BEAR RIVER WATERSHED STUDY
LEVEL I

For

Wyoming Water Development Commission

Lincoln and Uinta County Conservation Districts

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I. INTRODUCTION

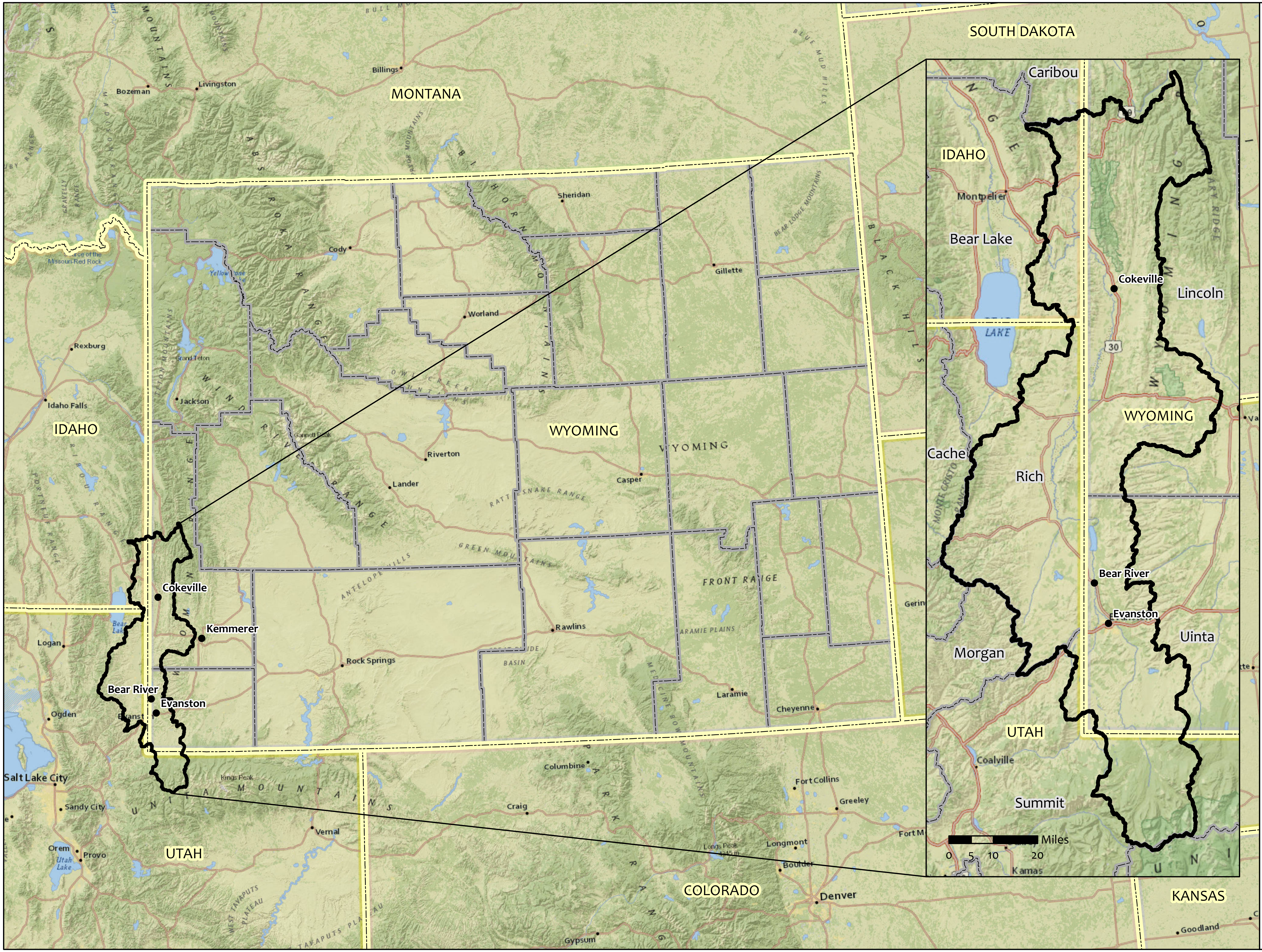
In June 2015 Sunrise Engineering was contracted by the Wyoming Water Development Commission (WWDC) to provide professional services for the preparation of the Bear River Watershed – Level I Study. The purpose of the contract was to provide professional and technical services necessary to 1) assess, describe, and inventory the watershed and 2) develop management and rehabilitation plans for the watershed. The watershed study provides both practical and economical recommendations that, if implemented, will help solve issues and realize opportunities identified during the inventory and assessment of the Bear River Watershed. Additionally, the study analyzes the potential for developing surface water within the Bear River Watershed with particular emphasis on irrigation and small upland water projects. These projects include both public and private lands and are intended to advance agriculture production and grazing management through public-private partnerships that develop small and under-utilized water resources. Larger scale water storage was evaluated in light of the many studies already completed while relying on the detailed analysis and concepts of earlier studies. To date, at least sixty-seven State or Federal studies related to basin water resources have been completed. The study was conducted in association with Biota Research and Consulting, Inc. (Biota), Pierson Landworks (Pierson), HDR, and RJH Consultants (RJH). Figure 1.1 Location Map outlines the location and extent of the Bear River Watershed. It straddles the western border of Wyoming with the States of Idaho and Utah. Within the Wyoming portion, two counties; Lincoln and Unita, further divide the watershed with administrative boundaries.

This study comprises two main documents divided to better meet the needs of the Lincoln and Unita Conservation Districts. The first document is this Bear River Watershed Study - Level I that covers the entire watershed and is the main document. The second document is the Appendices to the report containing drawings, exhibits, tables, and data helpful to the understanding of the main study. Each County has its own section in the Appendices related to the specific projects in the County.

1.1 PROJECT OVERVIEW

The State of Wyoming has recognized the benefits of basin planning efforts within watersheds that frequently do not fit within political boundaries (e.g. cities, counties, or states). The WWDC describes the watershed planning process as follows:

> *"Today, conservation by watershed is an old concept with new horizons. Watersheds have long been recognized in the western United States for their significant natural resources and the interrelationships found contained in land areas connected by stream systems. These relationships were recognized by John Wesley Powell from his early expeditions of the west and resulted in proposed conservation, low density open grazing, irrigation systems and state boundaries based on watershed areas.*
>
> *The conservation concept developed over time to coalesce in the early 1930's with the formation of special districts whose boundaries were often based on watersheds. At that time*



Bear River Watershed

Figure 1.1
Location Map

> *the relationship between stream systems and landscape function was recognized. This relationship was broadened to embrace watershed condition and quality and its response to human influences. This further provided some understanding of the historic land use effect on watershed condition and how management and restoration needs to be based on local landscape characteristics.*
>
> *Today, these relationships are embraced by the Wyoming Water Development Commission and Office through a watershed study program. On behalf of a local community sponsor, a watershed study can provide a comprehensive evaluation, analysis and description of the resources associated with a watershed and the watershed's water development opportunities. It is best stated that information related to the physical sciences is incorporated into a biological system.*
>
> *There are three prominent issues that are important considerations in a watershed information review and study. The first is surface water storage. Surface water storage is often of significant interest to a watershed community in order to address seasonal and/or annual shortages of water supply, augment late season stream flow to benefit riparian habitat, fisheries and wildlife, address flood impacts, enhance recreation opportunities, improve water quality and stream channel stability.*
>
> *Second is the evaluation of irrigation infrastructure and development of information necessary to guide its rehabilitation and conservation. Of interest to local water users are ways to improve water delivery and on-farm irrigation efficiencies often timed to address annual or seasonal shortages of water supply or irrigation water delivery issues. Third is the enhancement of upland water resources and distribution for livestock and wildlife that allows grazing management adjustments for range resource improvement. Benefits to the watershed, through plant community invigoration, reduction of erosion and stream channel stabilization, can be achieved from water development projects being strategically implemented over the watershed. Other issues and opportunities such as making beneficial use of produced water and removal of high water demand invasive species can also be important.*
>
> *A watershed study, providing management and rehabilitation plans for water storage, irrigation systems and upland water development, can help empower a community to proactively enhance their watershed. Conservation by watershed can be an effective holistic approach to embracing the natural resource challenges and opportunities facing a community. A watershed study can provide the information to meet those challenges."*

The Bear River Watershed Study is one of several watershed planning studies that have been completed or are ongoing including:

- Shell Valley Watershed Study
- Prairie Dog Creek Watershed Study
- Popo Agie River Watershed Study
- Middle N. Platte Watershed Study
- Little Snake River Watershed Study
- Thunder Basin Watershed Study
- Kirby Creek Watershed Study
- Badwater-Poison Creek Watershed Study
- Upper Laramie Watershed Study
- Nowood Watershed Study

Three Horses Watershed Study
Clear Creek Watershed Study
Buffalo Creek Watershed Study
Sweetwater River Watershed Study
Cottonwood Creek/Grass Creek Watershed Study
Upper Green River Watershed Study
Blacks Fork Watershed Study
Upper Platte Watershed Study
Belle Fourche Watershed Study
New Fork Watershed Study
South Platte Watershed Study
Middle NP-Glendo Watershed Study
Goose Creek Watershed Study
Owl Creek Watershed Study
Medicine Bow Watershed Study

1.2 BACKGROUND

The Lincoln and Uinta County Conservation Districts, the project co-sponsors, requested the WWDC conduct a study within the Bear River Watershed in order to evaluate watershed function and to work with landowners to identify irrigation and upland livestock/wildlife water management and rehabilitation opportunities. Wetlands and riparian areas, development of a geomorphic classification for the watershed and a synopsis of past surface water storage efforts were of secondary interest to the Districts. The intent of the information generated from the watershed study is to provide baseline information from which the Districts can pursue implementation of management practices that address natural resource issues and capitalize on opportunities within the drainage.

