented for inclusion in the Phase II Study Area watershed management plan:

- Installation of stream channel degradation/incision mitigation measures based upon site-specific evaluation of conditions. Appropriate mitigation measures could be 'hard' engineering, 'soft' approaches, or combinations of both.

- Installation of stream bank erosion mitigation measures based upon site-specific evaluation of conditions. Appropriate mitigation measures could be 'hard' engineering, 'soft' approaches, or combinations of both.

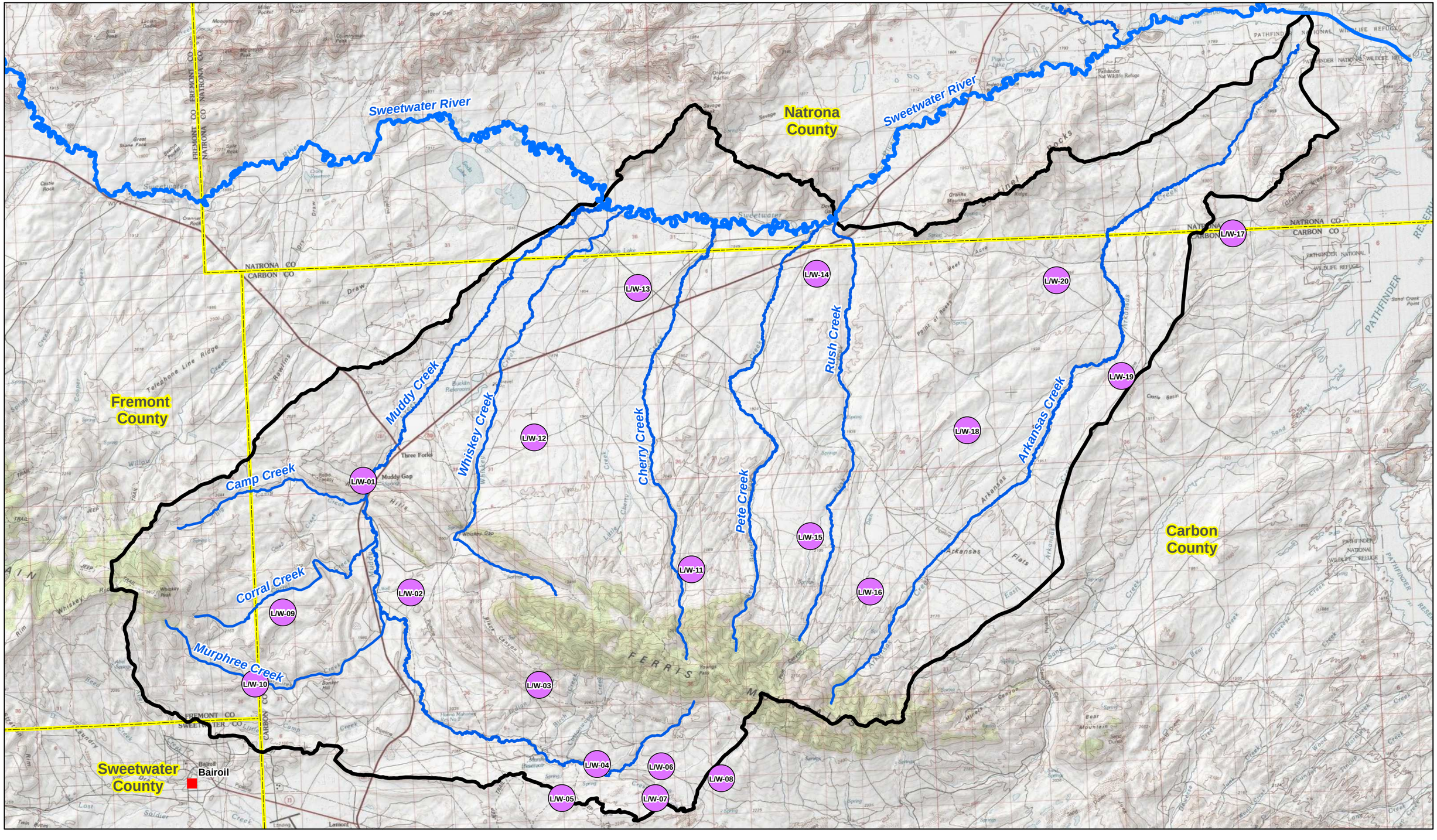
3.4 Livestock / Wildlife Watering Opportunities

Given the relatively gentle topography throughout most of the watershed, existing water sources were assumed to be capable of providing water to livestock within a one-mile radius. Based upon this premise, buffers were drawn around existing water sources. Figure 3.7 displays the existing water sources identified within the Phase II Study Area. The objective of the livestock / wildlife watering investigation was to evaluate alternative upland water supplies. Consequently, Figure 3.7 does not show buffers about perennial / intermittent streams, nor springs. As indicated in this figure, a large portion of the watershed is adequately supplied with water sources. However, based upon this analysis, several areas may benefit by the development of upland water sources. In addition, allotment permittees indicated locations where existing sources could be supplemented / developed or infrastructure enhanced.

Based upon the information presented above pertaining to existing water supplies and areas in need of upland water development, and interviews with representatives of the BLM and allotment permittees, several conceptual water development projects were identified and also illustrated in Figure 3.7. The general objective of this effort was to provide means of providing reliable sources of livestock / wildlife drinking water in water-short portions of the watershed as well as alternative water supplies to riparian corridors. In the following paragraphs, several alternatives are presented at the conceptual level. For each project, a conceptual design is also presented. It must be kept in mind that these designs are conceptual only and if implemented, detailed design would be required for these projects.

3.4.1 Muddy Gap Spring Project (Plan Component L/W-01)

This alternative would develop water available at one of several springs identified in the vicinity of Muddy Gap. The objective of this alternative would be to provide additional upland watering opportunities on the east side of Highway 287 and a new source of water on the west



N
W E
S

Legend

- Sweetwater River
- Streams - Phase II Study Area
- Phase II Study Area
- Cities
- County Boundary

0 12,500 25,000

Feet

Figure 3.7 Sweetwater River Phase II: Locations of Proposed Wildlife and Livestock Water Supply Projects

side of the highway. This project lies within the Cherry Creek Allotment. Figure 3.8 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- An existing spring would be developed to facilitate diversion to a gravity pipeline.
- The pipeline would be routed downslope to Highway 287 and cross under the highway via an existing culvert (36-inch diameter).
- Stock tanks (1,200 gallon capacity each) would be placed on each side of Highway 287.

3.4.2 McIntosh Well Enhancement (Plan Component L/W-02)

This alternative is intended to enhance existing facilities located in Section 14, T. 27 N., R. 89 W., by incorporating the capability to store water and to provide additional livestock / wildlife watering opportunities. Additional upland water sources in this area would provide additional alternatives to the riparian corridor within the Cherry Creek Allotment.

Currently, the well (referred to in BLM database as the "McIntosh Well") serves a buried HDPE pipeline extending westerly about one mile from the well. Two stock tanks are supplied by the pipeline. A third stock tank is located at the well. Figure 3.9 displays the general configuration of this alternative.

Under this alternative, the following enhancements would be installed:

- A storage tank (15,000 gallon capacity) would be installed at the existing well

3.4.3 Indian Creek Spring Development Project (Plan Component L/W-03)

Wildlife and livestock in this portion of the Muddy Creek watershed obtain water from several ephemeral and perennial streams. In an effort to relieve pressure within the riparian corridor, this alternative is provided. The objective of the project would be to provide an alternative water source to the stream and to encourage livestock usage of the upland areas. The project lies within the Ferris Mountain Allotment. The project provides the additional benefit of providing water to an adjacent fenced pasture lacking upland water sources in this area. Figure 3.10 displays the general configuration of this alternative.

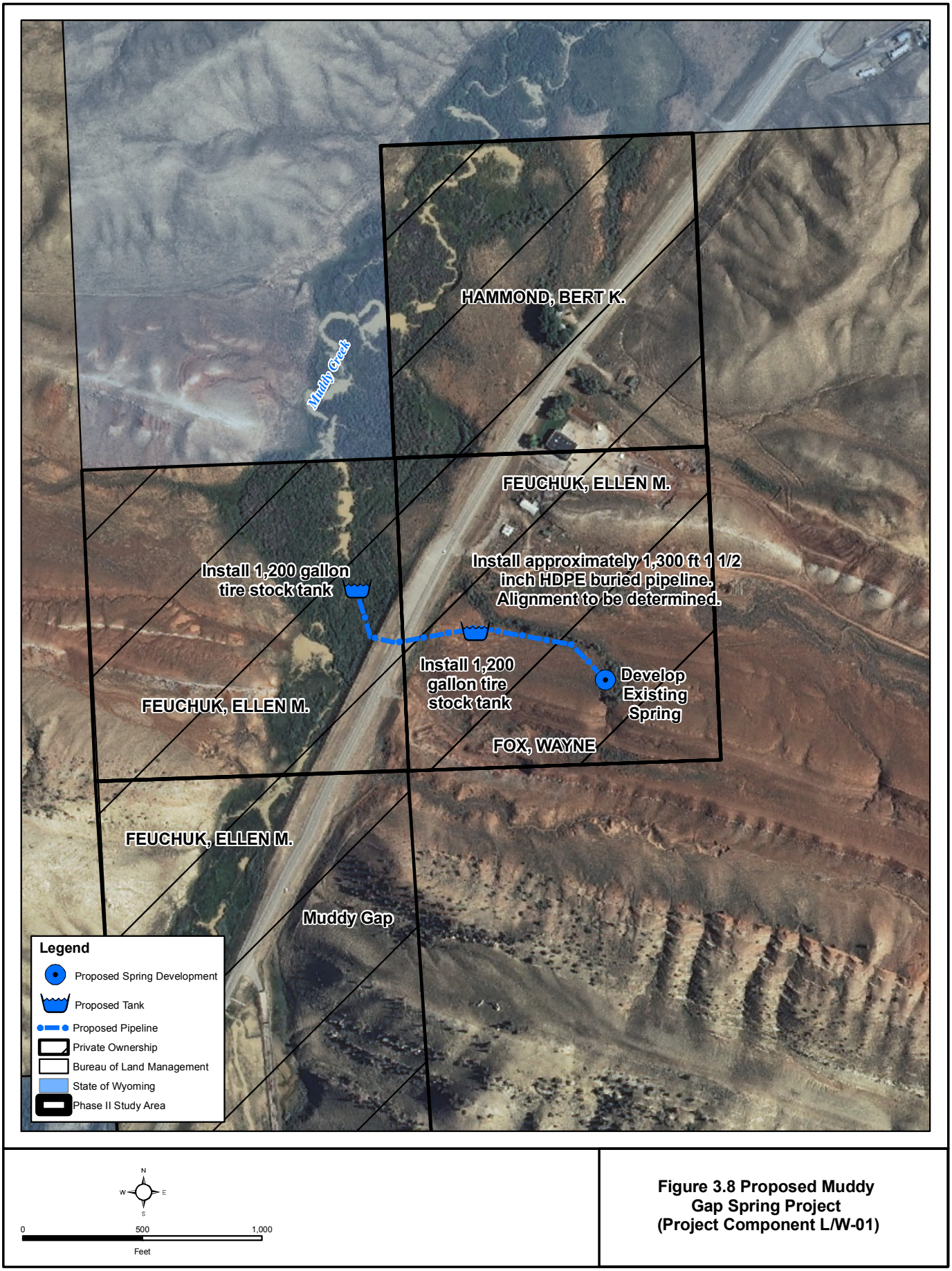


Figure 3.8 Proposed Muddy Gap Spring Project (Project Component L/W-01)

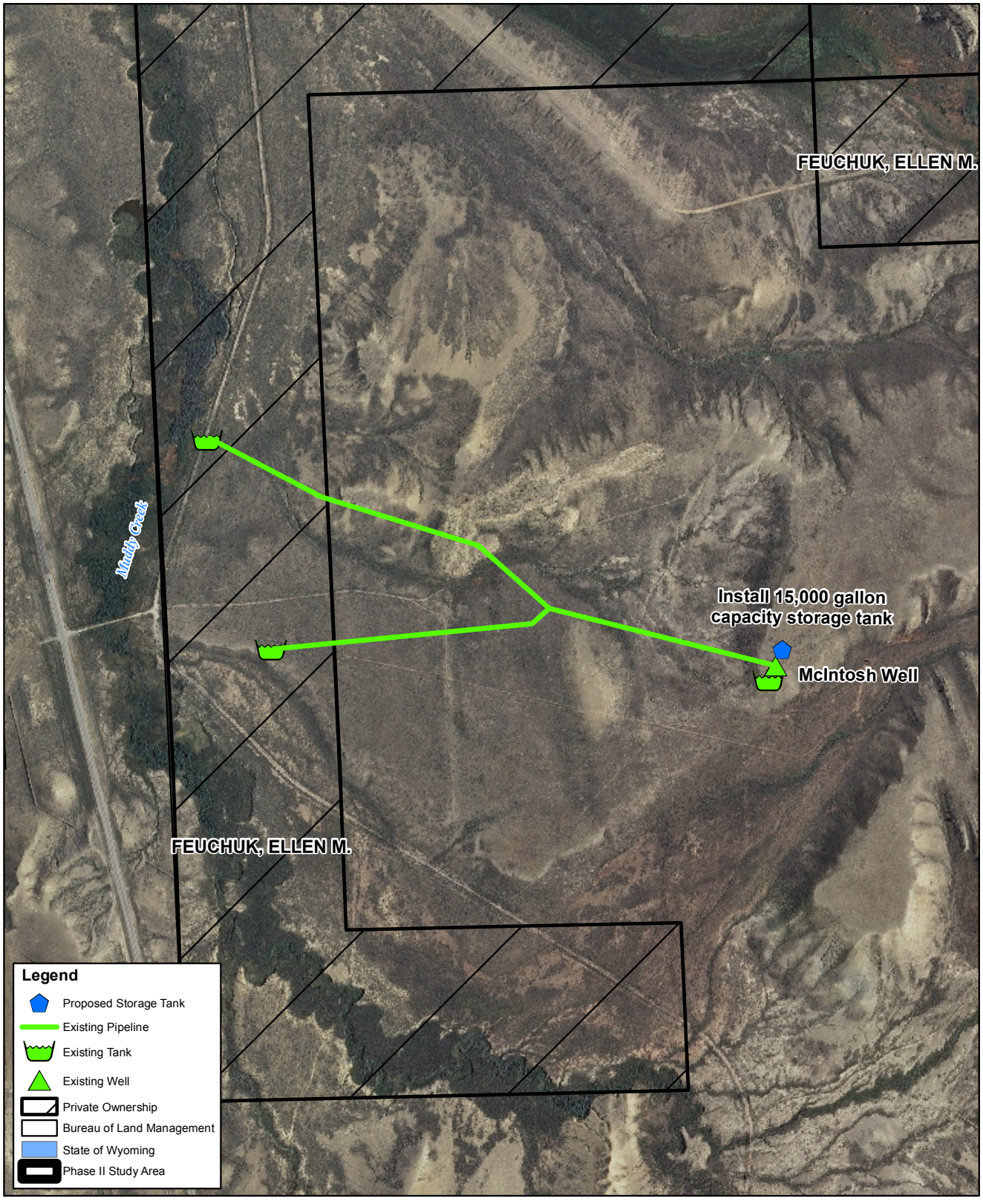


Figure 3.9 Proposed McIntosh Well Enhancement Project (Project Component L/W-02)

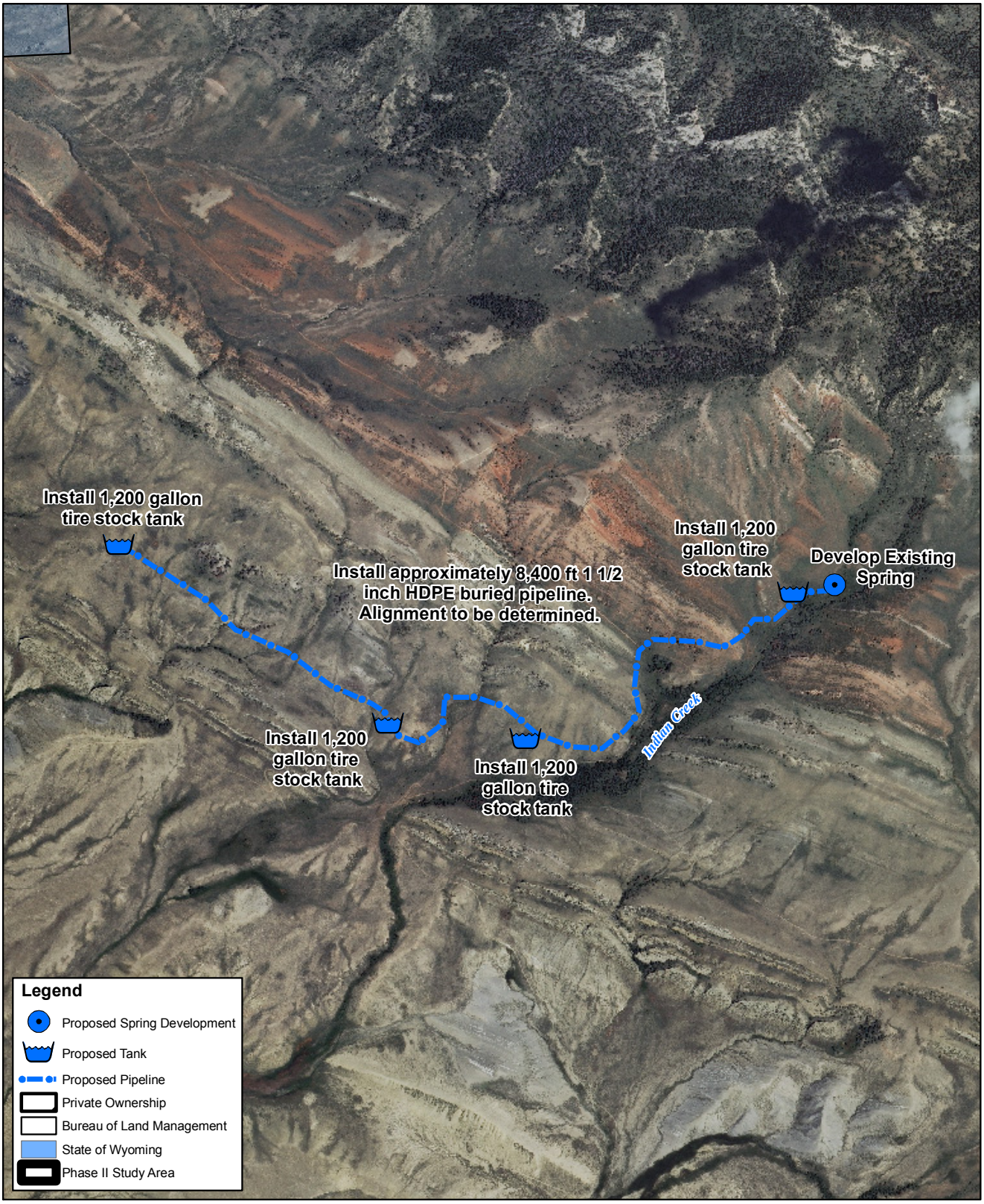


Figure 3.10 Proposed Indian Creek Spring Development (Project Component L/W-03)

Under this alternative, the following components would be employed:

- Existing springs in Indian Creek would be developed to facilitate diversion to a gravity pipeline.
- The pipeline would be routed downslope along the western side of Indian Creek. The total length of the buried HDPE pipeline (1.5 inch diameter) would be approximately 8,400 linear feet.
- Four (4) stock tanks (1,200 gallon capacity each) would be placed outside of the riparian corridor of Indian Creek.

3.4.4 Muddy Creek Pipeline Project (Plan Component L/W-04)

Wildlife and livestock in this portion of the Muddy Creek watershed obtain water from Muddy Creek. In an effort to relieve pressure within the riparian corridor, this alternative is provided. The objective of the project would be to provide an alternative water source to the stream and to encourage livestock usage of the upland areas within the Ferris Mountain Allotment. This project would involve construction of a diversion facility in Muddy Creek, a relatively short buried pipeline, and a single stock tank located outside of the riparian corridor. Figure 3.11 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- A diversion facility would be constructed in Muddy Creek. The facility would consist of a buried gravel infiltration gallery and perforated pipe. A valve would be included for management of pipeline flows.
- The buried HDPE pipeline (1.5 inch diameter) would be routed along the south side of Muddy Creek. The length of the pipeline would be approximately 1,800 linear feet.
- A stock tank (1,200 gallon capacity) would be installed at the end of the proposed pipeline.

3.4.5 Ferris Mountain Well Construction (Plan Component L/W-05)

This alternative involves the completion of a well near the southern watershed divide as indicated in Figure 3.12. This portion of the Muddy Creek watershed is arid and lacking sufficient upland livestock and wildlife water sources. Given the lack of surface water sources

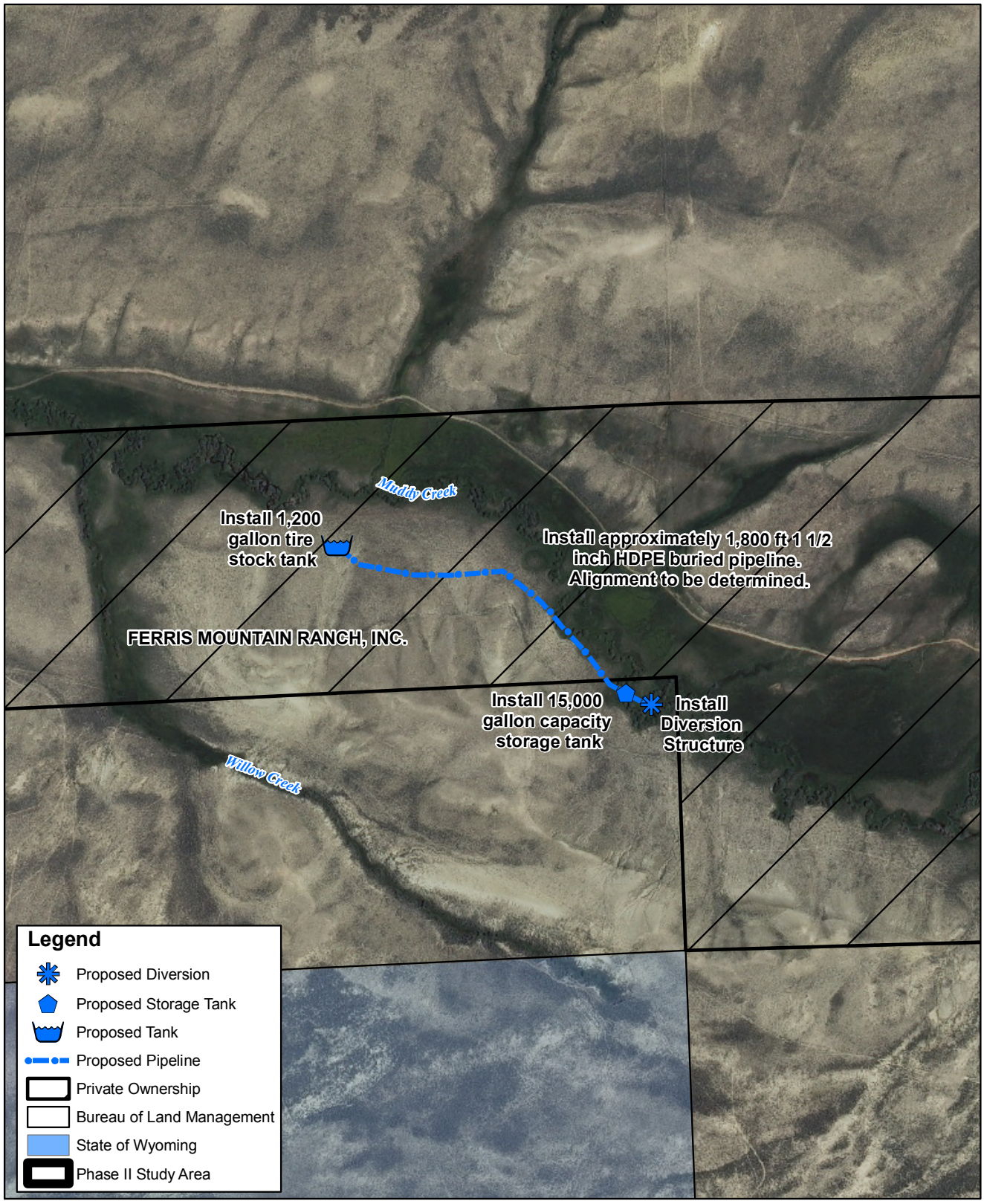


Figure 3.11 Proposed Muddy Creek Pipeline (Project Component L/W-04)

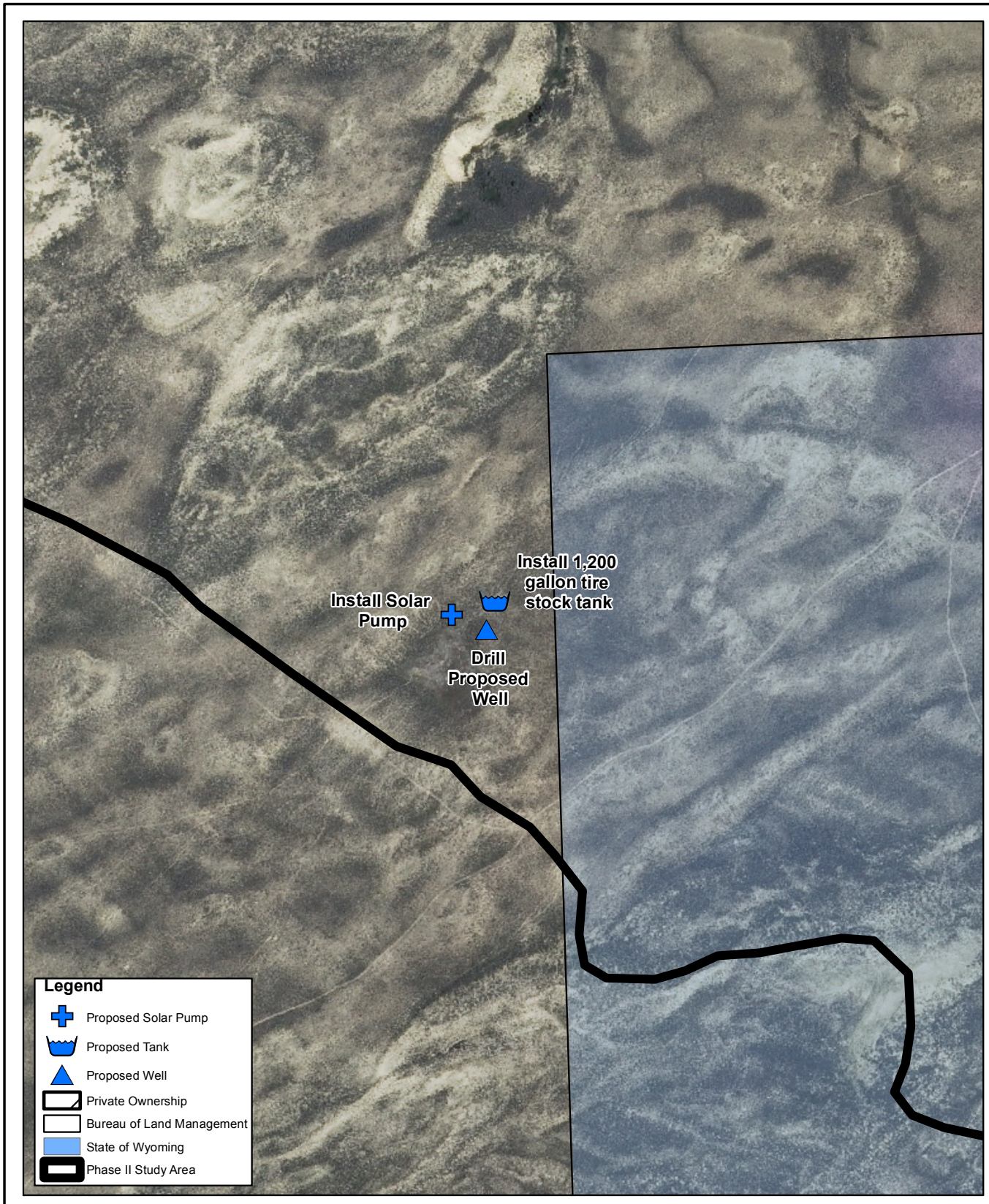


Figure 3.12 Proposed Ferris Mountain Well Construction (Project Component L/W-05)

or springs, a new well has been identified as the selected alternative. This project lies within the within the Ferris Mountain Allotment.

Under this alternative, the following components would be employed:

- A well would be constructed in the vicinity of the location shown on Figure 3.12. Existing databases do not indicate the presence of wells in the immediate vicinity to extrapolate approximate depth to water. According to representatives of the BLM, a well in this vicinity would require a minimum depth of approximately 200 feet. Evaluation of existing springs north of the proposed site indicates the depth could be on the order of 300 feet deep. For the purpose of this investigation and the uncertainty of the hydrogeologic conditions at the site, a depth of 400 feet was used for cost estimating purposes.
- The proposed well would be equipped with a solar pump.
- A stock tank (1,200 gallon capacity) would be installed at the well.

3.4.6 Muddy Creek Spring Development (Plan Component L/W-06)

Wildlife and livestock in this portion of the Muddy Creek watershed obtain water from Muddy Creek and ephemeral streams. In an effort to relieve pressure within the riparian corridors, this alternative is provided. The objective of the project would be to provide an alternative water source to the stream and to encourage livestock usage of the upland areas within the Ferris Mountain Allotment. This project would involve development of an existing spring within an unnamed drainage tributary to Muddy Creek, a relatively short buried pipeline, and a single stock tank located outside of the riparian corridor. Figure 3.13 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- An existing spring in an unnamed drainage tributary to Muddy Creek would be developed to facilitate diversion to a gravity pipeline.
- The pipeline would be routed downslope to a single stock tank (1,200 gallon capacity) located outside of the Muddy Creek riparian corridor.

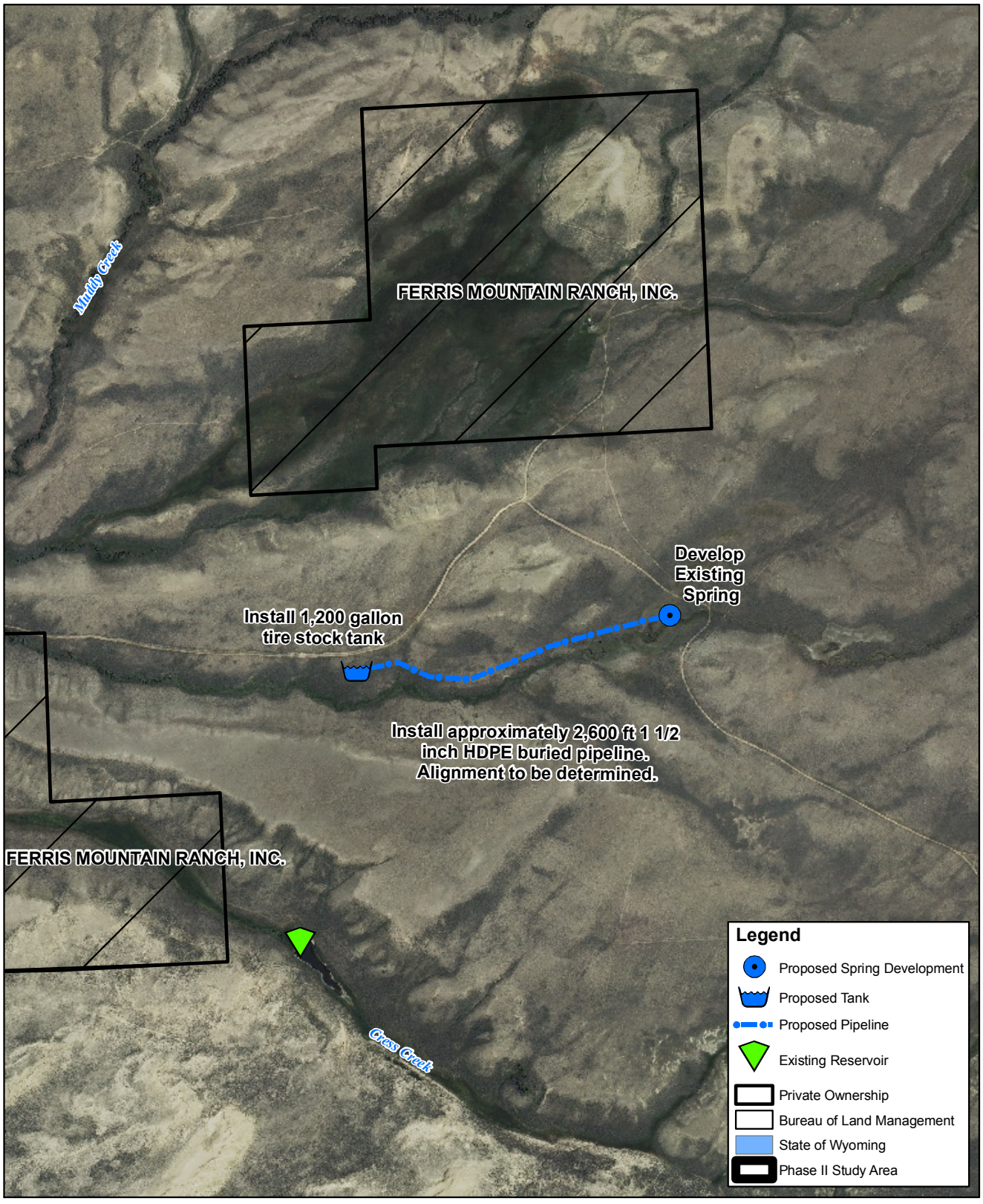


Figure 3.13 Proposed Muddy Creek Spring Development (Project Component L/W-06)

3.4.7 Cress Creek Spring Rehabilitation Project (Plan Component L/W-07)

Wildlife and livestock in this portion of the Muddy Creek watershed obtain water directly from Cress Creek, Cress Creek Reservoir, or existing springs upstream of the reservoir. In an effort to relieve pressure within the riparian corridor and for protection of the spring, this alternative is provided at the recommendation of the allottee. The objective of the project would be to provide an alternative water source to the stream and the spring and to encourage livestock usage of the upland areas within the Ferris Mountain Allotment. According to the allottee, the spring has been previously developed but is in need of rehabilitation. For the purpose of this investigation, it was assumed a new spring development would be completed for cost estimating purposes. Figure 3.14 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- A new spring development would be completed in the vicinity of the existing spring.
- The spring development would facilitate diversion of flows into a gravity pipeline.
- A short buried HDPE pipe would supply a 1,200 gallon capacity stock tank located upstream of Cress Creek Reservoir.
- The spring area would be fenced.

3.4.8 Unnamed Spring Development Project (Plan Component L/W-08)

Wildlife and livestock water sources in this portion of the Muddy Creek watershed are limited to scattered springs and intermittent streams. This project lies immediately east of the Muddy Creek watershed boundary but is included in this investigation because its radius of influence (1 mile) could potentially provide an upland source of wildlife and livestock water to the eastern limits of the watershed (Figure 3.15). The project lies within the within the Ferris Mountain Allotment.

Under this alternative, the following components would be employed:

- A new spring development would be completed and fenced.
- The spring development would facilitate diversion of flows into a gravity pipeline.
- A short buried HDPE pipe would supply a 1,200 gallon capacity stock tank.