The Bear River Watershed in Wyoming is approximately 1.9 million acres in size and is located within Lincoln and Uinta Counties (79%), significant portions also lay in Utah and Idaho with the main stem of the Bear River crossing state boundaries three times before exiting into Idaho near Border. The watershed includes the main stem of the Bear River, the primary river system; a variety of larger tributaries include the following by county:

Uinta County
Willow Creek
Bazoo Hollow Creek
Sulpher Creek
Coyote Creek
Washatch Creek
Plesant Valley Creek
Red Canyon Creek
Alkali Creek

Lincoln County
Bridger Creek
Bridger Fork
Cottonwood Creek
Collett Creek
Bullpen Creek
Clear Creek
South Fork Twin Creek
Twin Creek
Leeds Creek
Horse Creek
Trail Creek
Sublette Creek
Spring Creek
Pine Creek
Sams Creek
Contag Creek
Hobble Creek
Poker Creek
Porcupine Creek
Dry Fork Smiths Fork
Little Muddy Creek
Huff Creek
Salt Creek
Third Creek
Smiths Fork
Mill Creek
Birch Creek
Bruner Creek
Coal Creek (Tributary to Smith's Fork)
Thomas Fork of Salt Creek (also Coal Canyon)

Elevations in the Uinta County portion of the Bear River range from mid 9,500’ in the the Willow Creek area to 6352’ as the river exits Uinta County into Utah downstream of the Woodruff Narrows Dam. Portions of the basin further south in Utah extend to 12,700’. In the Lincoln County portion of the drainage the higher elevations are the 10,780’ Greysalt Ridge on the Smiths Fork down to Border Gauge Station at 6,051.6’.

Land ownership in the Bear River drainage is a mixture of public (federal and state) and private land. The ownership breakdown is as follows: Bureau of Land Management (BLM) (41%); Forest Service (12%); private land (37%); State of Wyoming (8%); National Park Service (1%); and U.S. Fish and Wildlife service (1%).

There are three incorporated municipalities within the project area; the Town of Cokeville in Lincoln County and the Town of Bear River and City of Evanston in Uinta County.

Administratively the study areas fall within Division IV of the State Engineer’s offce water divisions and includes Districts 2 and 4.

During prepration of this study it became apparent that the watershed faces the following general challenges with regard to its land and water resources including:

- Distribution of water resources
- Water quality
- Infrastructure maintenance
- Erosion
- Rangeland health
- Maintenance of riparian habitat

1.3 PURPOSE AND SCOPE

The primary purpose of this Level I Study was to gather relevant existing information and combine that information with data generated by this study to form a comprehensive Watershed Management and Rehabilitation Plan. Specific objectives of the project include the following:

1. Conduct an evaluation and description of the watershed, including quantity and quality of surface water resources, and riparian/upland conditions.
2. Conduct an evaluation of water storage needs and opportunities to augment upland water available for livestock and wildlife.
3. Conduct an irrigation system inventory and develop a rehabilitation plan for those land owners expressing an interest in participating.
4. Promote public participation in the study.
5. Facilitate participation and consensus building with the landowners and the public at large, the Conservation Districts, and the Wyoming Water Development Commission.
6. Identify natural resource issues within the watershed and propose practical economic solutions.

7. Identify permits, easements and clearances necessary for plan implementation.
8. Develop a watershed management and rehabilitation plan describing and prioritizing potential projects and management strategies to address water resource related issues and water development opportunities identified in the watershed inventory.
9. Develop conceptual-level cost estimates of the projects identified in the watershed management and rehabilitation plan.
10. Compile and collate all spatial data, relevant published and unpublished reports, and other existing background information into a comprehensive digital library to be available as a resource for the conservation districts and future studies.
11. Conduct a geomorphic investigation of primary tributary channels within the watershed and identify potential mitigation measures to improve impaired channel reaches.

1.4 POTENTIAL EFFECTS AND BENEFITS IDENTIFIED THROUGH A WATERSHED STUDY

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

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

There can be one or more benefits resulting from the implementation of BMPs and conservation practices. Such benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP or conservation practice, ecological site, watershed, or major land resource area. BMPs and conservation practices also provide opportunities to relieve grazing pressure on riparian areas and create the potential to induce improvements to soil health, plant community diversity, and improved forage production. They allow for grazing deferment in the event that rest is required due to invasive species control efforts, which can also stimulate water release.

Benefits to ecosystem functionality and landscape health can be and is a response to soil health, water infiltration/percolation and a functioning water cycle. Expected project benefits can be related to watershed function including collection and storage of water along with ecological enhancements such as plant and animal habitat and stream corridor or riverine stability as well as societal values including economic stability and open space maintenance. Multiple benefits can result from improvement opportunities for water resources, which are critical to meet the daily water demands of the resident population of man and beast, develop, increase or extend irrigation water availability, and improve fishery habitat and potential recreational benefits.

1.4.1 NATURAL RESOURCES CONSERVATION SERVICE (NRCS) CONSERVATION EFFECTS ASSESSMENT PROJECT

In 2003, in the interest of government accountability, Congress and the Office of Management and Budget requested information from the U.S. Department of Agriculture (USDA) about the effectiveness of its conservation programs. In response, the Conservation Effects Assessment Project (CEAP) was initiated by NRCS to provide quantitative information about the environmental impacts of its conservation practices on agricultural lands within the contiguous 48 United States. The CEAP is a joint effort of the NRCS, Agricultural Research Service (ARS), National Institute for Food and Agriculture, other federal agencies, and university scientists to quantify the environmental effects of conservation practices and develop the science base for managing the agricultural landscape for environmental quality. Initially focused on croplands, the CEAP effort was expanded to include wildlife, wetlands, pastures, and rangelands.

Project findings have been used to guide USDA conservation policy and program development that will assist conservationists, farmers, and ranchers with informed conservation decisions [Spaeth et al., 2013]. The end product of the CEAP is a literature review and concise collation of information from hundreds of published scientific papers, journals, and additional references. Consequently, the CEAP documents provide a valuable source of information pertaining to BMPs incorporated in a watershed management plan and is referenced throughout the remainder of this document.

1.4.1.1 WATERSHED FUNCTION

Identifying improvement opportunities for hydrologic and watershed function, including water quantity, yield and use, is an essential element of the Level I Watershed Study. Hydrologically, there are three fundamental watershed functions: (1) collection of the water from rainfall, snowmelt, and storage that becomes runoff, (2) storage of various amounts and durations, and (3) discharge of water as runoff [Black, 1997]. Watershed characteristics such as geologic structure, soils, landform, topography, vegetation, and climate influence the capture or collection of precipitation, infiltration and storage of surface and ground water, and the runoff or discharge of water.

1.4.1.2 WATER QUANTITY

Implementation of BMPs and conservation practices can improve water resource quantity through promotion of plant communities, vegetative diversity, and ecological site health achieved by water development and the creation of reliable water sources in areas devoid of such allowing for the establishment of grazing systems and changes in grazing distribution.

Hydrological responses to grazing are strongly contingent on the vegetative community composition, with communities that provide greater cover and obstruction to overland flow, such as midgrass-dominated communities having greater hydrological function, including infiltration rate, than shortgrass-dominated communities [Wood and Blackburn 1981b; Thurow 1991; Natural Resources Conservation Service, 2011]. Poor water distribution has been the primary cause of poor livestock distribution [Holecheck, 1997]. Livestock distribution and grazing behavior can be modified by adjusting the location of supplemental feed and water, implementation of patch burns, and herding in addition to the traditional practice of fencing [Williams 1954; Ganskopp 2001; Fuhlendorf and Engle 2004; Bailey 2005]. Natural Resources Conservation Service [2011] reviewed many studies and found that water distribution, steep slopes, and high elevations unequivocally influenced livestock distribution. Also sufficient evidence existed to recommend that NRCS increase the role of herding and supplement placement along with water development and fences for managing livestock distribution [Natural Resources Conservation Service, 2011]. Section 4.2 will more particularly describe the livestock water sources in the Bear River Watershed study area.

Soil vegetative cover is widely recognized as a critical factor in maintaining soil surface hydrologic condition and reducing soil erosion [Gifford, 1985; Natural Resources Conservation Service, 2011]. Stocking rates, regardless of grazing system, that reduce soil surface vegetative cover below a site-specific threshold increases detachment and mobilization of soil particles due to raindrop impact, decreases soil organic matter and soil aggregate stability, increases soil surface crusting and reduces soil surface porosity, thus decreasing infiltration and increasing soil erosion and sediment transport [Blackburn, 1984]. Sufficient vegetative cover, critical soil cover, or residual biomass must remain during and following grazing to protect soil surface condition (e.g., porosity, aggregate stability, and organic matter) and hydrologic properties (e.g., infiltration). However, these site-specific vegetation cover requirements vary depending on cover type (e.g., vegetation, litter, or rock), soil type, rainfall intensities, and water quality goals [Gifford 1985]. The erosive energy of water and the long-term reduction of organic matter additions to soil detrimentally affect numerous soil properties, including the increase of bulk density, disruption of biotic crusts, reduced aggregate stability, and organic matter content, which collectively reduce infiltration rate and increase sediment yield and runoff [Natural Resources Conservation Service, 2011].

The above mentioned efforts can increase water infiltration/percolation, stimulate spring flows and increase flow volume and duration. An example of restoring watershed function and water quantity was in a 74,000 acre watershed in West Texas near San Angelo where West Rocky Creek, a dry, intermittent stream for decades, started flowing again [Moseley, 1983; Wiedenfeld, 1986]. In the early part of the 20th century, West Rocky Creek was a yearlong flowing stream until the late 1910s, when it became an intermittent stream and by 1935, the springs feeding the creek had been dried up by mesquite and other invading woody plants [Moseley, 1983; Wiedenfeld, 1986].

During the 1950s and 1960s, ranchers and landowners on five ranches, covering about half the watershed, began conservation work including root-plowing, reseeding, tree-dozing, aerial spraying, and chaining of mainly mesquite and juniper brush, which limited water availability for native grasses such as sideoats grama, buffalograss, curly mesquite, and tobosa [Moseley, 1983]. About 30,000 acres or 70 percent of the mesquite was removed from the watershed, and the original prairie was restored [Moseley, 1983; Wiedenfeld, 1986]. In the mid to late 1960s, one of the 5 ranchers noticed that a spring, which was dry since 1935, had started flowing again and by replacing the water-hungry brush with a good grass cover, more rainfall soaked into the aquifer, recharging the dormant springs which began flowing on all 5 ranches by 1970 [Moseley, 1983]. Ongoing grazing management on each ranch enhanced the cover of grasses in the watershed with soils producing an estimated 2,000 to 2,500 pounds of forage per acre which helps retard brush succession; the ranchers periodically must do maintenance brush control to keep the desired vegetation balance [Moseley, 1983].

In southeast Arizona, long-term data on soils, vegetation, hydrology, and climate have been collected for over five decades on the Walnut Gulch Experimental Watershed, which is operated by the USDA's Agricultural Research Service (ARS). The Walnut Gulch Experimental Watershed is one of the most intensively instrumented semiarid experimental watersheds in the world, with a 10 to 100-year record of abiotic and biotic measurements and photographs [Moran et al, 2008]. Researchers studied the interaction between rainfall intensity and soils and vegetation by comparing the frequency of runoff producing summer events between a shrub-dominated watershed and a grass-dominated watershed and found that it takes higher rainfall intensities to produce runoff on the grassed watershed [USDA Agricultural Research Service, 2013]. Results also indicate that the grassland plant community is producing more plant material than the shrubland, with close to the same amount of precipitation input, making the grassland ecosystem more water use efficient [USDA Agricultural Research Service, 2013]. The researchers found that runoff quantities at the watershed scale are controlled more by infiltration of water into alluvial channels and spatial distribution of thunderstorm rainfall [USDA Agricultural Research Service, 2013].

1.4.1.3 ECOLOGICAL ENHANCEMENT

Ecosystems are dynamic complexes of animal, plant, and microorganism communities interacting with each other and the nonliving environment. Ecosystems provide numerous services to human populations, including provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling (Millennium Ecosystem Assessment 2005).

Ecological enhancement is the act of improving the structure and/or function of a degraded ecosystem. This can be accomplished through a number of means such as stabilizing erosive soils, improving soil quality, planting or maintaining native vegetation, controlling invasive species, and restoring or protecting riparian/wetland areas. The watershed study area contains a diverse array of ecological sites, and the potential benefits achieved from implementing targeted conservation practices to restore or enhance the condition of these ecological sites are many. Benefits typically include improved water quality, plant community diversity, soil health, and fish and wildlife habitat. Cumulative benefits to water quality can be significant, as these practices often improve the chemical, physical, and biological constituents of a water body. Wetland and riparian enhancement and restoration can provide numerous ecological benefits such as water quality improvement, shoreline and streambank stabilization, flood attenuation, groundwater recharge, and enhanced fish and wildlife habitat. Section 4 discusses BMPs and conservation practices commonly used to restore ecosystem health in landscapes such as those found in the watershed study area.

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Millennium Ecosystem Assessment. 2005. Ecosystems and human well-being: Synthesis. Island Press, Wash. DC. 137 pp. http://www.millenniumassessment.org/documents/document.356.aspx.pdf.

1.4.1.4 PLANT AND ANIMAL HABITAT

Plant and animal communities are intrinsically bound together, and impacts to one community often affects the other. When the interactions between these communities are in balance, a functional, healthy, and resilient ecosystem can be maintained. Management practices and the spatial distribution of rangeland infrastructure including fences, watering points, and feeders can substantially impact overall health and productivity of vegetation communities. The use of rangelands for sustainable livestock production has the potential to ensure the maintenance of wildlife habitat which will ensure that wildlife habitat will persist into the future (NRCS 2011). Wildlife responses to conservation practices are usually species and even species-habitat specific, meaning not only that each species may respond differently to any specific practice, but also that a single species may respond differently to the same practice in different vegetation associations or conditions. For example, livestock grazing can have negative or positive impacts on game bird habitat, depending on timing and intensity of grazing and the habitat being influenced (Beck and Mitchell 2000).

Water availability is the primary factor that limits distribution and abundance of many species of wildlife in arid regions of the United States, and water developments have been used since the 1940s to improve wildlife habitat (Simpson et al. 2011). Positive effects of water developments on wildlife populations have been documented in numerous studies. Researchers studying the effects of wildlife water developments in southwestern Arizona found that water developments were used by a diverse array of wildlife, including mule deer, game birds, a number of nongame species (Rosenstock et al. 2004).

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Rosenstock, S. S., C. S. O’Brien, R. B. Waddell, and M. J. Rabe. 2004. Studies of wildlife and water developments in southwestern Arizona: Wildlife use, water quality, wildlife disease, wildlife mortalities and influences on native pollinators. Technical Guidance Bulletin No. 8. AZ Game and Fish Dept., Phoenix.

Simpson, N. O., K. M. Stewart, and V. C. Bleich. 2011. "What Have We Learned About Water Developments for Wildlife? Not enough!" CA Fish & Game, Vol. 97. No. 4, pp. 190–209.

1.4.1.5 STREAM CORRIDORS AND RIPARIAN/WETLAND AREAS

The health and productivity of riparian areas are highly dependent on natural disturbance regimes associated with annual episodic flood events that provide areas of localized scour, remove decadent plant material, and deliver pulses of nutrients and fine sediment. These are typically low-intensity, high-frequency disturbances that enhance overall ecosystem function. Conversely, anthropogenic disturbances in riparian areas are often of a level of intensity beyond that of the natural disturbance regime, and as such result in reduced ecosystem function and resiliency. Improper management of grazing, or overgrazing, in riparian areas is one such disturbance.