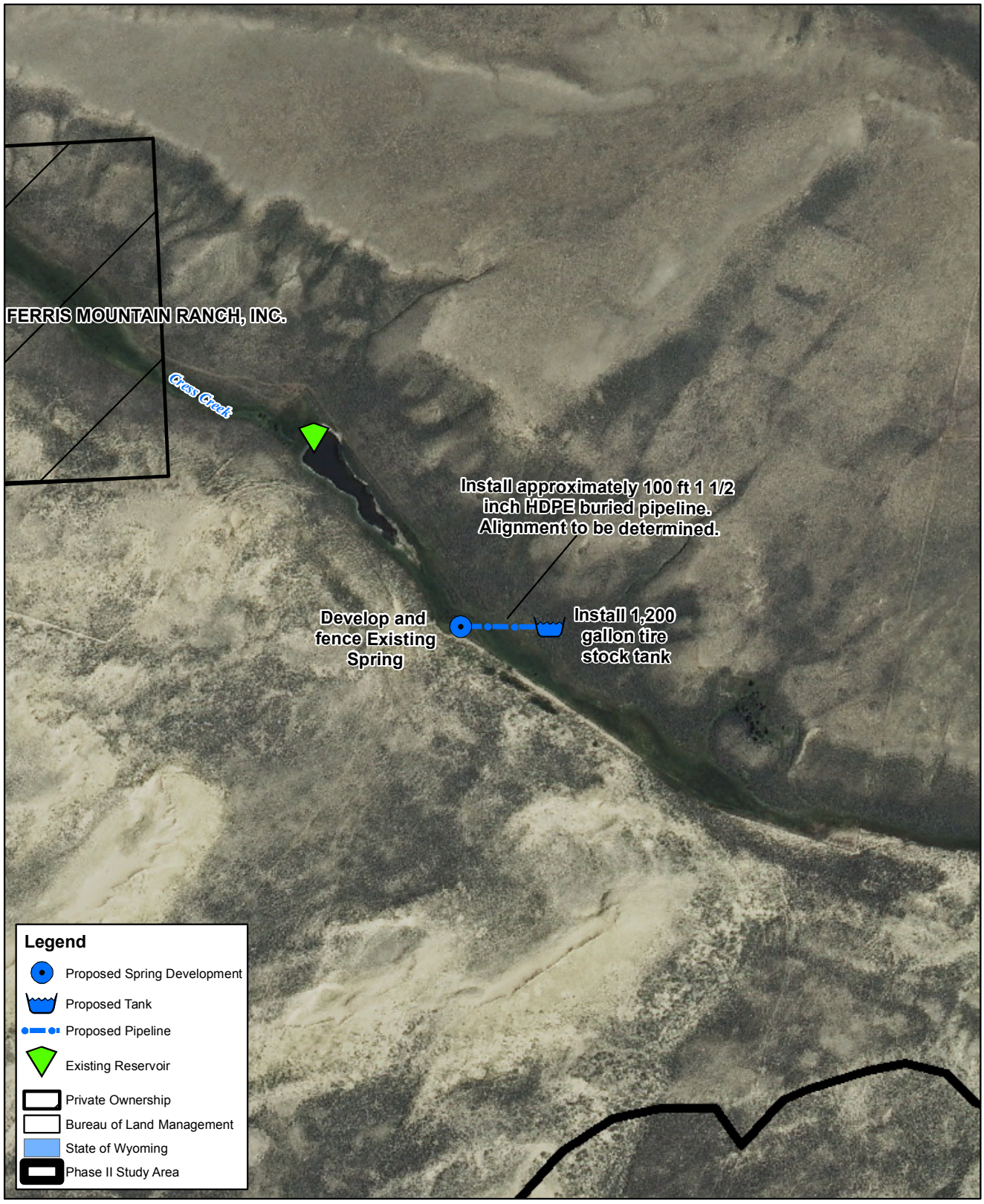


Figure 3.14 Proposed Cress Creek Spring Rehabilitation (Project Component L/W-07)

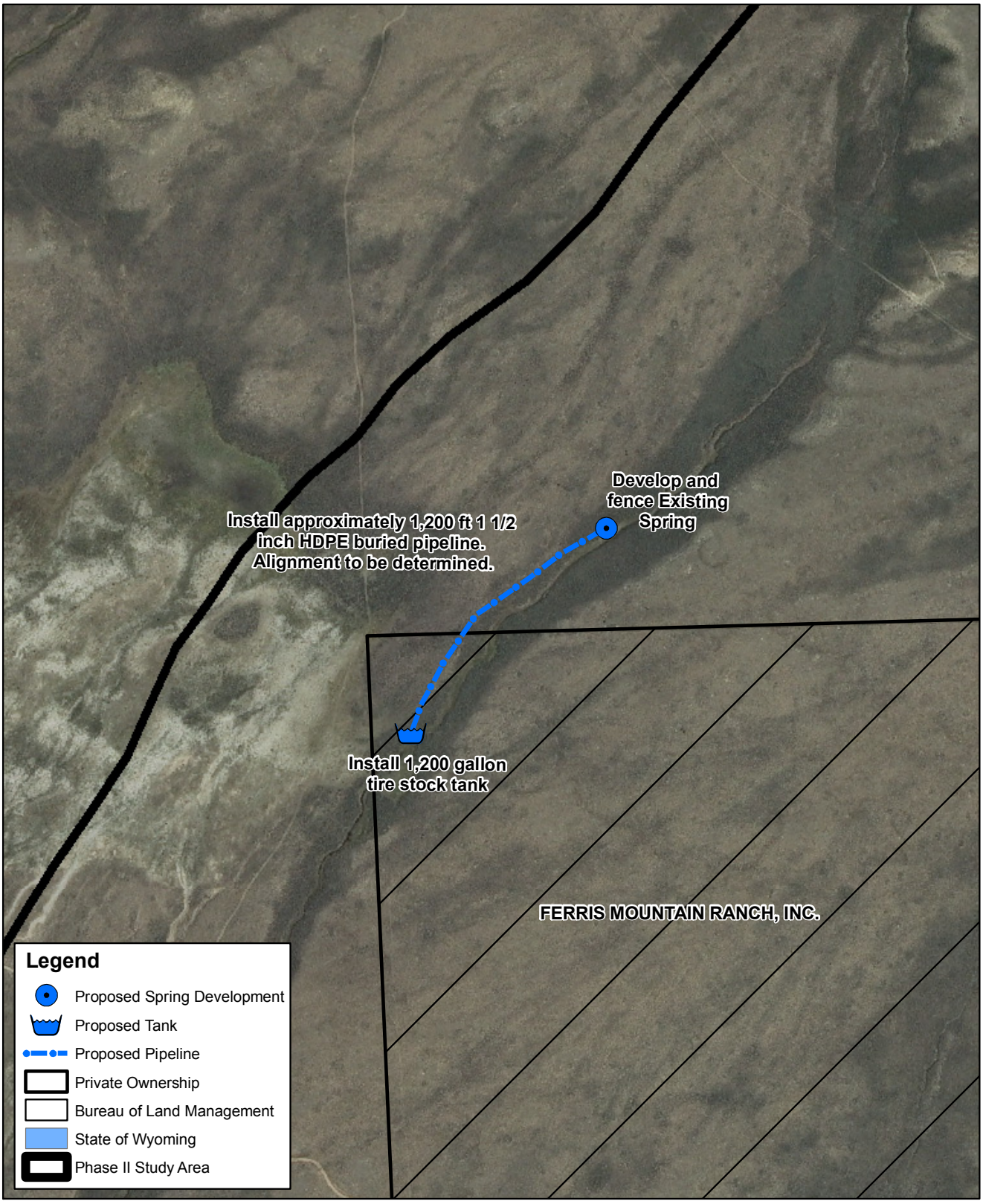


Figure 3.15 Proposed Unnamed Spring Development (Project Component L/W-08)

3.4.9 Corral Creek Pipeline Project (Plan Component L/W-09)

This portion of the Muddy Creek watershed lies within the Whiskey Peak Common Allotment (Lander District BLM). Wildlife and livestock water sources in this region obtain water directly from Corral Creek (ephemeral channel) or scattered springs, ponds or other improvements. In an effort to relieve pressure within the riparian corridor and degradation of existing springs, this alternative is provided. The objective of this alternative would be to enhance water distribution in addition to providing an alternative water supply to the riparian corridor.

Pending site-specific assessment of the springs, the project would involve development of existing springs in the upper portions of Corral Creek and construction of a pipeline serving several stock tanks located downstream (Figure 3.16).

Under this alternative, the following components would be employed:

- Existing springs in Corral Creek would be developed to facilitate diversion to a gravity pipeline.
- The buried HDPE pipeline (approx. 17,100 feet) would be routed downslope (Easterly) within the Corral Creek watershed.
- Three (3) 1,200 gallon stock tanks would be placed outside of the riparian corridor of Corral Creek.

3.4.10 Murphrey Creek Pipeline Project (Plan Component L/W-10)

This portion of the Muddy Creek watershed lies within the Whiskey Peak Common Allotment (Lander District BLM). Wildlife and livestock water sources in this region obtain water directly from Murphrey Creek (ephemeral channel) or scattered springs, ponds or other improvements. In an effort to relieve pressure within the riparian corridor and degradation of existing springs, this alternative is provided. The objective of this alternative would be to enhance water distribution in addition to providing an alternative water supply to the riparian corridor.

Pending site-specific assessment of the springs, the project would involve development of existing springs in the upper portions of Murphrey Creek and construction of a pipeline serving several stock tanks located downstream (Figure 3.17).

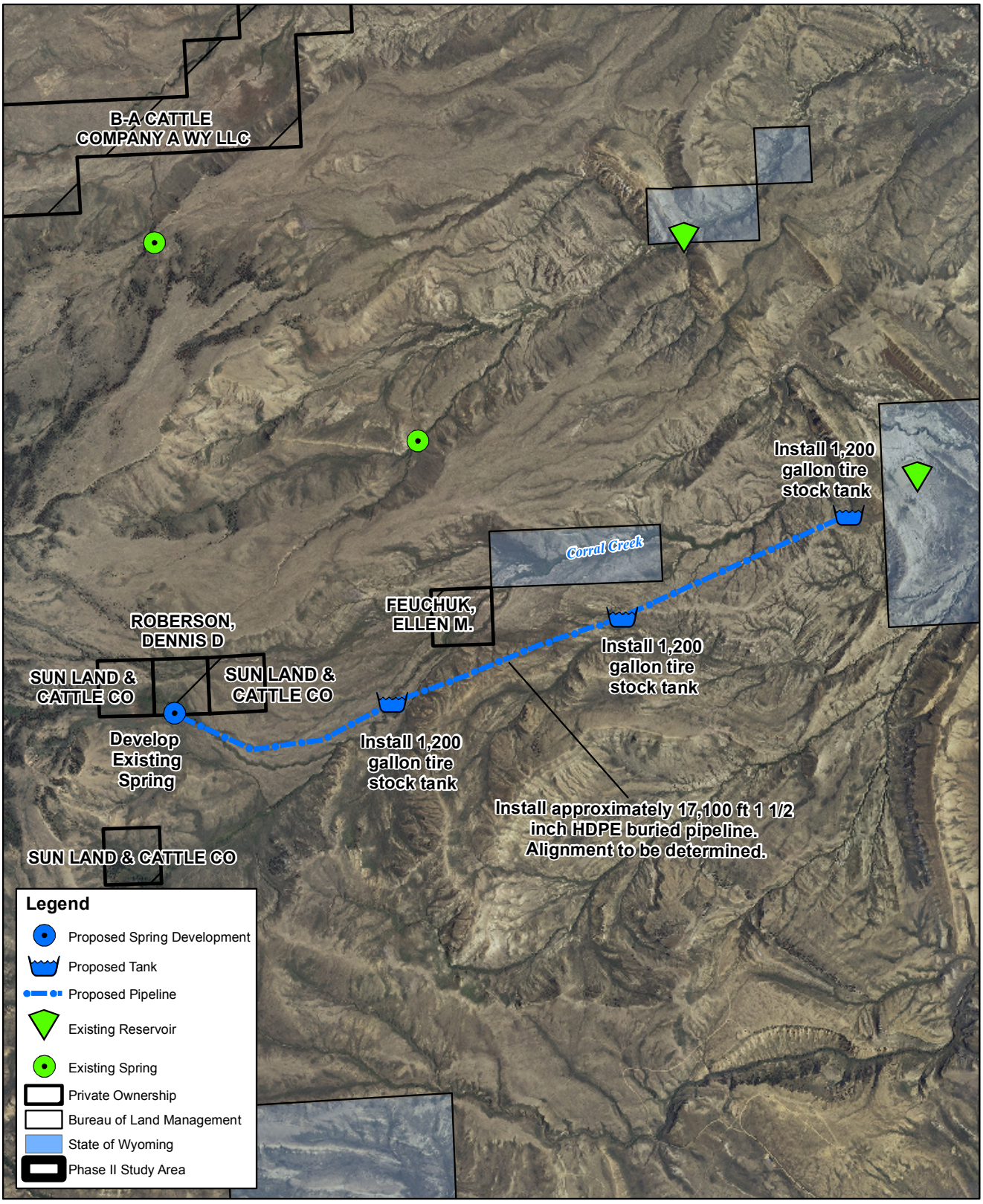


Figure 3.16 Proposed Corral Creek Pipeline (Project Component L/W-09)

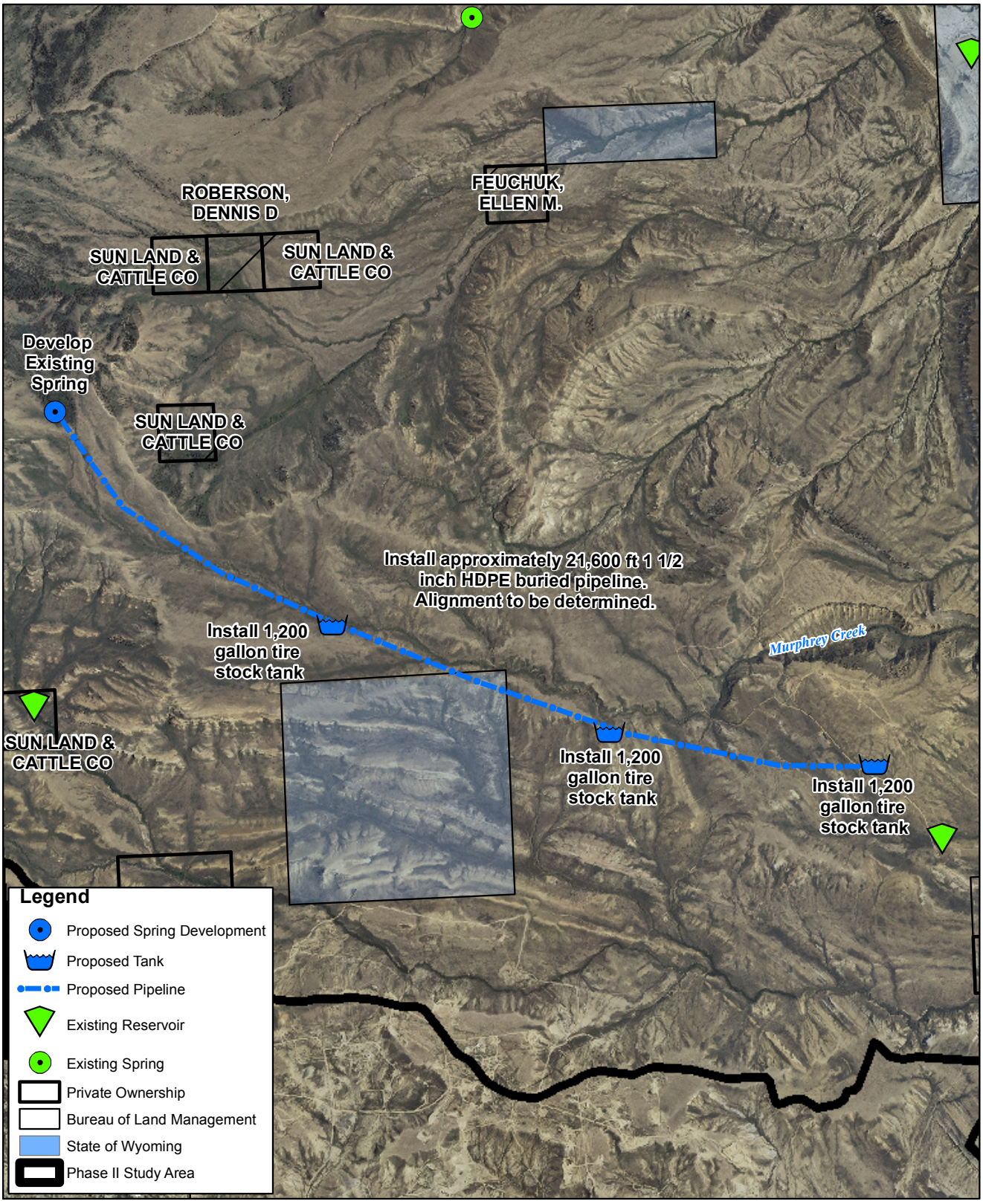


Figure 3.17 Proposed Murphrey Creek Pipeline (Project Component L/W-10)

Under this alternative, the following components would be employed:

- Existing springs in Murphrey Creek would be developed to facilitate diversion to a gravity pipeline.
- The buried HDPE pipeline (approx. 21,600 feet) would be routed downslope (Easterly) within the Murphrey Creek watershed.
- Three (3) stock tanks (1,200 gallon capacity each) would be placed outside of the riparian corridor of Murphrey Creek.

3.4.11 Cherry Creek / Pete Creek Pipeline Project (Plan Component L/W-11)

This alternative would take advantage of perennial surface water supplies available in upper Cherry Creek near the wilderness study area boundary in an effort to supply water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. The objective of this alternative would be to enhance water distribution within the Bar Eleven Allotment. Figure 3.18 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- A diversion facility would be constructed in Cherry Creek. The facility would consist of a buried gravel infiltration gallery and perforated pipe. A valve would be included for management of pipeline flows.
- The buried HDPE pipeline (approx. 33,000 feet) would be routed downslope (Northerly) within the Cherry and Pete Creek watersheds.
- Eight (8) stock tanks (1,200 gallon capacity each) would be placed outside of the riparian corridors of Cherry Creek and Pete Creek.

3.4.12 Whiskey Creek Pipeline Extension Project (Plan Component L/W-12)

This alternative would take advantage of infrastructure currently being installed in the upper Cherry Creek watershed. The current project includes a diversion to utilize perennial sources of Cherry Creek, installation of buried HDPE pipeline, and installation of three new stock tanks. The proposed project would extend this pipeline to provide an additional source of livestock / wildlife water in the Bar Eleven Allotment. The objective of this alternative would be to enhance water distribution within the allotment and to provide a viable source of water to

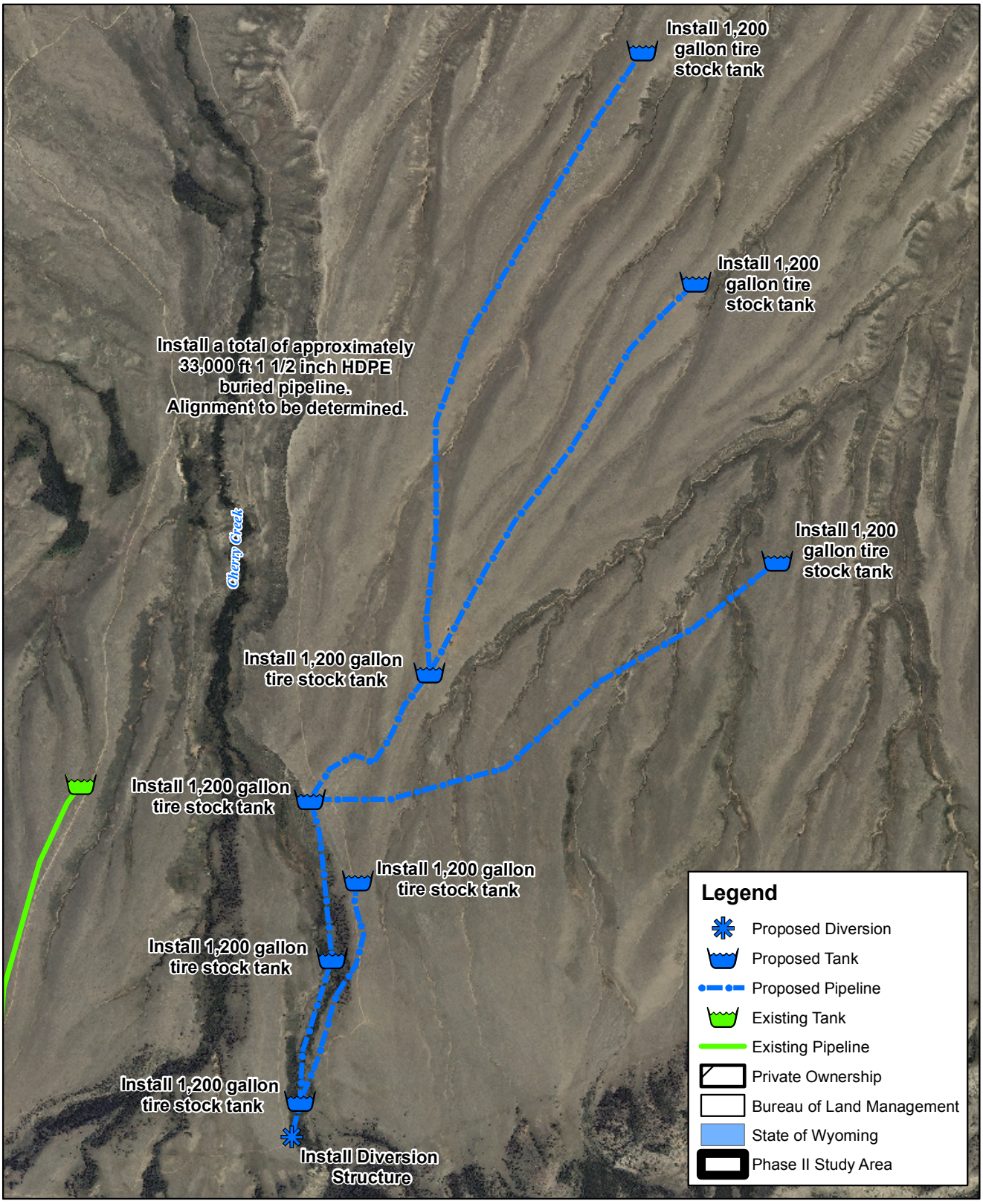


Figure 3.18 Proposed Cherry Creek / Pete Creek Pipeline Project (Project Component L/W-11)

an area which is currently lacking livestock / wildlife water sources. Figure 3.19 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- The existing system would be extended by adding approximately 9,200feet of buried HDPE pipeline and routing it northerly.
- At the northern end of the new pipeline, a stock tank (1,200 gallon capacity) would be installed.

3.4.13 Cherry Creek / Whiskey Creek Pipeline Project (Plan Component L/W-13)

This alternative would take advantage of infrastructure currently installed in the lower Whiskey Creek watershed. Currently, a well provides water to a small stock pond and pipeline to an existing stock tank. The objective of this alternative would be to enhance water distribution within the allotment and to provide a viable source of water to an area which is currently lacking livestock / wildlife water sources in the lower reaches of the Whiskey Creek watershed and north of Highway 220. Figure 3.20 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- Approximately 36,000 feet of buried HDPE pipeline would be installed to extend the existing pipeline.
- An existing culvert under Highway 220 could conceivably be used to cross the highway and extend the system to the area north of the highway where viable livestock / wildlife water supplies are limited.
- Six (6) additional stock tanks (1,200 gallon capacity each) would be installed.
- Two storage tanks with solar pumps would be installed.

3.4.14 Pete Creek Pipeline Extension Project (Plan Component L/W-14)

This alternative would take advantage of existing infrastructure and stock ponds in order to extend coverage of the existing system. Currently, irrigation surplus is captured in a small reservoir. From the reservoir, a pipeline runs northerly to an additional stock reservoir and ultimately to a stock tank located in the Bar Eleven Allotment. The objective of this

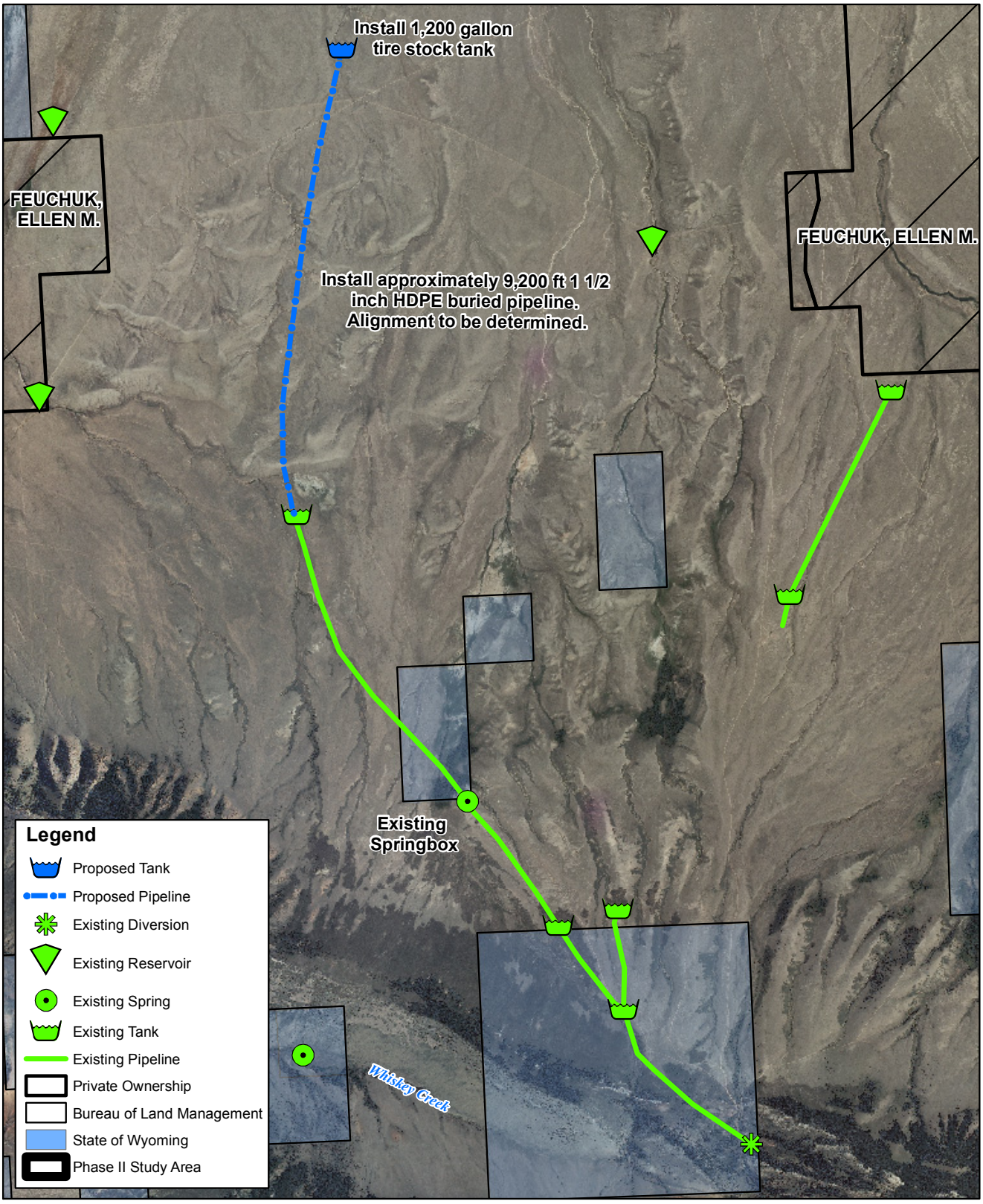


Figure 3.19 Proposed Whiskey Creek Pipeline Extension (Project Component L/W-12)

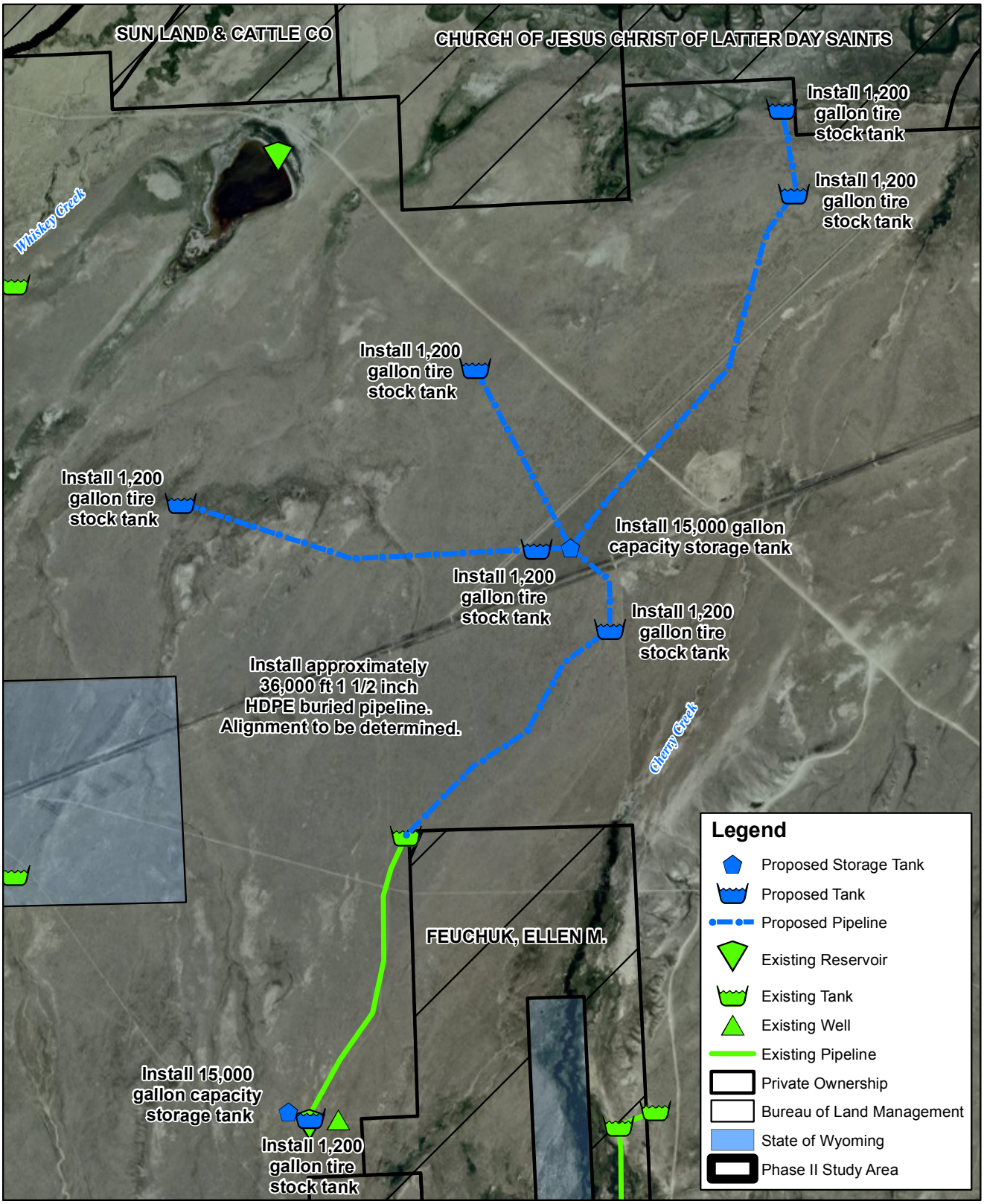


Figure 3.20 Proposed Cherry Creek / Whiskey Creek Pipeline Project (Project Component L/W-13)

alternative would be to enhance water distribution within the Bar Eleven Allotment and to provide a viable source of water to an area which is currently lacking livestock / wildlife water sources. Figure 3.21 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- Connections would be made to the existing HDPE pipeline. From the new connections, the new HDPE pipeline (approx. 21,000 feet) would be routed northeasterly within the Bar Eleven Allotment.
- Two (2) stock tanks (1,200 gallon capacity each) would be placed outside of the riparian corridors of Pete Creek.

3.4.15 Rush Creek Pipeline Project (Plan Component L/W-15)

Wildlife and livestock in this portion of the Phase II Study Area obtain water from Rush Creek and ephemeral streams. In an effort to relieve pressure within the riparian corridors, this alternative is provided. The objective of the project would be to provide an alternative water source to the stream and to encourage livestock usage of the upland areas within the Bar Eleven Allotment. This project would involve development of an existing spring within an unnamed drainage tributary to Rush Creek. Figure 3.22 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- Existing springs in Rush Creek would be developed to facilitate diversion to a gravity pipeline.
- The buried HDPE pipeline (approx.17,300 feet) would be routed downslope (Northerly) within the Rush Creek watershed
- Four (4) stock tanks (1,200 gallon capacity each) would be placed outside of the riparian corridor of Rush Creek.

3.4.16 Pole Canyon Creek Pipeline Project (Plan Component L/W-16)

Most of this portion of the Arkansas Creek watershed is relatively dry with respect to upland water sources for wildlife and livestock. Pole Canyon Creek provides a perennial source

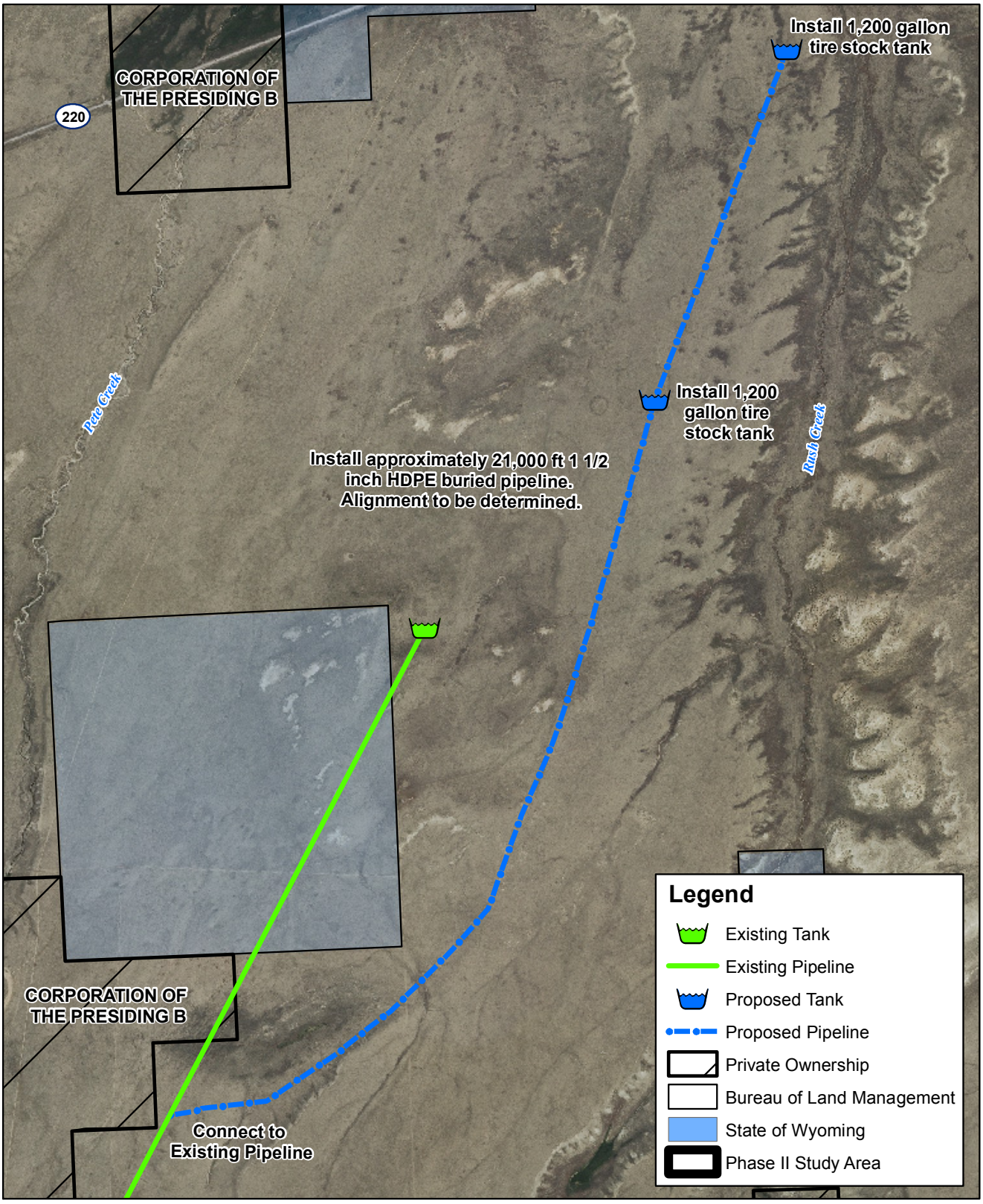


Figure 3.21 Proposed Pete Creek Pipeline Extension Project (Project Component L/W-14)

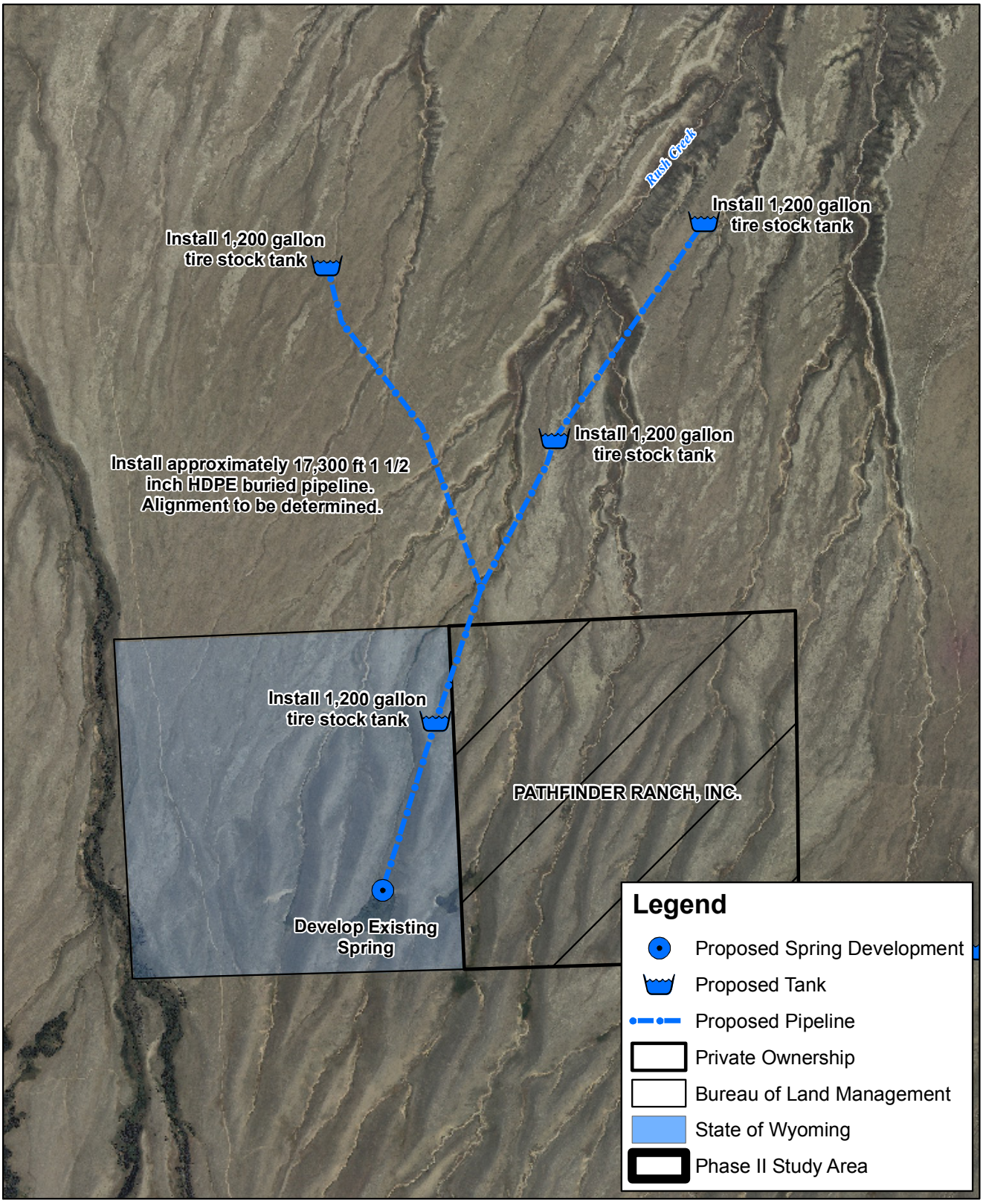


Figure 3.22 Proposed Rush Creek Pipeline Project (Project Component L/W-15)

for the southern end of the area, however, the northern portion has been identified as being 'dry' and would benefit from additional upland water sources. The objective to this alternative would be to enhance water distribution in addition to providing an alternate supply to the riparian corridors within the Buzzard and Pole Canyon Allotments. Figure 3.23 displays the general configuration of this alternative.