The season and duration of grazing determines livestock effects on riparian plant communities, particularly woody plants. The Natural Resources Conservation Service suggests riparian grazing management that maintains or enhances key riparian vegetation attributes (i.e., species composition, root mass and root density, cover, and biomass). Properly managed grazing can benefit the health of the riparian community by breaking up dead and decadent plant material and reducing competition from herbaceous species. Fall and season-long grazing regimes can be detrimental to woody riparian communities, while actively managed winter, spring, or early summer grazing can often be accomplished without much damage to woody species. Livestock distribution practices such as water developments, supplement placement, and herding are effective means of managing the intensity and season of livestock grazing in riparian areas (NRCS 2011). The strategic development of upland water resources can relieve pressure on riparian plant communities and improve watershed processes. The resulting recovery of soil health and regeneration of native tree and shrub communities can help restore local water tables, trap sediments, stabilize stream banks, and enhance fish and wildlife habitat.

REFERENCES

NRCS. 2011. Conservation benefits of rangeland practices: Assessment, recommendations, and knowledge gaps, D. D. Briske (ed.). Allen Press, Inc. Lawrence, KS.

1.4.1.6 SOCIETAL VALUE

Natural resource stewardship not only has economic value in terms of forage, livestock, and wildlife production relationships, but also can have non-economic value placed on those conservation practices by society. Those values can even influence the perception of those implementing conservation practices and can be as much an influence in the decision process to implement conservation as is an economic value. Additionally, it is possible for a BMP or conservation practice that provides an ecological service to accrue more value to society in general than to a local landowner. Ecosystem services are defined as those things or experiences produced by natural systems on which humans place value [Natural Resources Conservation Service, 2011]. Ecosystem services benefit society in numerous and diverse ways while each of the conservation practices can potentially produce different kinds, qualities, and amounts of these goods and services, depending on location, natural potentials, current states, and other factors.

Non-economic values can and should be considered in determining watershed enhancement programs, particularly when considering public investment in conservation. The Natural Resources Conservation Service [2011] found little to no research exists showing the direct noneconomic effects of BMPs and conservation practices on individuals, households, or social systems but acknowledged it was likely that producers do realize psychological benefits from conservation because stewardship typically ranks high among the management goals of livestock producers [Huntsinger and Fortmann, 1990; Sayre, 2004]. Moreover, livestock producers who believe strongly in a responsibility to society are more likely to engage in environmentally desirable management practices, such as invasive weed control and riparian protection [Kreuter et al, 2006].

In 2012, in cooperation with the Wyoming Stock Growers Association (WSGA), University of Wyoming, and University of California-Davis, research scientists with the USDA's ARS Rangeland Resources Research Unit in Cheyenne, Wyoming investigating effects of rangeland management decision-making asked WSGA producer members about their goals, ranching operations, and management practices via a mail survey and received a total of 307 rancher responses to the survey [Kacheris et al, 2013; Wyoming Livestock Roundup, 2013]. Livestock production and forage production were the top management goals, with ecosystem characteristics that support these goals (e.g., soil health, water quality) tied for second [Kacheris et al, 2013; Wyoming Livestock Roundup, 2013].

In addition to other social values and ecological enhancements, open spaces have long been held in high value to Wyoming and other western region states. From a ranching industry perspective, tourism interest, outdoor recreationist activity, or a real estate value, open space is significant. Preservation of our custom and culture has been and continues to be a focal point of consideration. Open spaces are critical for upland/riparian conductivity, wildlife migrations and habitat, and recreational opportunity. Open space is valued for preservation of cultural resources and for the reduction or prevention of land conversion to a condition that can be stewarded to an improved ecological condition.

1.4.2 EXAMPLES OF EFFECTS AND BENEFITS OF WATERSHED MANAGEMENT PLAN COMPONENTS

The watershed management and rehabilitation plan and components presented in the final report of a watershed study provides recommendations for improvements for the following:

- Irrigation system rehabilitation components
- Livestock/wildlife upland watering opportunities

- Grazing management opportunities
- Storage opportunities
- Stream channel condition and stability
- Wetland enhancement opportunities
- Other watershed management opportunities.

An itemized priority list of components and associated conceptual cost estimates are typically tabulated in the watershed management plan along with specific recommendations for addressing water issues in the watershed. In the following sections, the potential effects and benefits associated with key BMPs and conservation practices are discussed in relation to the various plan components: Livestock/wildlife water supply, irrigation system rehabilitation, and stream channel. The intent of this discussion is to provide the decision makers with the background necessary to make informed decisions regarding future planning efforts.

The NRCS prepares Network Effects Diagrams (NEDs) of conservation practices or BMPs which act together to achieve desired purposes. The NEDs "are flow charts of direct, indirect and cumulative effects resulting from installation of the practices. Completed network diagrams are an overview of expert consensus on the direct, indirect and cumulative effects of installing proposed practice installation. They show the potential positive and negative outcomes of practice installation, and are useful as a reference point for next steps, and as a communication tool with partners and the public" [Natural Resources Conservation Service, 2014].

Benefits associated with a particular conservation practice or BMP can be classified as direct, indirect or cumulative. Direct and indirect benefits would be considered measureable or tangible benefits. For example, construction of a reservoir designed to augment late season irrigation water supplies provides the direct or measurable benefit, of providing a supply of water commensurate with its storage capacity. An indirect benefit could be the habitat provided to wildlife. Likewise, the same reservoir could provide the cumulative benefit of increased income to producers and improved health of the local economy.

As previously discussed, such benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP, ecological site, watershed, or major land resource area. Project benefits can be related to ecological enhancement, water quantity, economic stability, stream corridor or riverine stability, or maintenance of open spaces. Examples of the NRCS NED for common conservation practices and/or BMPs from a typical watershed management plan are presented in the following section of this document.

A broader supplemental Network Effects Diagrams (NEDs) spreadsheet is contained in Appendix K with links to resource documents for over 160 conservation practices.

1.4.2.1 IRRIGATION WATER CONVEYANCE—PIPELINE

The rehabilitation and replacement of existing irrigation system delivery conveyance structures help to efficiently deliver water and to facilitate management of irrigation water. The practice reduces erosion, conserves water, and protects water quality. Underground pipelines serve as an integral part of the irrigation water distribution system and significantly improve the overall efficiency of the system. Several irrigation projects were identified during completion of this study and are outlined in Section 5.1.1.2.

Strategies defining placement of irrigation water conveyance pipelines typically involve:

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

Effects and benefits of rehabilitating and improving water conveyance for irrigation systems are numerous and are displayed in the NRCS's NED in Figure 1.4.2.1. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Water availability for irrigation
    - Plant growth and productivity
- Infiltration and evaporation losses
    - Increased plant growth and productivity
    - Decreased leaching of nutrients
- Erosion associated with practice
    - Decreased sediment delivery to surface waters

Cumulative effects/benefits of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community
- Improved aquatic health of humans, domestic animals and wildlife
- Improved stream fauna and environmental quality.