Under this alternative, the following components would be employed:

- A diversion facility would be constructed in Pole Canyon Creek downstream of the Wilderness Study Area boundary. The facility would consist of a buried gravel infiltration gallery and perforated pipe. A valve would be included for management of pipeline flows.
- The pipeline would be routed downslope from Pole Canyon Creek along the western edge of the Arkansas Creek watershed. The total amount of pipe required for this alternative was estimated to be approximately 27,800 linear feet (1.5-inch dia.).
- Five (5) stock tanks (1,200 gallon capacity each) would be constructed within locations as indicated in Figure 3.23. The location of the stock tanks would be selected to optimize management of upland resources. It is recommended that stock tanks be placed within each of the three pastures defined by existing fences within the Buzzard Allotment.

3.4.17 Annis Pipeline (Phase I and II) (Plan Component L/W-17)

The objective of this alternative would be to enhance water distribution in addition to providing an alternative water supply to the riparian corridors within the Buzzard and Desert Claim Allotments. This alternative represents a phased modification of an original plan presented by Mr. Ben Annis, the allottee. Preliminary designs of the system have been completed by Civil Engineers Professionals Inc. (Casper, WY). It is our understanding that subsequent to the completion of the plans, the alignment has been altered but there are no significant changes in materials or quantities.

In an effort to qualify for funding through the Wyoming Water Development Commission's (WWDC) Small Water Project Program (SWPP), the project was downsized by eliminating several stock tanks and portions of the originally proposed pipeline. The scaled down project is presented as Phase I. Those portions of the original plan and not included in Phase I, are incorporated as Phase II.

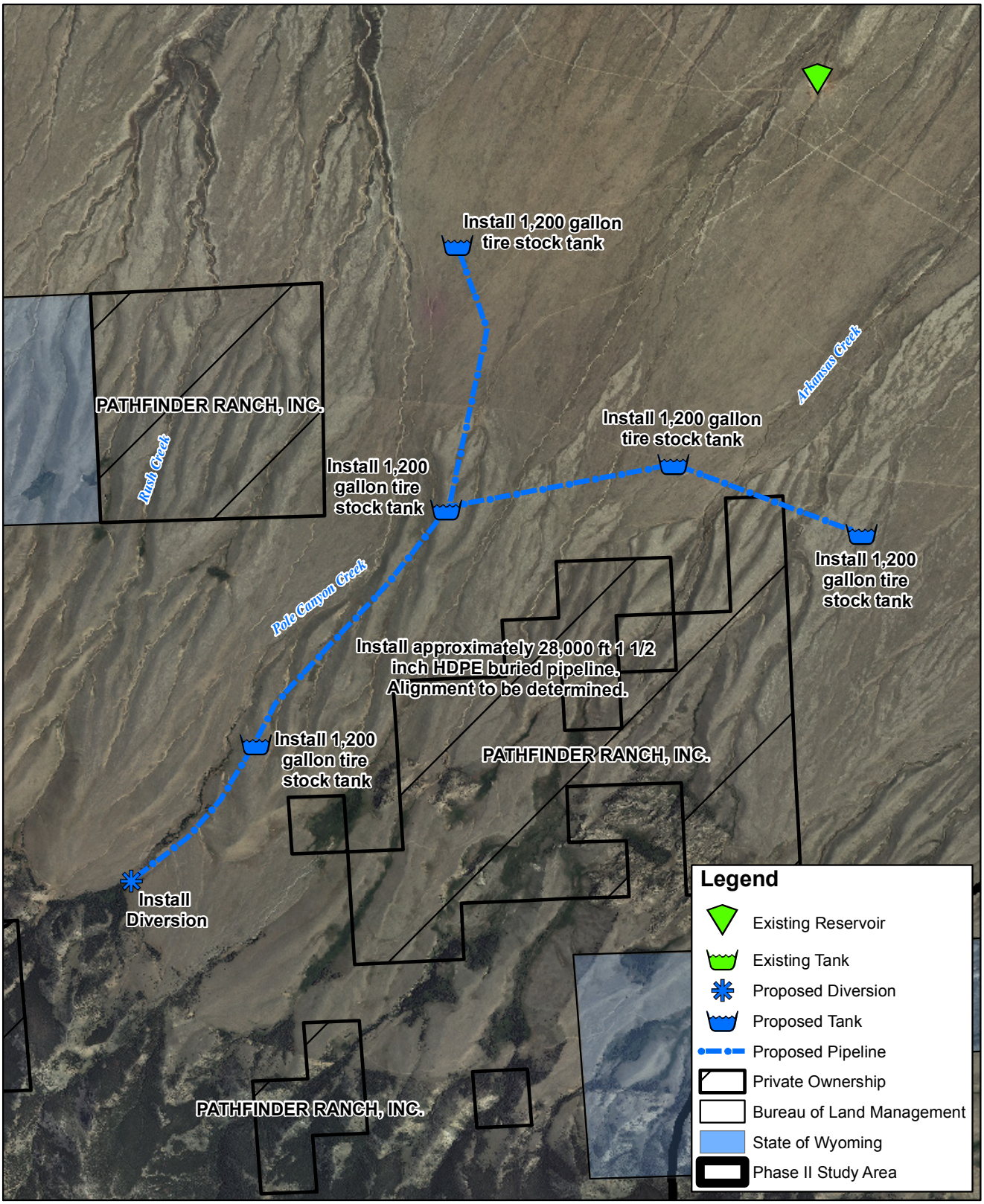


Figure 3.23 Proposed Pole Canyon Creek Pipeline (Project Component L/W-16)

Mr. Annis applied for, and received funding through the SWPP during the initial phases of this project to construct Phase I of the project. The general configurations of both phases of this alternative are displayed on Figure 3.24.

Phase I of the alternative consists of diverting flows from Arkansas Creek near the base of Ferris Mountain. Flows will then be conveyed downslope via a buried pipeline to supply approximately three stock watering tanks. The proposed tanks will be 1,200 gallons each. The system alignment will be entirely upon federal lands managed by the BLM.

The following components have been identified for the Phase I alternative:

- One diversion facility on Arkansas Creek
- One storage tank (15,000 gallon capacity)
- Approximately 42,000 linear feet buried HDPE pipe and accompanying valves and connections
- Three (3) stock watering tanks (1,200 gallon capacity each)

Phase II of the project would involve extension of the Phase I project to provide viable sources of water to the lower reaches of the Arkansas Creek watershed. The objective of this alternative would be to enhance water distribution in addition to providing an alternative water supply to the riparian corridors within the Station 8 Allotment.

Under this alternative, the following components would be incorporated:

- Approximately 40,000 linear feet of buried HDPE pipe (1.5-inch diameter) and accompanying valves and fittings.
- Six (6) stock watering tanks (1,200 gallon capacity each).

3.4.18 Mary's Well Pipeline Project (Plan Component L/W-18)

This alternative would utilize an existing well located in Section 31, T. 28 N., R. 86 W., in an effort to supply water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. The objective of this alternative would be to enhance water distribution within the Buzzard and Bar Eleven Allotments. Figure 3.25 displays the general configuration of this alternative.

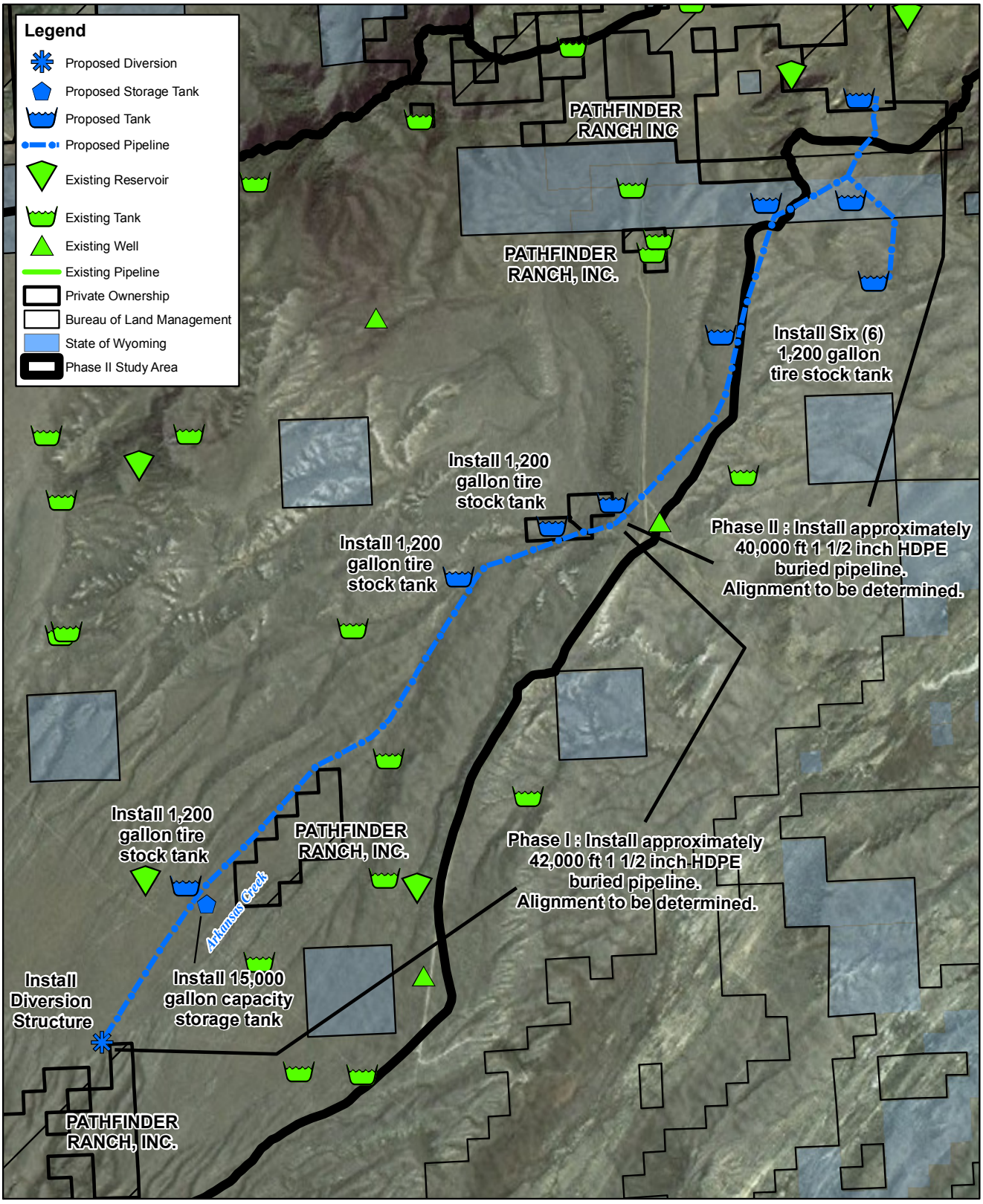


Figure 3.24 Proposed Annis Pipeline Project (Phase I and II) (Project Component L/W-17)

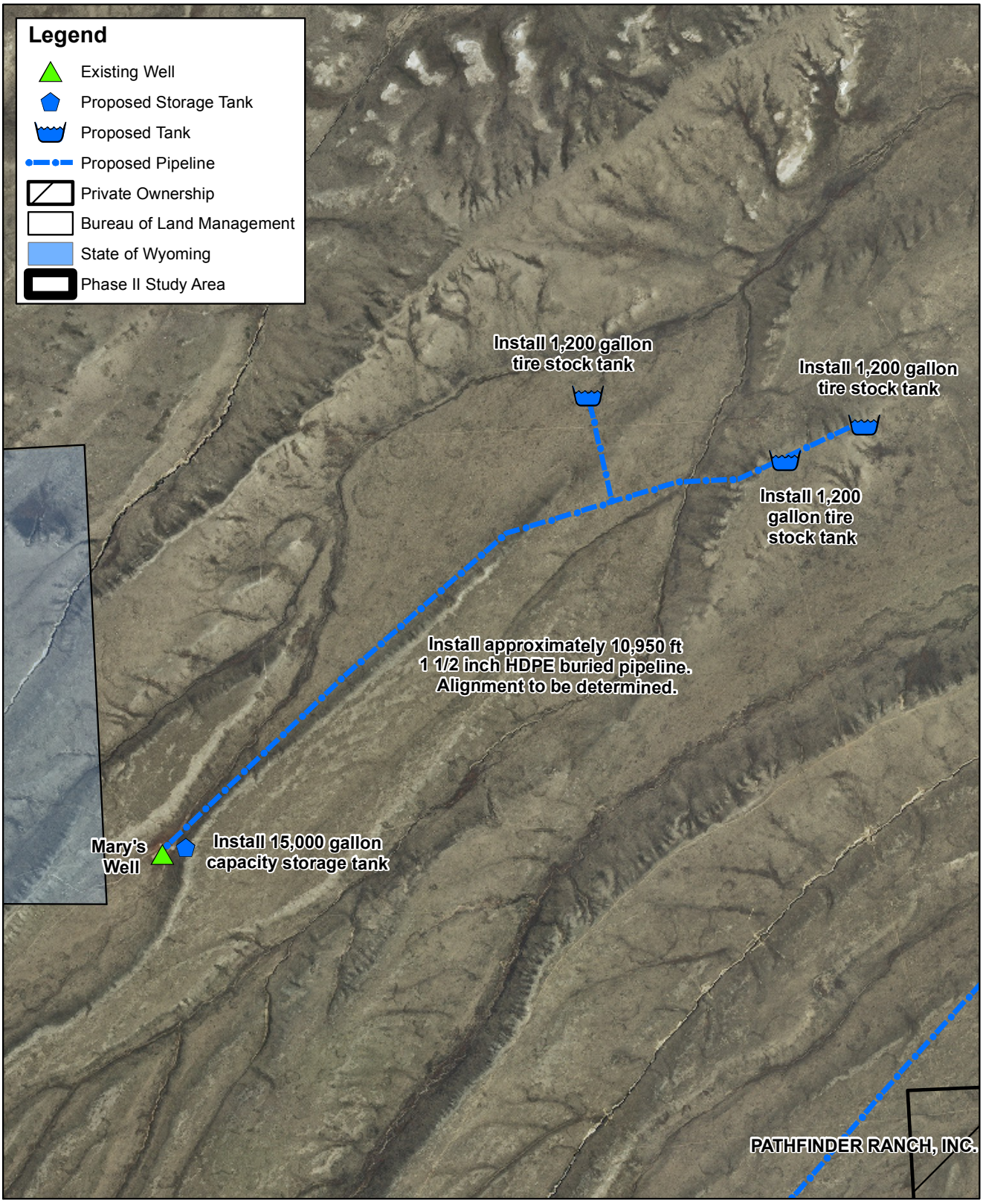


Figure 3.25 Proposed Mary's Well Pipeline (Project Component L/W-18)

The well (referenced in BLM's database as Mary's Well) has been reported by land users to be of adequate quality to supply the proposed project. Under this alternative, the following components would be utilized:

- The existing well would be equipped with a storage tank (15,000 gallon capacity).
- From the well, a gravity pipeline would be constructed to serve three stock tanks within three separate pastures. Two of the tanks would be within the Buzzard Allotment and the third within the Bar Eleven Allotment.
- The total length of the HDPE pipeline (1.5-inch diameter) would be 10,950 linear feet.

3.4.19 Berra #3 Well Pipeline Project (Plan Component L/W-19)

This alternative would utilize an existing well located in Section 19, T. 28 N., R. 85 W., in an effort to supply water to augment water supplies within the Buzzard Allotment in the vicinity of the Desert Claim Allotment. The objective of this alternative would be to enhance water distribution within the Buzzard Allotment.

The well (referenced in BLM's database as the Berra #3 Well) currently supplies water to a pipeline which extends northeasterly conveying water to a stock tank at its end. Under this alternative, an additional pipeline would be constructed to provide water to a stock tank located southwest of the well.

An additional stock tank would be served from the well via a pipeline running southwest. Figure 3.26 displays the general configuration of this alternative. The following components would be utilized:

- The existing well would be equipped with a storage tank (15,000 gallon capacity). The storage tank would serve both the existing and the proposed pipelines.
- From the storage tank, a gravity pipeline would be constructed to provide water to a new stock tank placed about 1.5 miles southwest of the Berra #3 well.
- The total length of the HDPE pipeline (1.5-inch diameter) would be 7,800 linear feet.