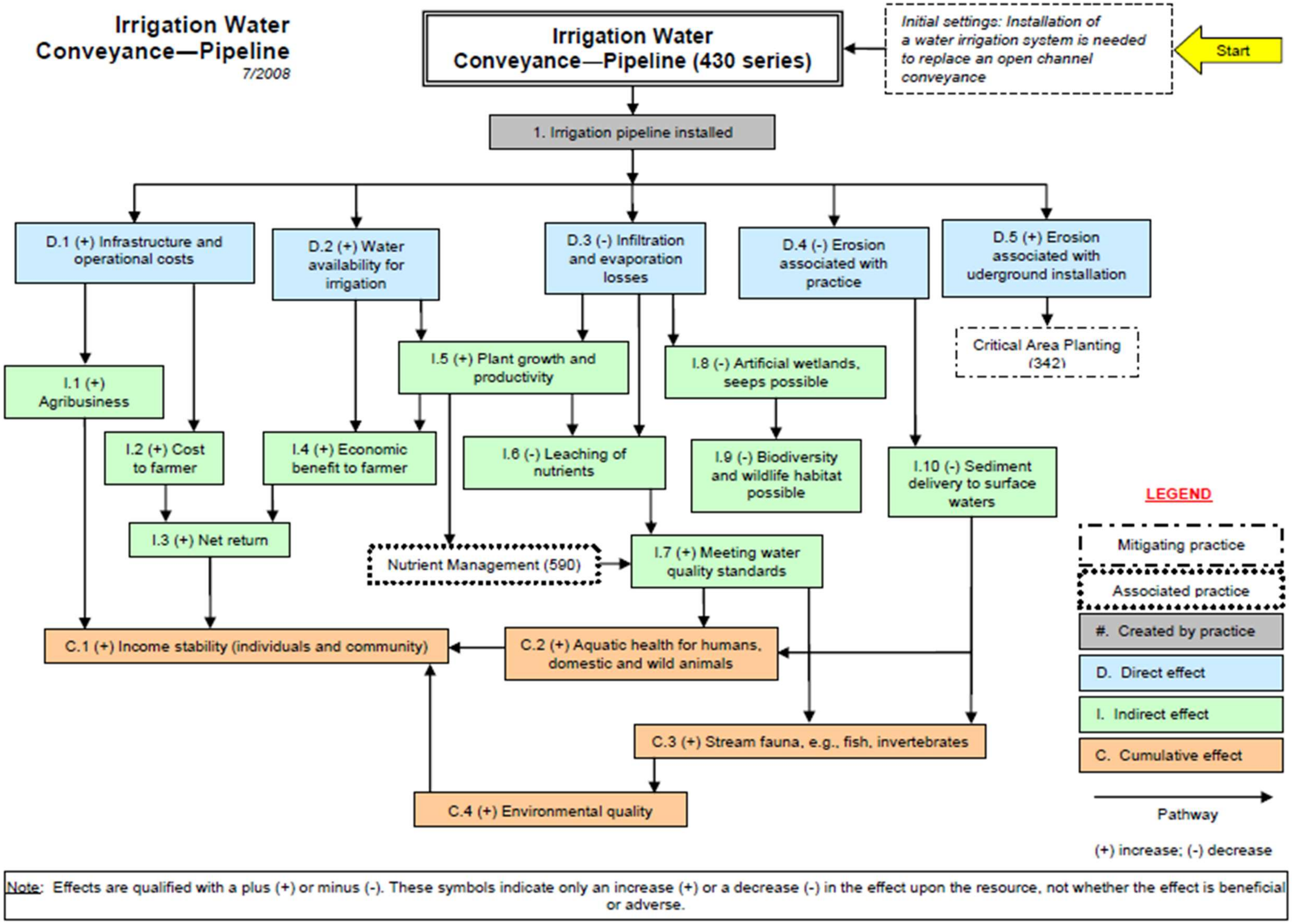


Figure 1.4.2.1 Network Effects Diagrams for Irrigation Conveyance—Pipeline.

1.4.2.2 LIVESTOCK/WILDLIFE WATER SUPPLY FACILITIES

The development of reliable watering facilities in areas otherwise lacking reliable sources of water for livestock and wildlife, help to promote improved rangeland conditions in several ways. Watering facilities may be associated with wells, springs, streams, ponds or hauled water. ***Reliable water sources are integral aspects of a range management plan involving distribution of livestock.*** Section 4 contains basin specific upland water projects identified during completion of this study.

Strategies defining placement of water facilities typically involve:

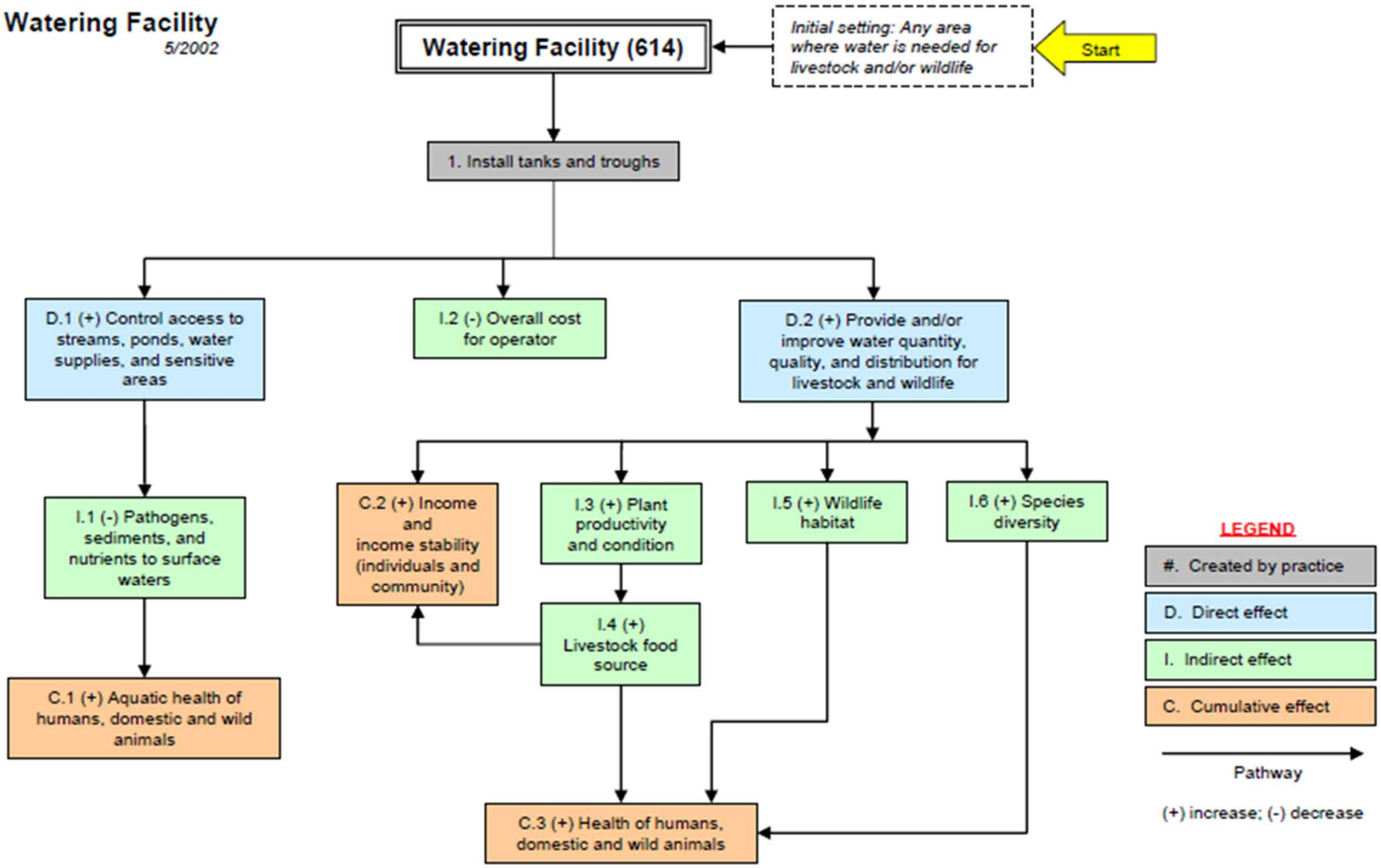
- Facilitation of prescribed grazing management plans
- Alternative water supplies to riparian sources
- Provision of a reliable source where no other sources may exist
- Optimization of upland range resources.

Benefits of providing reliable water facilities for livestock and wildlife are numerous and are displayed in the NRCS's NED in Figure 1.4.2.2. As shown in this figure, direct and indirect benefits associated with this BMP include:

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

Cumulative benefits of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community,
- Improved aquatic health of humans, domestic animals and wildlife, and
- Improved health of humans, domestic animals and wildlife.



Note: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Figure 1.4.2.2 Network Effects Diagrams for Livestock/Wildlife Watering Facility.

1.4.2.3 GRAZING MANAGEMENT AND PRESCRIBED GRAZING

The watershed study and management plan includes conservation practices and BMPs such as water developments, fencing, salting and herding, ecological sites and state and transition models, prescribed fire, and application of chemicals and other tools that can be used to facilitate and enhance grazing distribution and optimize range conditions through prescribed grazing. Prescribed grazing is the controlled harvest of vegetation with grazing animals managed with the intent to achieve a specific objective. Prescribed grazing may be applied on lands where grazing and/or browsing animals are managed. A grazing schedule is prepared for allotments, pastures to be grazed. Removal of vegetation by the grazing animals is in conformity with realistic yield goals, plant growth needs, and management goals. Duration and intensity of grazing is based on desired plant health and productivity of the forage species to meet management objectives.

Strategies for applying prescribed grazing involve managing the intensity, frequency, duration, distribution, and season of grazing by:

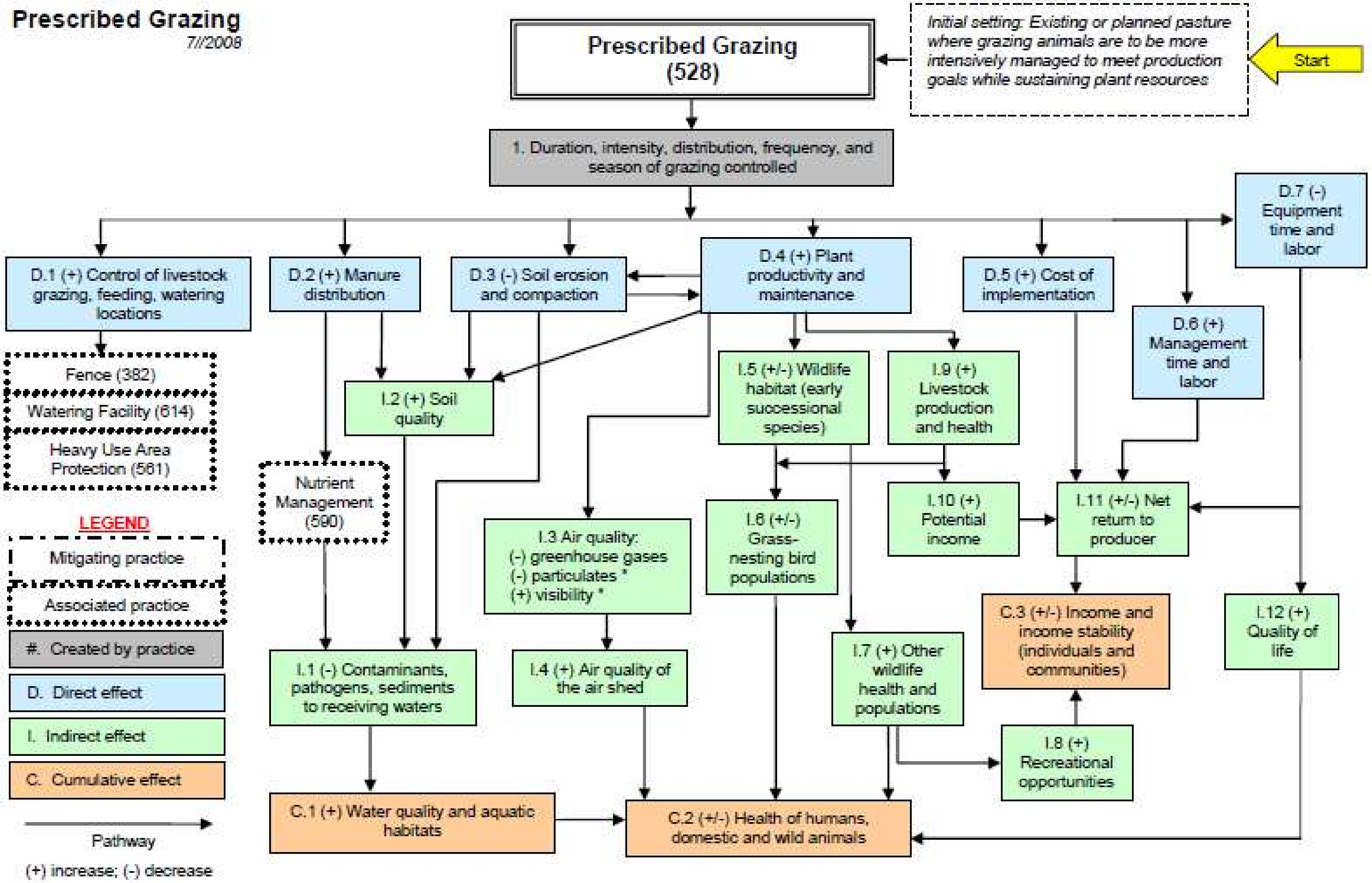
- Defining landowner and/or manager goals and objectives
- Identifying needs for reliable water sources and supplies
- Feed and forage inventories and analyses
- Range condition and health evaluations and assessments
- Managing desirable and undesirable plant communities to meet grazing objectives

Benefits of implementing prescribed grazing and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 1.4.2.3. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Increased control of livestock grazing, feeding, watering locations
    - Decreased loading of pathogens, sediments, and nutrients to surface waters
- Increased manure distribution
    - Increased soil quality
    - Reduced contaminants, pathogens, sediments to receiving waters
- Soil erosion and compaction
- Increased plant productivity and maintenance
    - Increased livestock production and health
    - Increased wildlife health and populations

Cumulative benefits of implementing prescribing grazing could include:

- Positive impacts to income and stability of individual producers and the community
- Improved water quality and aquatic habitat
- Improved health of humans, domestic animals and wildlife.



Note: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Figure 1.4.2.3 Network Effects Diagrams for Prescribed Grazing.

1.4.2.4 STREAM CHANNEL RESTORATION PROJECTS

The watershed study and management plan includes conservation practices and BMPs such as installation of stream channel degradation/incision and streambank erosion mitigation measures based upon site-specific evaluation of conditions along with routine monitoring of completed stream projects to identify necessary maintenance repairs and determine their effectiveness. Appropriate measures could be ‘hard’ engineering, ‘soft’ approaches, or combinations of both. Streambank and shoreline protection is the stabilization and protection of streambanks, constructed channels, and shorelines of lakes and reservoirs. Strategies for applying streambank and shoreline protection involve:

- Streambanks of natural or constructed channels and shorelines of lakes and reservoirs where they are susceptible to erosion
- Various materials used for protection of streambanks and shorelines
- Conducting a site-specific assessment to determine if the causes are local or systemic and selecting appropriate treatment to achieve the desired objective
- Building functional and stable treatments for design flows and sustainability for higher flows
- Preventing the loss of adjacent land or damage to land uses or other facilities
- Protecting historical, archeological, and traditional cultural properties
- Reducing the offsite or downstream effects of sediment resulting from bank erosion
- Improving the stream corridor for fish and wildlife habitat, aesthetics, and recreation

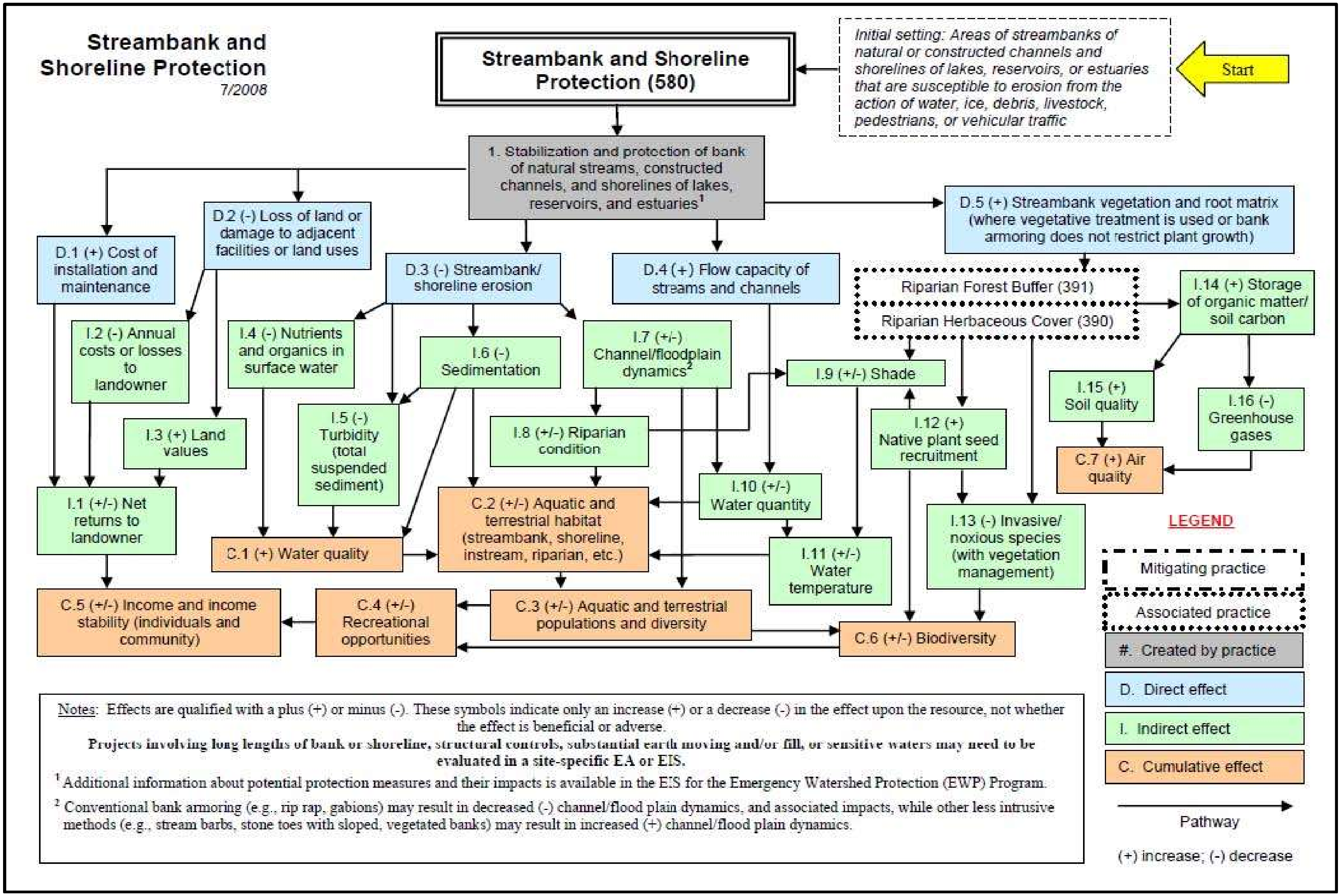
Benefits of implementing streambank and shoreline protection and associated BMPs and conservation practices are numerous and are displayed in the NRCS’s NED in Figure 1.4.2.4. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Decreased streambank and/or shoreline erosion
    - Increased soil quality
    - Decreased sedimentation
- Increased flow capacity of streams and channels
- Increased streambank vegetation and root matrices
    - Increased soil quality
    - Increased native plant recruitment
    - Decreased invasive/noxious species