3.4.20 North Beefacre Well Replacement / Pipeline Project (Plan Component L/W-20)

This alternative would involve completion of a new well in the vicinity of the "North Beefacre Well" located in Section 3, T.28 N., R. 86 W. The existing well is powered by an

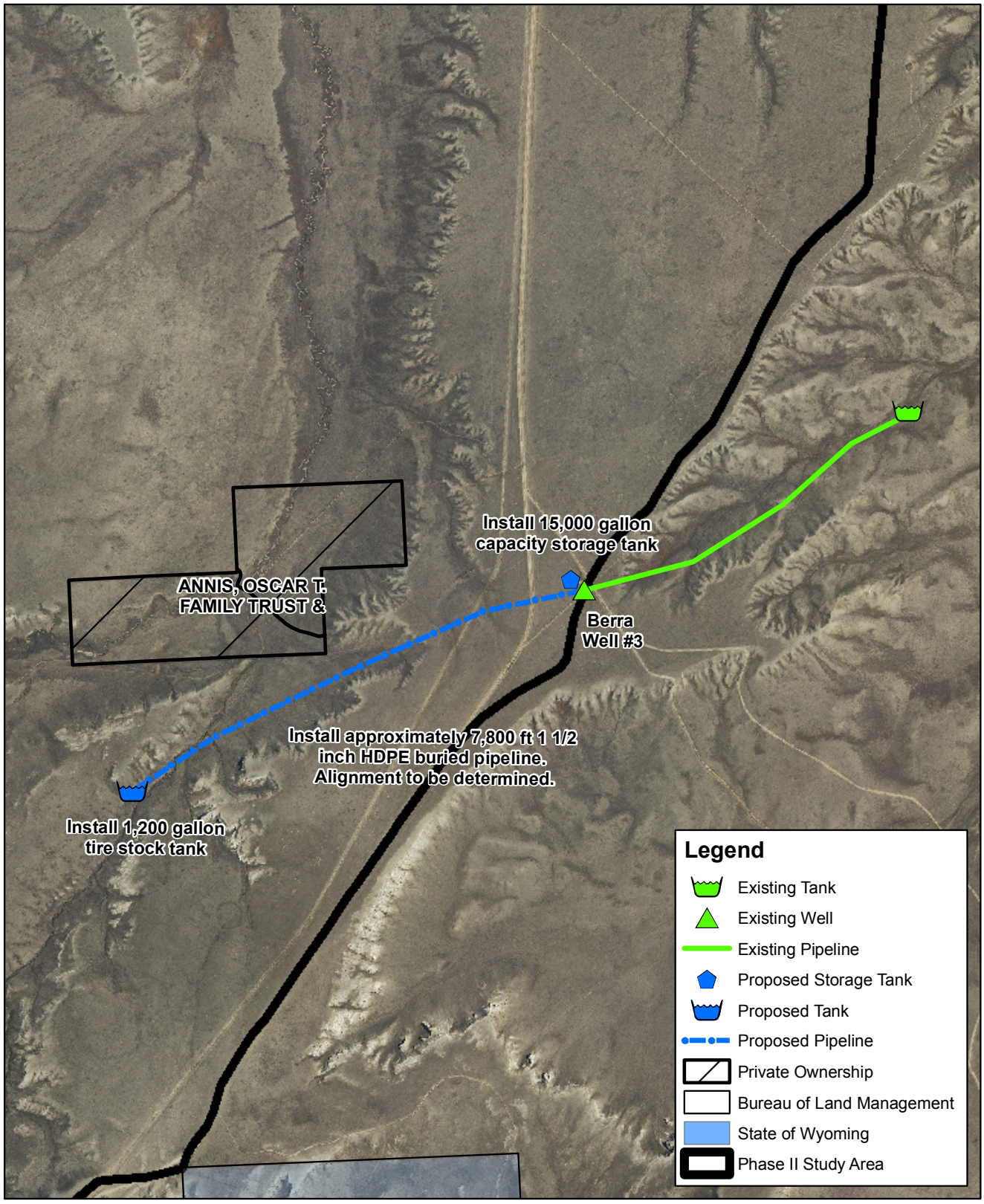


Figure 3.26 Proposed Berra #3 Well Pipeline (Project Component L/W-19)

electrical supply and is reported have had previous rehabilitation attempts which have not been successful. Currently, the well is nonproductive. The alternative would involve construction of a new well in the vicinity of the existing well and utilization of the existing electrical supply to power a pump. A storage tank located approximately one mile west of the new well would then supply a gravity pipeline serving three stock tanks.

The objective of the alternative is to provide a viable source of upland water to livestock and wildlife in an area identified as benefiting from additional upland water sources. The project would be located within the Bar Eleven Allotment. Figure 3.27 displays the general configuration of this alternative.

Under this alternative, the following components would be utilized:

- A new well with submersible pump would be constructed in the vicinity of the existing well. The new well is assumed to be approximately 400 ft deep based upon reported depth of the existing well.
- A storage tank (15,000 gallon) tank would be installed approximately one mile west of the well. Water would be pumped to the storage tank by a well located at the well head.
- From the storage tank, approximately 11,600 linear feet of buried HDPE pipeline (1.5-inch diameter) would be installed.
- Three 1,200 gallon stock tanks would be installed at specific locations to be determined.

3.4.21 Additional Upland Management Opportunities

Guzzlers are artificial catchments providing sources of water in remote areas for wildlife. Larger systems could be employed for livestock watering purposes. They rely entirely upon direct precipitation; therefore, their reliability is only as good as can be expected in a water short region. Figure 3.28 displays a photo of a guzzler installed in the Cottonwood Creek watershed near Thermopolis, Wyoming. The option of installing a guzzler type water collection system with watering facilities may be considered in areas where wildlife water is needed, and alternative options are not available.

Figure 3.28 Typical Wildlife Guzzler.

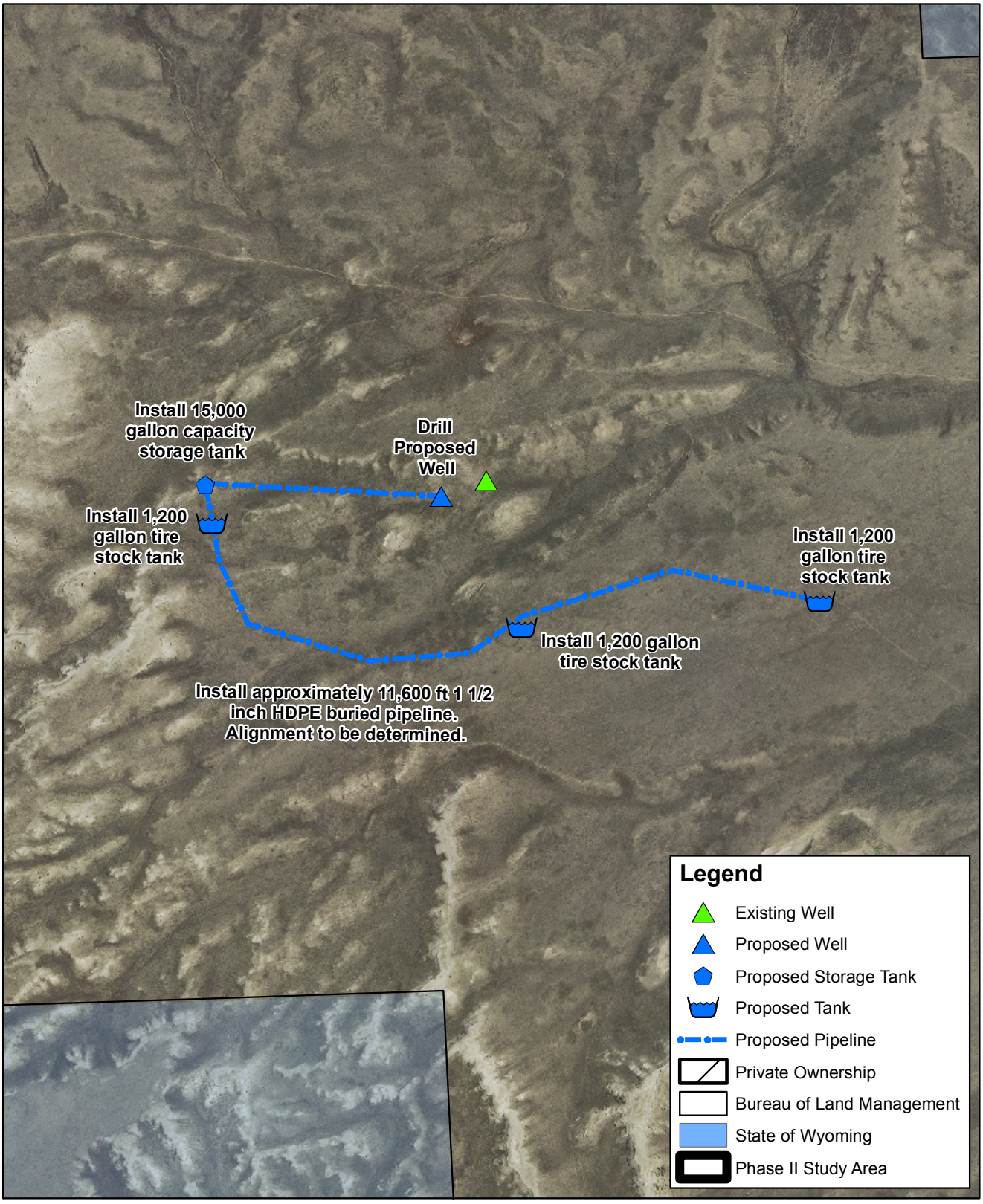


Figure 3.27 Proposed North Beefacre Well Replacement / Pipeline (Project Component L/W-20)

Guzzler watering systems utilize direct precipitation as a source of supply, with a storage tank of capacity suitable to the watering need. Wildlife guzzlers are typically designed to maximize use by wildlife and discourage use by livestock. A complete guzzler system is comprised of the following components:

- Catchment apron – typically made of textured HDPE; secured with rocks placed on a suitable grid spacing, and protected by suitable fencing from trampling by wildlife or livestock,
- Catchment outlet - pipe boot, clamps and well screen section,
- HDPE pipe – typically 1.5-2-inch, 160 psi, SDR 11,
- Catchment tank – HDPE tank sized to accommodate wildlife or livestock watering needs, with integral drinker (ideally with no float valve required), small animal escape ladder and overflow adapter, and
- Overflow pipe – with erosion protection at discharge.

These guzzlers would be installed at locations to be determined. The guzzler operates by intercepting direct rainfall or snowmelt on the catchment, routing the captured water via a pipe to the tank, and controlling the tank level via a simple overflow outlet pipe. Complete guzzler systems are commercially available.

3.4.22 Cost Estimates: Upland Wildlife/Livestock Water

Conceptual level cost estimates for upland wildlife / livestock water opportunities are presented in Table 3.6.

3.5 Grazing Management Opportunities

3.5.1 State and Transition Models

In Chapter 2, the ecological sites found within the watershed were presented and the concept of the ecological site description (ESD) was introduced. The ESD for a given ecological site contains a wealth of information pertaining to the site and its community. Within each ESD is a State and Transition model.

Table 3.6 Conceptual Cost Estimates: Upland Wildlife/Livestock Water Components.

Project Component		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10	Alternative 11
		Muddy Gap Spring	McIntosh Well Enhancement	Indian Creek Pipeline	Muddy Creek Pipeline	Ferris Mountain Well Construction	Muddy Creek Spring Development	Cress Creek Spring Rehabilitation	UnNamed Spring Development	Corral Creek Pipeline	Murphrey Creek Pipeline	Cherry/Pete Creek Pipeline
Well Construction / Spring Development	Mobilization	$3,000	$0	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
	Well / Spring	Spring Development	Well Enhancement	Spring Development	New Diversion	New Well Construction	Spring Development	Spring Rehabilitation	Spring Development	Spring Development	Spring Development	New Diversion
	Units (each)	1	1	1	1	1	1	1	1	1	1	1
	Depth Each	NA	NA	NA	NA	400	0	0	0	0	0	0
	Unit Cost ($/LF wells or $/EA springs	$5,000	$0	$5,000	$5,000	$40	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
	Well Screen (LF each well)	NA	NA	NA	NA	50	NA	NA	NA	NA	NA	NA
	Well Screen ($/LF)	NA	NA	NA	NA	$50	NA	NA	NA	NA	NA	NA
	Component Subtotal	$8,000	$0	$8,000	$8,000	$19,500	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000
Stock Pond Construction	Mobilization	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Units (EA)											
	Pond Unit Cost ($ EA)											
	Liner (SF each pond)											
	Liner Unit Cost ($/SF)											
	Liner Cost per Pond											
	Component Subtotal											
Pump	Units (EA)	NA	NA	NA	NA	1	NA	NA	NA	NA	NA	NA
	Type					Solar						
	Unit Cost (EA)					$8,640						
	Component Subtotal					$8,640						
Pipeline	Units	1	1	1	1	1	1	1	1	1	1	1
	Units (LF)	1,280	0	8,400	1,800	100	2,550	100	1,150	17,100	21,600	33,000
	Unit Cost	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34
	Component Subtotal	$1,715	$0	$11,256	$2,412	$134	$3,417	$134	$1,541	$22,914	$28,944	$44,220
Additional: Storage Tanks	Units (EA)	0	1	0	1	0	0	0	0	0	0	0
	Size (gal)	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000
	Unit Cost ($1/gal)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
	Component Subtotal	$0.00	$15,000.00	$0.00	$15,000.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Water Tanks	Units (EA)	2	0	4	1	1	1	1	1	3	3	8
	Size (gal)	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200
	Unit Cost	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
	Component Subtotal	$6,000	$0	$12,000	$3,000	$3,000	$3,000	$3,000	$3,000	$9,000	$9,000	$24,000
Fencing	Units (EA)	0	0	0	0	0	0	1	0	0	0	0
	Units (LF each)	600	600	600	600	600	600	400	600	600	600	600
	Unit Cost ($/LF)	$3	$3	$3	$3	$3	$3	$3	$3	$3	$3	$3
	Component Subtotal	$0	$0	$0	$0	$0	$0	$1,000	$0	$0	$0	$0
Construction Subtotal		**$15,715**	**$15,000**	**$31,256**	**$28,412**	**$31,274**	**$14,417**	**$11,134**	**$12,541**	**$39,914**	**$45,944**	**$76,220**
Engineering (10%)		$1,572	$1,500	$3,126	$2,841	$3,127	$1,442	$1,113	$1,254	$3,991	$4,594	$7,622
Construction and Engineering Subtotal		**$17,287**	**$16,500**	**$34,382**	**$31,253**	**$34,401**	**$15,859**	**$12,247**	**$13,795**	**$43,905**	**$50,538**	**$83,842**
Contingency (15%)		$2,593	$2,475	$5,157	$4,688	$5,160	$2,379	$1,837	$2,069	$6,586	$7,581	$12,576
Total Construction Cost		**$19,880**	**$18,975**	**$39,539**	**$35,941**	**$39,562**	**$18,238**	**$14,085**	**$15,864**	**$50,491**	**$58,119**	**$96,418**
Final Plans and Specs		$2,000	$500	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000
Additional Geotechnical Services												
Permitting / Legal Fees / Acces and Rights of Way		$1,000	$0	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Total Project Cost		**$22,880**	**$19,475**	**$42,539**	**$38,941**	**$42,562**	**$21,238**	**$17,085**	**$18,864**	**$53,491**	**$61,119**	**$99,418**

Table 3.6 Conceptual Cost Estimates: Upland Wildlife/Livestock Water Components (Continued).

Project Component		L/W-12	L/W-13	L/W-14	L/W-15	L/W-16	L/W-17		L/W-18	L/W-19	L/W-20	L/W-21
		Whiskey Creek Pipeline Extension	Cherry/Whiskey Creek Pipeline	Pete Creek Pipeline Extension	Rush Creek Pipeline	Pole Canyon Pipeline	Annis Pipeline Phase I	Annis Pipeline Phase II	Mary's Well Pipeline	Berra #3 Well Pipeline	North Beefacre Well Replacement/Pipeline	Wildlife Guzzlers
Well Construction / Spring Development	Mobilization	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	Three (3) guzzlers to be installed.
	Well / Spring	Pipeline Extension	Pipeline Extension	Pipeline Extension	Spring Development	New Diversion	Spring Development	Spring Development	Existing Well	Existing Well	New Well Construction	
	Units (each)	0	0	0	1	1	1	1	0	0	1	
	Depth Each	0	0	0	0	NA	0	0	NA	NA	400	
	Unit Cost ($/LF wells or $/EA springs	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	NA	NA	$40	
	Well Screen (LF each well)	NA	NA	NA	NA	NA	NA	NA	NA	NA	50	
	Well Screen ($/LF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	$50	
	Component Subtotal	$3,000	$3,000	$3,000	$8,000	$8,000	$8,000	$8,000	$3,000	$3,000	$19,500	
Stock Pond Construction	Mobilization	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Unit cost for wildlife guzzlers = $10,000
	Units (EA)											
	Pond Unit Cost ($ EA)											
	Liner (SF each pond)											
	Liner Unit Cost ($/SF)											
	Liner Cost per Pond											
	Component Subtotal											
Pump	Units (EA)	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	Catchment = 2250 ft^2.
	Type										Electric	
	Unit Cost (EA)										$8,600	
	Component Subtotal										$8,600	
Pipeline	Units	1	1	1	1	1	1	1	1	1	1	
	Units (LF)	9,200	36,000	21,000	17,300	27,800	42,000	21,600	10,940	7,820	11,600	
	Unit Cost	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	$1.34	Storage = 1,800 gal
	Component Subtotal	$12,328	$48,240	$28,140	$23,182	$37,252	$56,280	$28,944	$14,660	$10,479	$15,544	
Additional: Storage Tanks	Units (EA)	0	1	0	0	NA	0	0	1	1	1	
	Size (gal)	15,000	15,000	15,000	15,000		15,000	15,000	15,000	15,000	15,000	
	Unit Cost ($1/gal)	$1.00	$1.00	$1.00	$1.00		$1.00	$1.00	$1.00	$1.00	$1.00	
	Component Subtotal	$0.00	$15,000.00	$0.00	$0.00		$0.00	$0.00	$15,000.00	$15,000.00	$15,000.00	
Water Tanks	Units (EA)	1	6	2	4	5	3	6	3	1	3	
	Size (gal)	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	
	Unit Cost	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	
	Component Subtotal	$3,000	$18,000	$6,000	$12,000	$15,000	$9,000	$18,000	$9,000	$3,000	$9,000	
Fencing	Units (EA)	0	0	0	0	NA	0	0	NA	NA	NA	
	Units (LF each)	600	600	600	600		600	600				
	Unit Cost ($/LF)	$3	$3	$3	$3		$3	$3				
	Component Subtotal	$0	$0	$0	$0		$0	$0				
Construction Subtotal		**$18,328**	**$84,240**	**$37,140**	**$43,182**	**$60,252**	**$73,280**	**$54,944**	**$41,660**	**$31,479**	**$67,644**	**$30,000**
Engineering (10%)		$1,833	$8,424	$3,714	$4,318	$6,025	$7,328	$5,494	$4,166	$3,148	$6,764	$3,000
Construction and Engineering Subtotal		**$20,161**	**$92,664**	**$40,854**	**$47,500**	**$66,277**	**$80,608**	**$60,438**	**$45,826**	**$34,627**	**$74,408**	**$33,000**
Contingency (15%)		$3,024	$13,900	$6,128	$7,125	$9,942	$12,091	$9,066	$6,874	$5,194	$11,161	$4,950
Total Construction Cost		**$23,185**	**$106,564**	**$46,982**	**$54,625**	**$76,219**	**$92,699**	**$69,504**	**$52,699**	**$39,821**	**$85,570**	**$37,950**
Final Plans and Specs		$2,000	$2,000	$2,000	$2,000	$3,000	$2,000	$2,000	$2,000	$2,000	$3,000	$1,000
Additional Geotechnical Services												
Permitting / Legal Fees / Acces and Rights of Way		$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Total Project Cost		**$26,185**	**$109,564**	**$49,982**	**$57,625**	**$80,219**	**$95,699**	**$72,504**	**$55,699**	**$42,821**	**$89,570**	**$39,950**

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

Based upon the analysis presented in Chapter 2, the two dominant ecological sites likely to be found within the Phase II Study Area are:

- Sandy (Sy) 10-14 inch precipitation zone, High Plains Southeast; and
- Shallow Sandy (SwSy) 10-14 inch precipitation zone, High Plains Southeast.

These two ecological sites comprise over 62% of the entire watershed.

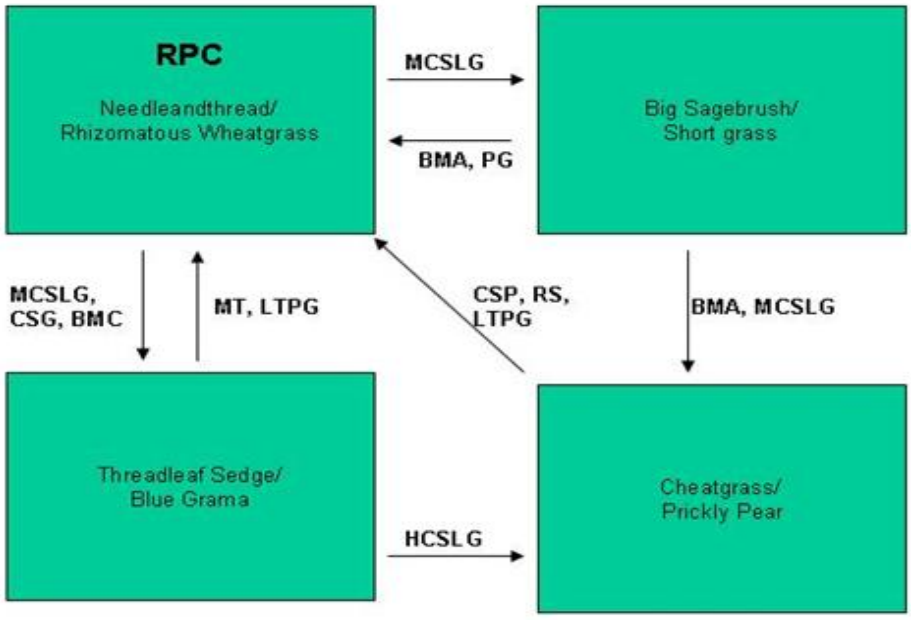
3.5.1.1 Sandy (Sy) 10-14 Inch Precipitation Zone, High Plains Southeast

Figure 3.29 displays the State and Transition model for the Sandy 10-14 inch Precipitation Zone High Plains Southeast. The following description of the ecological site was extracted from the NRCS ESD for the site:

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

• Moderate Continuous Season-long Grazing will convert the plant community to the Big Sagebrush/Shortgrass Plant Community if big sagebrush is present at 5-10%.

• Moderate Continuous Season-long Grazing or Continuous Spring Grazing with Brush Management (chemical) will convert the plant community to the Threadleaf Sedge/Blue grama Plant Community.



BMA – Brush Management (all methods)
BMC – Brush Management (chemical)
BMF – Brush Management (fire)
BMM – Brush Management (mechanical)
CSP – Chemical Seedbed Preparation
CSLG – Continuous Season-long Grazing
DR – Drainage
CSG – Continuous Spring Grazing
HB – Heavy Browse
HCSLG – Heavy Continuous Season-long Grazing
HI – Heavy Inundation
LPG – Long-term Prescribed Grazing
MT – Mechanical Treatment (chiseling, ripping, pitting)
MCSLG – Moderate Continuous Season Long Grazing

NF – No Fire
NS – Natural Succession
NWC – Noxious Weed Control
NWI – Noxious Weed Invasion
NU – Nonuse
P&C – Plow & Crop (including hay)
PG – Prescribed Grazing
RPT – Re-plant Trees
RS – Re-seed
SGD – Severe Ground Disturbance
SHC – Severe Hoof Compaction
WD – Wildlife Damage (Beaver)
WF – Wildfire

Figure 3.29 State and Transition Model for the Sandy 10-14 Inch Precipitation Zone, High Plains Southeast Ecological Site.

3.5.1.2 Shallow Sandy 10-14 Inch Precipitation Zone, High Plains Southeast

The second most prevalent ecological site within the watershed is the Shallow Sandy 10-14 inch Precipitation Zone High Plains Southeast site. Figure 3.30 displays the state and transition model for this site. The following description of the ecological site was extracted from the NRCS ESD for the site:

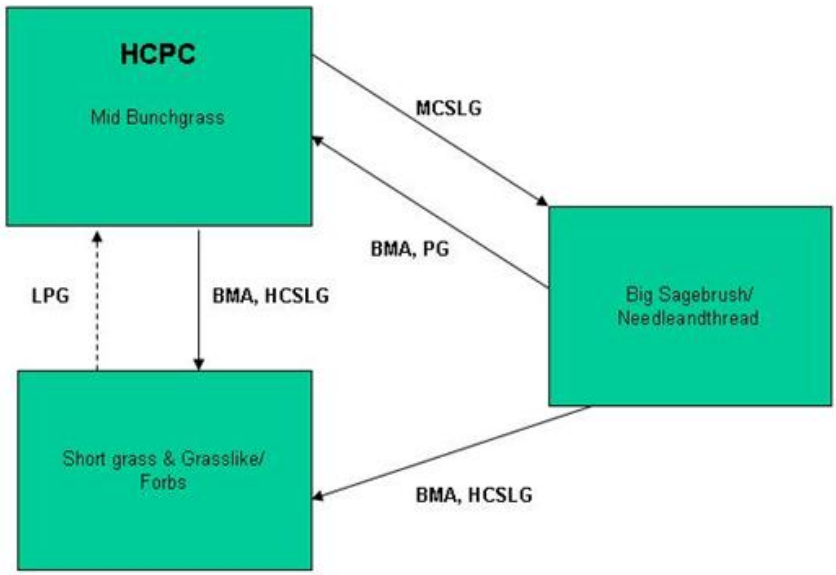
Transitions or pathways leading to other plant communities are as follows:

• Moderate Continuous Season Long Grazing will convert this plant community to the Big Sagebrush/Needleandthread Plant Community.
• Brush Management followed by Heavy Continuous Season-long Grazing will convert this plant community to the Short Grass & Grasslike/Forbs Plant Community.

3.5.2 Range and Grazing Management Considerations

Based on the information presented above, the following items are presented for inclusion in the Phase II Study Area watershed management plan:

- Water developments can be used to expand grazing distribution to areas that do not currently have reliable water. Riparian area plant community condition can be enhanced by development of water into upland areas.
- Fencing to create pastures of similar ecological condition can enable a rest-rotation grazing system.
- Strategic salting and herding are other tools that can be used to enhance grazing distribution.
- Most range improvement practices which improve watershed condition, may also improve wildlife habitat. Wildlife needs should be considered when installing practices such as wildlife friendly fences, wildlife escape ramps from tanks, and wildlife watering facilities.
- Strategies recommended in the state and transition models associated with NRCS descriptions of the ecological sites found within the watershed should be adopted and employed to optimize range conditions through prescribed grazing management and best management practices.



BMA – Brush Management (all methods)
BMC – Brush Management (chemical)
BMF – Brush Management (fire)
BMM – Brush Management (mechanical)
CSP – Chemical Seedbed Preparation
CSLG – Continuous Season-long Grazing
DR – Drainage
CSG – Continuous Spring Grazing
HB – Heavy Browse
HCSLG – Heavy Continuous Season-long Grazing
HI – Heavy Inundation
LPG – Long-term Prescribed Grazing
MT – Mechanical Treatment (chiseling, ripping, pitting)
MCSLG – Moderate Continuous Season Long Grazing

NF – No Fire
NS – Natural Succession
NWC – Noxious Weed Control
NWI – Noxious Weed Invasion
NU – Nonuse
P&C – Plow & Crop (including hay)
PG – Prescribed Grazing
RPT – Re-plant Trees
RS – Re-seed
SGD – Severe Ground Disturbance
SHC – Severe Hoof Compaction
WD – Wildlife Damage (Beaver)
WF – Wildfire

Figure 3.30 State and Transition Model for the Shallow Sandy 10-14 Inch Precipitation Zone, High Plains Southeast Ecological Site.

- Prescribed fire should be utilized as a tool to assist in the restoration of range health areas benefitting by this treatment according to the state and transition models. Delineation of specific areas potentially benefitting from this practice was beyond the scope of this Level I project. However, based upon input from landowners and land managers and observations made during the completion of this investigation, it is evident that there are areas which would likely benefit from prescribed fires.

These tools can be used to maintain and/or improve watershed function particularly when coupled with implementation of appropriate grazing management strategies.

3.6 Other Upland Management Opportunities

Prescribed fire can be used as a tool to restore conditions promoting desirable range species and reduction of invasive species and other species affecting rangeland production and watershed function. As a result of these treatments production of desirable forage increases, benefiting both livestock and wildlife. Watershed values improve overall by decreasing bare ground, decreasing runoff, and improving infiltration, again to the benefit of wildlife and stock. Base flows in creeks sustained by groundwater discharges can extend later into the summer, benefiting the riparian environment and aquatic habitat in these reaches. According to the BLM (2003) and supported by local landowners, historic suppression of fires on Ferris Mountain and the vicinity has resulted in decadent vegetation and an abundance of non-desirable species.

3.7 The Phase II Study Area Watershed Management Plan

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

- Irrigation System Rehabilitation,
- Stream Channel Restoration Opportunities,
- Upland Wildlife/Livestock Water Opportunities,
- Grazing Management Opportunities, and
- Other Management Opportunities.

These improvements focus on potential mitigation of several key issues that presently exist within the watershed. For the Phase II Study Area, the watershed management plan consists of a compilation of the recommendations for each category. The plan is summarized in Table 3.7.

Table 3.7 Phase II Study Area Watershed Management Plan.

Rehabilitation Item Number	Description	Station (feet from headgate)	Priority	Total Project Cost
Hays Ditch				
1	Install diversion structure	0	1	$ 19,680
2	Install 2-ft Parshall flume	100	2	$ 4,295
3	Install approx. 1,000 ft 12-inch PIP	To Be Determined	2	$ 10,855
4	Realign Ditch	103+00 to lateral enc	2	$ 5,560
5	Install 12-inch farm turnout headgate	To Be Determined	2	$ 3,030
6	Install 3-ft wide check structure	Varies	2	$ 3,030
7	Install 8-inch gated pipe (app. 3,000 LF)	To Be Determined	3	$ 13,650
Mahoney / Marsh Ditches				
1	Marsh Irrigating Ditch: Install diversion structure in Muddy Ck.	0	1	$ 17,680
2	Install three Parshall Flumes (18-inch) on ungaged ditches	Varies	2	$ 11,885
3	Monitor rebuilt spillway	NA	1	--
4	Clear vegetation from selected ditch reaches	Varies	1	$ 3,795
Whiskey Creek / Dexter Ditches				
1	Dexter Ditch: Install headgate	0	1	$ 5,310
2	Whiskey Ditch No. 1: Install headgate	0	1	$ 5,060
3	Whiskey Ditch No. 2: Install headgate	0	1	$ 5,060
Storage Components				
No reservoir storage alternatives are recommended for inclusion in the watershed management plan at this time				
Stream Channel Restoration and Management Components				
Stream	**Reach**			
S-1	Arkansas Creek Restoration Project			
S-2	Murphrey Creek Restoration Project			
S-3	Camp Creek Restoration Project			
S-4	Corral Creek Restoration Project			
Recommended Restoration and Management Strategies				
Riparian Vegetation Degradation:				
Development of alternative wildlife / livestock water supplies				
Revegetation				
Riparian Fencing				
Wildlife / Livestock Water Supply Alternatives				
Recommended Alternative	**Description**		**Priority**	**Cost**
L/W-01	Muddy Gap Spring		2	$ 22,880
L/W-02	McIntosh Well Enhancement		2	$ 19,475
L/W-03	Indian Creek Pipeline		2	$ 42,539
L/W-04	Muddy Creek Pipeline		2	$ 38,941
L/W-05	Ferris Mountain Well Construction		2	$ 42,562
L/W-06	Muddy Creek Spring Development		2	$ 21,238
L/W-07	Cress Creek Spring Rehabilitation		2	$ 17,085
L/W-08	UnNamed Spring Development		2	$ 18,864
L/W-09	Corral Creek Pipeline		2	$ 53,491
L/W-10	Murphrey Creek Pipeline		2	$ 61,119
L/W-11	Cherry/Pete Creek Pipeline		2	$ 99,418
L/W-12	Whiskey Creek Pipeline Extension		2	$ 26,185
L/W-13	Cherry/Whiskey Creek Pipeline		2	$ 109,564
L/W-14	Pete Creek Pipeline Extension		2	$ 49,982
L/W-15	Rush Creek Pipeline		2	$ 57,625
L/W-16	Pole Canyon Pipeline		2	$ 80,219
L/W-17	Annis Pipeline Phase I		2	$ 95,699
	Annis Pipeline Phase II		2	$ 72,504
L/W-18	Mary's Well Pipeline		2	$ 55,699
L/W-19	Berra #3 Well Pipeline		2	$ 42,821
L/W-20	North Beefacre Well Replacement/Pipeline		2	$ 89,570
L/W-21	Wildlife Guzzlers		2	$ 39,950

IV. FUNDING SOURCES

IV. FUNDING SOURCES

Project funding/financing is a critical aspect associated with the implementation of watershed improvement projects. Given the scope of the investigation and the perceived projects which may be pursued as part of any watershed plan, there may be a large variety of funding sources which may be available to provide funding for future watershed improvements**.**

Table 4.1 is presented as a brief synopsis of some of the various options available for different components of the Muddy Creek Study Area Watershed Management Plan.

Table 4.1 Funding Options.

Primary Funding Sources / Program			Irrigation Rehab	Upland Water	Other Range Management
Local:					
PACD	–	Rangeland Management Program		✓	✓
		Irrigation Water Management Program	✓		
State:					
WWDC	–	Small Water Project Program	✓	✓	✓
	–	New Development Program	✓	✓	
WGFD	–	Riparian Habitat Improvement Grant		✓	✓
	–	Walter Development / Maintenance Habitat		✓	✓
SLIB	–	Small Water Development Project Loans	✓	✓	
Federal:					
NRCS	–	EQIP	✓	✓	✓
FSA	–	Conservation Reserve Program (CRP)		✓	✓
BLM	–	Range Betterment Funds		✓	✓
EPA	–	Targeted Watershed Grants Program		✓	✓
USFWS	–	Landowner Incentive Program		✓	✓
	–	North American Wetlands Conservation Act		✓	✓
Other:					
TU	–	Watershed Restoration	✓	✓	✓
Weed & Pest	–	Assistance			✓

V. REFERENCES

V. REFERENCES

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APPENDIX A

GROUNDWATER PERMITS

Tabulation of Phase II Groundwater Permits

Identifier	Permit	PRIORITY	Applicant	Facility Name	Permitted Uses	Yield (gpm)	Depth (ft)	Static Water Depth (ft)
6	P10693P	7/2/1941	BUREAU OF LAND MANAGEMENT	SOUTH LONE ROCK SPRING #102	STO	5	-1	-1
7	P10694P	7/2/1941	BUREAU OF LAND MANAGEMENT	EAST LONE ROCK SPRING #101	STO	5	-1	-1
15	P8345P	9/30/1934	WM. M. MCINTOSH** VIRGINIA SHARP EST	CHERRY CREEK WELL #1	STO	5	-1	-1
16	P8348P	12/31/1934	WM. M. MCINTOSH** MARY SHARP EST.**R	MUDDY WELL #1	STO	5	-1	-1
59	P71277W	9/25/1985	AMOCO PRODUCTION COMPANY	WERTZ BATTERY #2	IND	2200	0	-4
75	P88186W	5/21/1992	USDI BLM - RAWLINS DISTRICT	UPPER PETE CREEK SPR.-6316	STO	5	2	-4
76	P88187W	5/21/1992	USDI BLM - RAWLINS DISTRICT	MCINTOSH HORSE PASTURESPR.-6315	STO	5	2	-4
77	P88188W	5/21/1992	USDI BLM - RAWLINS DISTRICT	BAR ELEVEN PIPELINE SPR.-6274	MIS	5	2	0
78	P90630W	1/11/1993	BLM	POINT SPR. (#6427)	STO	2	2	0
2	P12964P	7/2/1941	U.S. GOVERNMENT	WEST BEEF ACRE SPRING #0045	STO	4	3	-1
3	P12965P	7/2/1941	U.S. GOVERNMENT	MIDDLE BEEF ACRES SPRING #0044	STO	3	3	-1
79	P90632W	1/11/1993	BLM	U. RUSH CREEK SPR. #2 (6321)	STO	1	3	0
80	P90633W	1/11/1993	BLM	U. RUSH CREEK SPR. #1 (6319)	STO	2	3	0
22	P11133P	9/8/1967	UNITED STATES GOVERNMENT	COAL CREEK SPRING #2 #0873	STO	10	5	-1
27	P11134P	8/15/1967	UNITED STATES GOVERNMENT	COAL CREEK SPRING #1 #0872	STO	10	5	-1
55	P59383W	1/27/1982	USDI BLM, RAWLINS DISTRICT	BUZZARD SPRING & PIPELINE #1, #4967	STO	7	5	3
44	P48775W	5/23/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #5	STO	20	11	4
43	P48774W	5/23/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #4	DOM,STO	10	12	8
39	P48762W	5/1/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #1	DOM,STO	25	15	8
41	P48772W	5/23/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #2	DOM	10	15	6
45	P48776W	5/23/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #6	DOM	10	22	13
28	P8441P	11/12/1965	HUB & SPOKE RANCH CO.	CHICKEN HOUSE #1	STO	10	23	5
24	P8456P	1/16/1959	HUB & SPOKE RANCH CO.	WASH HOUSE #1	DOM	10	27	9
42	P48773W	5/23/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS #3	DOM,STO	25	30	12
20	P8453P	10/5/1943	SUN LAND/CATTLE CO.	MUDDY #1	STO	10	35	20
51	P8454P	9/25/1970	SUN LAND/CATTLE CO.	MUDDY #2	STO	10	35	20
53	P60198W	4/2/1982	HUB & SPOKE RANCH CO.	BEAR TRAP #2	STO	10	35	10
29	P8472P	9/11/1963	HUB & SPOKE RANCH CO.	CELLAR WELL #1	DOM	10	38	16
40	P48763W	5/1/1979	THE OSCAR T. ANNIS FAMILY TRUST	CAROLS WELL #1	STO	10	38	28
52	P60197W	4/2/1982	HUB & SPOKE RANCH CO.	H & S #1	STO	10	40	10
66	P109762W	4/16/1998	CHURCH OF JESUS CHRIST OF LDS	66 #1	MIS	15	40	20
67	P109763W	4/16/1998	CHURCH OF JESUS CHRIST OF LDS	66 #2	MIS	15	40	20
5	P10692P	7/15/1943	BUREAU OF LAND MANAGEMENT	MUDDY #1 - 239	STO	17	48	20
33	P28365W	11/6/1974	SUN LAND/CATTLE CO.	COYOTE #2	STO	5	60	30
36	P38712W	7/8/1977	ELLEN M FOX	BAR V #2	STO	6	60	20
25	P8349P	10/31/1954	WM. M. MCINTOSH** MARY SHARP EST.**R	BAR V HOUSE WELL #1	DOM	10	62	30
4	P17700P	12/31/1942	GEORGE TULLY	TULLY #1	DOM,STO	5	65	10
8	P10698P	7/28/1943	BUREAU OF LAND MANAGEMENT	MUDDY WELL #2 - 240	STO	15	70	30
11	P8468P	1/30/1930	HUB & SPOKE RANCH CO.	BEAR TRAP WELL #1	DOM,STO	10	70	20
18	P8450P	12/31/1925	SUN LAND/CATTLE CO.	REED #1	STO	10	90	30
60	P80300W	7/19/1989	ALFRED FORSTER	FORSTER #1	DOM	25	90	30
13	P8476P	12/31/1930	SUN LAND/CATTLE CO.	WHITE HOUSE #1	DOM,STO	10	100	55
17	P8447P	12/31/1946	SUN LAND/CATTLE CO.	BAR 11 #1	DOM	10	100	80
19	P8451P	9/10/1943	SUN LAND/CATTLE CO.	66 #1	DOM	10	100	-1
23	P8442P	4/23/1959	SUN LAND/CATTLE CO.	STONE HOUSE WELL #2	DOM	20	100	60
35	P28364W	11/6/1974	SUN LAND/CATTLE CO.	II #2	DOM,STO	16	100	-1
71	P117471W	7/30/1999	CORPORATION OF THE PRESIDING BISHOP	66 #3	MIS	25	100	24
30	P17701P	9/30/1964	GEORGE TULLY	TULLY #2	DOM	5	105	75
69	P115931W	5/17/1999	HANDCART RANCH	BAR 11 #1	DOM,STO	8	110	50
61	P105021W	2/18/1997	CORPORATION OF THE PRESIDING BISHOP	CHERRY CREEK #1	MIS	15	120	27
62	P105022W	2/18/1997	CORPORATION OF THE PRESIDING BISHOP	HANDCART TRAIL #1	MIS	15	120	25
63	P107992W	11/4/1997	CORPORATION OF THE PRESIDING BISHOP	JACKSON #1	MIS	10	120	17
65	P109516W	3/26/1998	CHURCH OF JESUS CHRIST OF LDS	ENL CELLAR WELL #1	DOM,MIS	25	120	21
68	P114352W	3/4/1999	Corp of Presiding BP of the church c	PARKING LOT #1	MIS	5	120	12
70	P117260W	7/16/1999	Corp of Presiding BP of the church c	ENL PARKING LOT #1	MIS	15	120	12
82	P134774W	5/3/2001	CHURCH OF JESUS CHRIST OF LATTER-DAY	MHVC # 3	MIS	13	120	25
83	P134777W	5/11/2001	Corp of Presiding BP of the church c	Cherry Creek #2	MIS	5	120	18
84	P134779W	5/11/2001	Corp of Presiding BP of the church c	Jackson #2	MIS	15	120	19