Cumulative benefits of implementing streambank and shoreline protection could include:

- Positive impacts to income and stability of individual producers and the community,
- Improved water quality and aquatic and/or terrestrial habitat,
- Improved recreational opportunities.

Several stream channel/bank projects are identified in Section 5.1.1.2 and include projects associated with headgate serviceability as well as erosion and water quality improvement projects.



Notes: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Projects involving long lengths of bank or shoreline, structural controls, substantial earth moving and/or fill, or sensitive waters may need to be evaluated in a site-specific EA or EIS.

[1] Additional information about potential protection measures and their impacts is available in the EIS for the Emergency Watershed Protection (EWP) Program.

[2] Conventional bank armoring (e.g., rip rap, gabions) may result in decreased (-) channel/flood plain dynamics, and associated impacts, while other less intrusive methods (e.g., stream barbs, stone toes with sloped, vegetated banks) may result in increased (+) channel/flood plain dynamics.

Figure 1.4.2.4 Network Effects Diagrams for Streambank and Shoreline Protection.

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II. PROJECT MEETINGS

2.1 INTRODUCTION

Various meetings were held by the Wyoming Water Development Office (WWDO) staff to inform the Lincoln and Uinta County Conservation Districts and the community of the WWDC's watershed study process. The meetings held were as follows:

- September 9th, 2015 – Kickoff Meeting at Cokeville Town Hall
- September 10th, 2015 – Kickoff Meeting at Unita County Libarary, Evanston
- February 23rd, 2016 – Evanston - Landowner Meeting
- February 24th, 2016 – Cokeville - Landowner Meeting
- April 20th, 2016 - Kemmerer – Wyoming Water Update – Bear River

During the course of the study, meetings were conducted on two different levels. The first level of meetings were the publicly advertised and attended meetings held at the Cokeville Town Hall, and the Uinta County Library, or at the Offices of the Lincoln and Uinta County Conservation Districts. These meetings were general project meetings discussing approach and project findings. The attendanace at the meetings was between eight and twenty individuals with roughly half being land owners at the public meetings. The remaining attendees were from State and Federal agencies. The Conservation Districts provided an initial contact list for the first meeting. Invitations to the meetings were by postcard, email, or telephone as contact information dictated.

The second level of meetings were arranged with individual property owners to review their proposed upland water projects and irrigation improvement projects. These contacts were initially made at the public meeting, or by referrals from the Conservation Districts, or by word of mouth.

2.2 FIELD VISITS

2.2.1 UPLAND WATER VISITS

The meetings with individual property owners were held in the field and where practical, (favorable weather and access conditions) included a site visit. In some cases the review was made using aerial photography. During the meeting, the landowner or allotment lesee described the purpose and location of the proposed improvement. In instances of existing failed infrastructure, the landowner provided information as to the probable cause of failure and ideas on what might be changed to rectify the problem. Using this data, proposed development concepts were discussed with the landowner. The engineer subsequently prepared a sketch and estimate of cost for the proposed project.

A second follow-up meeting with individual landowners was accomplished via an open-house held at the Cokeville Town Hall and Unita County Library. At the meeting, maps and project descriptions based on the initial consultation were reviewed for accuracy by the landowner. After the landowner review, sketches and estimates were finalized according to the review comments. Section IV of this study contains additional detail and description of the results of these efforts.

2.2.2 TEMPORARY STREAM GAUGING VISITS

During the course of this study, temporary stream gauges were installed at four locations in the watershed. Mill Creek, Salt Creek, Yellow Creek and Rock Creek were monitored from April, 2016 to mid October, 2016. During the course of installation and retrieval these streams and streams along the access routes were observed in terms of condition and geomorphology. Section 3.4.4.3 contains additional information as to gauge location and monitoring results.

2.3 AGENCY/LANDOWNER COORDINATION

Landowner coordination was direct with the Lincoln and Unita County Conservation District. The Districts assisted with landowner access for the stream gauges and was also a point of contact for landowners with upland water projects. The Districts provided helpful insight and assisted with questions from both landowners and the consultants working on the study. Landowner names were forwarded from the District to the project engineer along with contact information and a brief description of the landowner initiated project.

The GIS data sets were coordinated with the State GIS clearinghouse as well as several agencies such as the USFS, BLM, Oil and Gas Commission, the Wyoming Natural Diversity Database, Uinta County, and Lincoln County. Some report sections were also reviewed by the Wyoming Game and Fish.

III. WATERSHED DESCRIPTION AND INVENTORY

3.1 INTRODUCTION

A considerable amount of information pertaining to the Bear River Watershed already exists. These data span a wide variety of disciplines, including basin hydrology, water quality, wetlands, wildlife, land use and ownership, climate, geology, soils, agricultural practices and others. The data comes from Federal, State, local, corporate, and private interests and spans the previous century. Interest in the above topics began with early settlement in the basin and has since grown to the point of massive amounts of data being available to the general public at present through the use of computers and public data sets.

A primary goal of watershed planning studies conducted on behalf of the Wyoming Water Development Commission (WWDC) is to:

1. Collect, review, and compile pertinent information regarding the project area;
2. Collate the data in a single dataset; and
3. Use this information to characterize the watershed and facilitate current and future planning, permitting, and improvement efforts within the watershed.

3.2 DATA COLLECTION AND MANAGEMENT

3.2.1 COLLECTION OF EXISTING INFORMATION

The information collected during the course of this study primarily came from existing data sets already in existence. Many Federal, State and local governmental agencies have successfully cataloged and scanned historic paper documents into electronic databases and have made these documents available. In addition, on-going research and more recent studies completed in electronic format are available from various contacts including the following:

U.S. Geological Survey (USGS)

U.S. Forest Service (USFS)

U.S. Department of Agriculture (USDA)

U.S. Fish and Wildlife Service (FWS)

U.S. Environmental Protection Agency (EPA)

U.S. Bureau of Land Management (BLM)

U.S. Department of the Interior Bureau of Reclamation (BOR)

USDA Natural Resources Conservation Service (NRCS)

Wyoming Water Development Office (WWDO)

Wyoming Department of Environmental Quality (WDEQ)

Wyoming State Engineer’s Office (SEO)

Wyoming Game and Fish Department (WGFD)

Wyoming State Geological Survey (WSGS)

Wyoming Geographic Information Science Center (WyGISC)

Wyoming State Geological Survey (WSGS)

Wyoming Oil and Gas Conservation Commission (WOGCC)

Wyoming Secretary of State's Office

Lincoln County

Uinta County

Lincoln County Conservation District

Unita County Conservation District

Lincoln County Weed and Pest

Uinta County Weed and Pest

3.2.2 GEOGRAPHIC INFORMATION SYSTEM (GIS)

Much of the collected data and some data generated during the preparation of the study are in GIS format. GIS is a powerful mapping tool that allows the map creator to collect and display graphical information in a variety of combinations and formats. The map becomes a window into larger data sets of attributes (tables of facts, descriptions, and numbers) associated with the graphically displayed map data. The GIS user can access the data sets through the user interface. In this way, a simple exhibit depicting various basin features can contain vast amounts of tabular data. For instance, a map of soil types can access portals to tabular data such as soil abbreviations, soil types, soil characteristics, acreage by type, etc.

The following Table 3.2.2 outlines in general terms the available information.