Tabulation of Phase II Groundwater Permits

Identifier	Permit	PRIORITY	Applicant	Facility Name	Permitted Uses	Yield (gpm)	Depth (ft)	Static Water Depth (ft)
85	P134776W	5/11/2001	Corp of Presiding BP of the church o	MHVC Parking Lot # 2	MIS	10	120	25
37	P38713W	7/8/1977	PATRICK WATSON	47 #2	STO	10	160	85
72	P81689W	1/24/1990	USDI BLM, RAWLINS DISTRICT	LITTLE CHERRY	STO	5	180	60
50	P8056W	2/9/1971	WM. M. MC INTOSH	MC INTOSH #3	DOM	17	220	35
81	P124862W	4/14/2000	MARTIN E. ANNIS	MAIN ROAD WELL #1	DOM,STO	10	220	180
34	P27507W	7/24/1974	FRANK & ROBERTA ERICKSON	ERICKSON #1 (DEEPENED)	DOM	10	223	97
48	P50290W	7/5/1979	FRANK & ROBERTA ERICKSON	ENL ERICKSON #1	MIS	12	223	97
64	P105647W	4/28/1997	USDI, BLM**COLORADO INTERSTATE GAS C	MUDDY GAP #1	MIS	12	230	62
12	P8473P	9/5/1933	HUB & SPOKE RANCH CO.	MARYS WELL #1	STO	10	250	200
21	P8474P	9/20/1941	HUB & SPOKE RANCH CO.	ARKANSAS #1	STO	5	250	234
1	P14483P	12/31/1934	SANFORD RANCHES INC.	SANFORD #7	STO	5	300	150
26	P10697P	11/2/1964	BUREAU OF LAND MANAGEMENT	CHALK VALLEY WELL #993	STO	5	300	200
31	P8446P	12/28/1960	HUB & SPOKE RANCH CO.	CHALK HILLS #1	STO	10	300	250
58	P75088W	7/9/1987	FRANK E. & ROBERTA M. ERICKSON	ERICKSON WELL #2	MIS,DOM	25	319	80
32	P10701W	10/22/1971	USDI BLM, RAWLINS DISTRICT	POINT OF ROCKS WELL #4331	STO	7	340	215
54	P61743W	8/12/1982	OSCAR T. ANNIS FAMILY TRUST	ANNIS KLINE #1	STO	7	340	150
74	P83811W	10/16/1990	WILLIAM M. MCINTOSH	47 #2	STO	2	360	160
10	P14485P	12/31/1934	SANFORD RANCHES INC.	SANFORD #8 STATION	STO	5	400	100
46	P46199W	12/12/1978	WYOMING STATE HIGHWAY DEPARTMENT	MUDDY GAP #4	MIS	20	400	63
73	P82019W	3/23/1990	USDI, BLM** PATHFINDER RANCH INC.	BERRA #2	STO	14	400	170
49	P5827W	6/19/1970	USDI BLM, RAWLINS DISTRICT	NORTH BEEF ACRE #1	STO	6	420	250
47	P48765W	5/1/1979	THE OSCAR T. ANNIS FAMILY TRUST	ANNIS DESERT #1	STO	4	440	263
57	P68777W	10/16/1984	USDI, BLM**SUN LAND & CATTLE CO.	DEPAD TEST #10 OVERFILING	STO	5	510	234
9	P224C	10/9/1937	THE ROCKY MOUNTAIN GAS CO.	KOSOMING WATER WELL #1	IND,DOM	13	775	-1
14	P408C	9/18/1935	SINCLAIR REFINING CO.	STATION #8 WATER WELL	IND	36	900	310
38	P41766W	11/29/1977	RAINBOW RESOURCES INC.	HUSKY-RAINBOW #11-6 FEDERAL	IND	4	6851	-1
56	P69630W	3/25/1985	USDI BLM, RAWLINS DISTRICT	DIPPING VAT	STO	NR	NR	NR
86	P141869W	1/16/2002	DENNIS ROBERSON	R BAR QUARTER CIRCLE SPRING	DOM,STO	NR	NR	NR
87	P157230W	2/10/2004	PRESIDING BISHIP OF THE CHURCH OF JE	MHVC BUS PARKING LOT WELL	MIS	NR	NR	NR
88	P163184W	10/4/2004	Corp of Presiding BP of the church o	CHERRY CREEK CG #3	MIS	NR	NR	NR
89	P162673W	9/21/2004	BUREAU OF LAND MANAGEMENT	MCINTOSH WELL	STO	NR	NR	NR
90	P168468W	6/14/2005	WYOMING WATER DEVELOPMENT COMMISSION	LAYNE TW-1	MIS	NR	NR	NR
91	P168469W	6/14/2005	WYOMING WATER DEVELOPMENT COMMISSION	LAYNE TW-2	MIS	NR	NR	NR
92	39/10/68W	5/31/2006	FERRIS MOUNTAIN RANCH, INC.	RAYMOND #1	STO,MIS	NR	NR	NR
93	38/5/556W	4/5/2006	Corp of Presiding BP of the church o	CHERRY CREEK #4	MIS	NR	NR	NR
94	39/5/471W	12/27/2006	Wyoming Water Development Commission	SR-1	IRR,MUN,IND,M	NR	NR	NR
95	40/7/595W	3/13/2008	ELLEN FOX	LITTLE CHERRY CK #16	STO	NR	NR	NR
96	40/8/595W	3/13/2008	ELLEN FOX	CHERRY CREEK NO. 23	STO	NR	NR	NR

APPENDIX B

SURFACE WATER RIGHTS

Tabulation of Phase II Study Area Surface Water Rights

Subbasin	Permit N	Facility	Status	Location	Stream Name
Arkansas	C26/141A	DAWES #3 DITCH	ADJ	T. 27 N., R. 87 W., S. 26	Arkansas Creek
Muddy	C35/120A	HARPER #1 DITCH	ADJ	T. 27 N., R. 89 W., S. 31	Little Camp Creek
Arkansas	C47/164A	ARKANSAS "B" DITCH	ADJ	T. 27 N., R. 86 W., S. 5	Arkansas Creek
Whiskey	P10159D	BUCKLIN OUTLET DITCH	ADJ	T. 28 N., R. 88 W., S. 18	Whiskey Creek
Whiskey	P1026R	BUCKLIN RESERVOIR	ADJ	T. 28 N., R. 88 W., S. 18	Whiskey Creek
Muddy	P11025D	BRADY #2 DITCH	ADJ	T. 27 N., R. 89 W., S. 27	Muddy Creek
Whiskey	P1251D	Whiskey CREEK #1 DITCH	ADJ	T. 27 N., R. 89 W., S. 1	Whiskey Creek
Whiskey	P1252D	Whiskey DITCH	ADJ	T. 27 N., R. 89 W., S. 1	Whiskey Creek
Muddy	P12762D	BRADY #3 DITCH	ADJ	T. 27 N., R. 89 W., S. 27	Muddy Creek
Muddy	P15354D	DESERT DITCH	ADJ	T. 27 N., R. 90 W., S. 2	Little Camp Creek
Muddy	P15355D	DESERT DITCH	ADJ	T. 27 N., R. 90 W., S. 2	Unnamed Creek
Arkansas	P15825D	ANNIS DITCH	ADJ	T. 29 N., R. 85 W., S. 27	Arkansas Creek
Muddy	P16449D	PRODUCERS & REFINERS CORP 2 INCH WATERLINE	ADJ	T. 27 N., R. 90 W., S. 35	Camp Creek
Muddy	P1645R	HARPER RESERVOIR	ADJ	T. 27 N., R. 89 W., S. 6	Little Camp Creek
Muddy	P16560D	MUDDY GAP DITCH	ADJ	T. 28 N., R. 89 W., S. 27	Muddy Creek
Muddy	P1704D	A R COWLEY #2 DITCH	ADJ	T. 26 N., R. 88 W., S. 2	Muddy Creek
Muddy	P17425D	H M DITCH	ADJ	T. 28 N., R. 88 W., S. 6	Muddy Creek
Arkansas	P17504D	ARKANSAS "B" DITCH	ADJ	T. 27 N., R. 86 W., S. 8	Arkansas Creek
Arkansas	P17505D	ARKANSAS "C" DITCH	ADJ	T. 27 N., R. 86 W., S. 5	Arkansas Creek
Whiskey	P17553D	NEW INLET DITCH	ADJ	T. 28 N., R. 88 W., S. 30	Whiskey Creek
Muddy	P1780D	MAHONEY #2 DITCH	AME	T. 26 N., R. 89 W., S. 2	Muddy Creek
Muddy	P1781D	MAHONEY #1 DITCH	AME	T. 26 N., R. 89 W., S. 2	Muddy Creek
Arkansas	P18109D	ESTHER #2 DITCH	ADJ	T. 28 N., R. 86 W., S. 23	Arkansas Creek
Arkansas	P18110D	ESTHER #2 DITCH	ADJ	T. 28 N., R. 86 W., S. 24	East Arkansas Creek
Arkansas	P18299D	OSCAR DITCH	ADJ	T. 29 N., R. 85 W., S. 22	Arkansas Creek
Muddy	P18787D	STATE HIGHWAY PIPE LINE	ADJ	T. 28 N., R. 89 W., S. 34	Major Springs
Muddy	P1888D	MAHONEY #2 DITCH	ADJ	T. 26 N., R. 89 W., S. 2	Muddy Creek
Muddy	P1889D	MAHONEY #1 DITCH	ADJ	T. 26 N., R. 89 W., S. 2	Muddy Creek
Muddy	P1951D	MAHONEY #3 DITCH	ADJ	T. 26 N., R. 88 W., S. 10	Muddy Creek
Muddy	P1965D	CONTINUATION MAHONEY #3 DITCH	ADJ	T. 26 N., R. 88 W., S. 10	Muddy Creek
Muddy	P1966D	MARSH & CO #7 DITCH	ADJ	T. 26 N., R. 88 W., S. 5	Muddy Creek
Whiskey	P1967R	BUCKLIN RESERVOIR	ADJ	T. 28 N., R. 88 W., S. 18	Whiskey Creek
Whiskey	P2121D	HAYS DITCH	ADJ	T. 27 N., R. 89 W., S. 12	Whiskey Creek
Pete's	P22420D	PETE #1 DITCH	ADJ	T. 28 N., R. 87 W., S. 4	Pete's Creek
Pete's	P22421D	PETE #2 DITCH	ADJ	T. 28 N., R. 87 W., S. 4	Pete's Creek
Pete's	P2244E	HOSPITALITY DITCH (enlarged)	ADJ	T. 28 N., R. 87 W., S. 29	Pete's Creek
Arkansas	P3307D	DAWES #1 DITCH	ADJ	T. 27 N., R. 87 W., S. 26	Little Arkansas Creek
Arkansas	P3308D	DAWES #2 DITCH	ADJ	T. 27 N., R. 87 W., S. 26	Arkansas Creek
Arkansas	P3309D	DAWES #3 DITCH	ADJ	T. 27 N., R. 87 W., S. 24	Arkansas Creek
Pete's	P4031D	GANTS DITCH	ADJ	T. 28 N., R. 87 W., S. 32	Red Birch Creek
Whiskey	P4108R	BUCKLIN #2 RESERVOIR	ADJ	T. 28 N., R. 88 W., S. 19	Whiskey Creek
Whiskey	P4109R	BUCKLIN #3 RESERVOIR	ADJ	T. 28 N., R. 89 W., S. 24	Whiskey Creek
Cherry	P4217E	CHERRY CREEK #1 DITCH (enlarged)	ADJ	T. 29 N., R. 87 W., S. 32	Cherry Creek
Cherry	P4218E	CHERRY CREEK #2 DITCH (enlarged)	ADJ	T. 29 N., R. 87 W., S. 32	Cherry Creek
Muddy	P4619E	MUDDY GAP	ADJ	T. 28 N., R. 89 W., S. 27	Muddy Creek
Muddy	P6119D	MUDDY GAP #1 DITCH	ADJ	T. 28 N., R. 89 W., S. 34	Major Springs

Tabulation of Phase II Study Area Surface Water Rights

Subbasin	Permit N	Facility	Status	Location	Stream Name
Muddy	P6120D	MUDDY GAP #2 DITCH	ADJ	T. 28 N., R. 89 W., S. 34	Major Springs
Muddy	P6121D	MUDDY GAP #3 DITCH	ADJ	T. 27 N., R. 89 W., S. 3	Muddy Creek
Muddy	P6122D	MUDDY GAP #4 DITCH	ADJ	T. 27 N., R. 89 W., S. 3	Muddy Creek
Muddy	P6379D	SPEYER #2 DITCH	ADJ	T. 27 N., R. 90 W., S. 2	Little Camp Creek
Muddy	P6380D	SPEYER #1 DITCH	ADJ	T. 27 N., R. 90 W., S. 2	Little Camp Creek
Whiskey	P7713D	BUCKLIN	ADJ	T. 28 N., R. 88 W., S. 30	Whiskey Creek
Muddy	P823R	HANNA MAHONEY #1 RESERVOIR	ADJ	T. 26 N., R. 88 W., S. 6	Muddy Creek
Muddy	P824R	HANNA MAHONEY #2 RESERVOIR	ADJ	T. 26 N., R. 89 W., S. 2	Muddy Creek
Muddy	P825R	MARSH & COMPANY RESERVOIR	ADJ	T. 26 N., R. 88 W., S. 8	Muddy Creek
Muddy	P9375D	BRADY DITCH	ADJ	T. 27 N., R. 89 W., S. 27	Muddy Creek
Muddy	P9381D	HARPER #1 DITCH	ADJ	T. 28 N., R. 89 W., S. 31	Little Camp Creek
Muddy	P9382D	HARPER #2 DITCH	ADJ	T. 28 N., R. 89 W., S. 31	Little Camp Creek
Muddy	P9383D	HARPER #3 DITCH	ADJ	T. 28 N., R. 89 W., S. 31	Little Camp Creek
Arkansas	P9831S	EAST ARKANSAS STOCK RESERVOIR	ADJ	T. 27 N., R. 86 W., S. 10	East Arkansas Creek
Arkansas	P9832S	UPPER ARKANSAS STOCK RESERVOIR	ADJ	T. 27 N., R. 86 W., S. 7	West Arkansas Creek
Muddy	P9901D	MUDDY GAP	ABA	T. 28 N., R. 89 W., S. 23	Muddy Creek
Pete's	P9902D	JOHNSON DITCH	ADJ	T. 28 N., R. 87 W., S. 29	Pete's Creek
Cherry	T5683D	CHERRY CREEK #1 DITCH	ADJ	T. 29 N., R. 87 W., S. 32	Cherry Creek
Cherry	T5684D	CHERRY CREEK #2 DITCH	ADJ	T. 29 N., R. 87 W., S. 32	Cherry Creek
Cherry	T5685D	STONEY SUPPLEMENTAL TO DEXTER DITCH	ADJ	T. 28 N., R. 88 W., S. 35	Cherry Creek
Cherry	T5686D	CHERRY CREEK #3 DITCH DEXTER DITCH	AME	T. 28 N., R. 88 W., S. 12	Cherry Creek
Cherry	T5687D	DEXTER DITCH	ADJ	T. 28 N., R. 88 W., S. 35	Cherry Creek
Cherry	T5688D	SAM DITCH	ADJ	T. 28 N., R. 88 W., S. 35	Cherry Creek
Cherry	T5689D	CENTER DITCH	ADJ	T. 28 N., R. 88 W., S. 35	Cherry Creek
Cherry	T5690D	FERRIS DITCH	ADJ	T. 27 N., R. 88 W., S. 2	West Cherry Creek
Pete's	T5703D	BARR 11 DITCH	ADJ	T. 28 N., R. 87 W., S. 29	Pete's Creek
Pete's	T5704D	PETER CREEK IRRIGATING DITCH	ADJ	T. 28 N., R. 87 W., S. 4	Pete's Creek
Pete's	T5705D	HOSPITALITY DITCH	ADJ	T. 28 N., R. 87 W., S. 29	Pete's Creek
Pete's	T5706D	CENTER DITCH	ADJ	T. 28 N., R. 87 W., S. 29	Pete's Creek
Muddy	T5727D	MARSH IRRIGATING DITCH	ADJ	T. 26 N., R. 88 W., S. 9	Muddy Creek