Table 3.2.2 Outline of Avaialble GIS Information

Project Study Area		**Fish and Wildlife**	
	Bear River Watershed (Wyoming portion)		Bear River Trout Stream Classifications
Political			Big Game Crucial Winter Range
	Cities and Towns		Big Game Partruition Areas
	UTM Zones		Big Game Migration Routes
	County		Big Game Winter Ranges
	Public Land Survey System		Big Game Habitat
Land Management			Canada Lynx Habitat
	BLM		Sage Grouse LeK Locations and Core Population Areas
	USFS		
	Wyoming State Lands	**Geology, Soils, and Geomorphology**	
	BLM Allotments		Bedrock Geology
	Wyoming Department of Enviromental Quality		Surficial Geology
	Lincoln County Conservation District		Statewide Geological Formation Layer
	Uinta County Conservation District		Landslides
	Wilderness Study Areas		Dikes and Faults
Ownership			Rosgen Level I Stream Classifications
	Lincoln and Uinta County Assessor and Parcel Mapping		Ecological Site Descriptions
Infrastructure			
	Oil and Gas Wells	**Irrigation**	
	Telecomunicaitons		Points of Diversion
	Electric Transmission		Irrigated Lands
	Roads		National Hydrography Data Set
	Wells		
	Pipelines	**Upland Water Projects**	
	Canals		Springs and Seeps
			Proposed Upland Projects
Cultural			
	Cultural Sites Eligible for the National Register of Historic Places	**Backgrounds**	
			National Geographic World Map
Hydrology			USGS 1:100,000K
	Dams and Reservoirs		2012 NAIP County Mosaic 1M Pixel Resolution
	USGS Stream Gauges		
	Points of Diversion		
	HUC 12 Watersheds		
	Existing Wells		
	Lakes and Streams		
	Canals and Conduits		

3.2.3 DIGITAL LIBRARY

As part of compiling the information for this study, a digital library was created. The digital library is a collection of documents pertaining to this project. Some of the documents were originally bound paper, but have now been scanned electronically. Other documents were generated in electronic format at the outset. All public documents provided to the study or located during the study have been included when possible. The collection of documents in the digital library improves access to the information so it can be used in current and future planning, permitting and improvement efforts in the watershed. There are some datasets of a sensitive nature and not all data was provided or the data was provided in a general sense. An example of this type of sensitive data would be cultural resources, where a general presence is noted on the map; however, specifics regarding the location and particular nature of the site have been withheld.

3.3 LAND USES AND ACTIVITIES

3.3.1 LAND OWNERSHIP

The Wyoming portion of the Bear River watershed totals about 1.8 million acres or 2,813 square miles in size, and includes 648,401 acres in Lincoln County and 313,896 acres in Uinta County in Wyoming; about 522,500 acres in Rich County and 188,200 acres in Summit County, Utah; and about 139,800 acres in Bear Lake County in Idaho (Fig. 3.3.1).

The focus of this watershed study is on the portions within Wyoming. Areas of the watershed located outside of Wyoming are only dealt with peripherally, mostly in the context of surface hydrology. This is because some Bear River tributaries originate outside of Wyoming but contribute (in varying degrees) to water resources within Wyoming.

The Wyoming portion of the watershed study area totals 962,298 acres and falls within the jurisdiction of 2 Wyoming conservation districts, Lincoln Conservation District and Uinta County Conservation District. The watershed study is being sponsored by both Conservation Districts.

The majority of land within the Wyoming watershed study area (525,833 acres, 55%) is administered by Federal agencies with the Bureau of Land Management (BLM) administering 391,601 acres (41%); the USDA Forest Service (USFS) administering 119,535 acres of the Bridger-Teton National Forest (12%); the USDI National Park Service (NPS) administering 8,347 acres at Fossil Butte National Monument (1%); and the USDI Fish and Wildlife Service (USFWS) administering 6,350 acres of the Cokeville Meadows National Wildlife Refuge (1%) [Chart. 3.3.1-2]. Private lands constitute 360,629 acres (37%) and State of Wyoming land constitutes 74,318 acres (8%); the remaining land consists of waterbodies totaling about 1,518 acres (<1%).

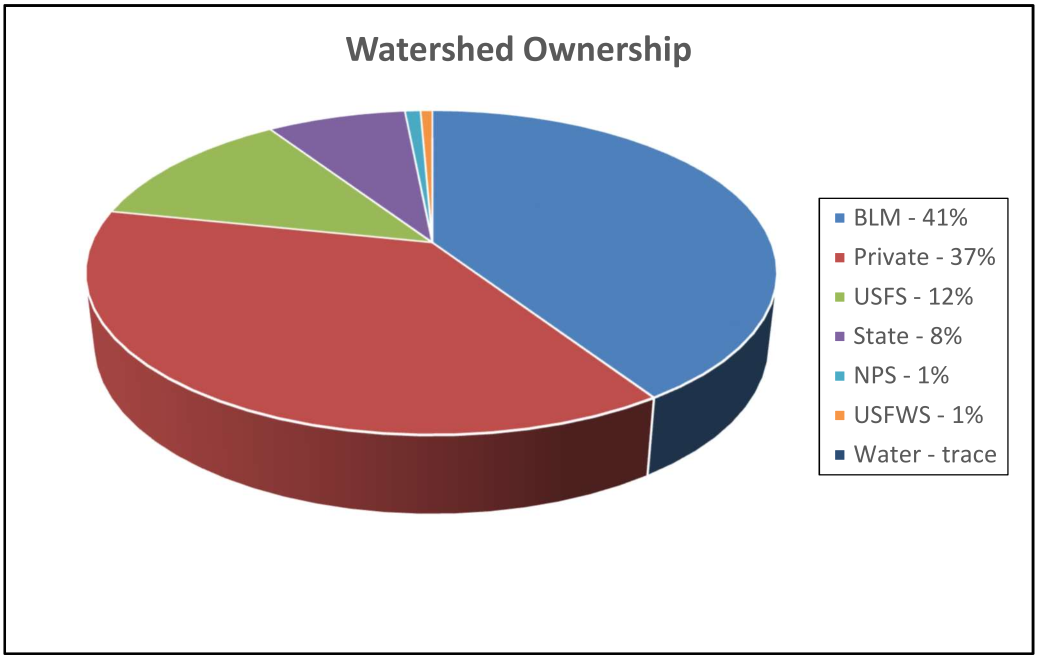


Chart 3.3.1-2. Proportion of land ownership within the Wyoming portion of the Bear River Watershed.

Ownership within the Wyoming portion of the watershed, displayed on a per county basis, is depicted for Lincoln County in Chart 3.3.1-3 and for Uinta County in Chart 3.3.1-4.

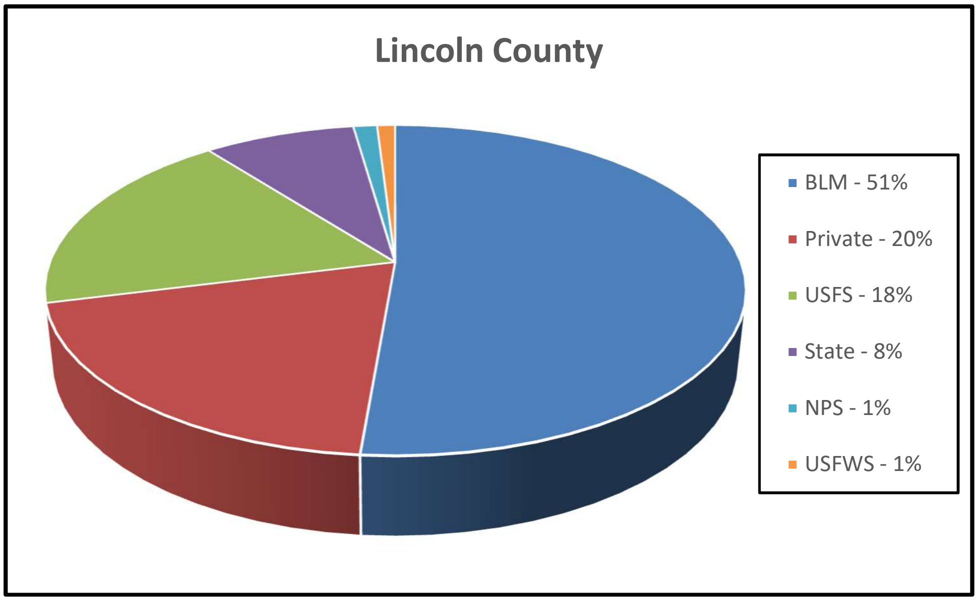


Chart 3.3.1-3. Proportion of land ownership in Lincoln County within the Bear River Watershed.

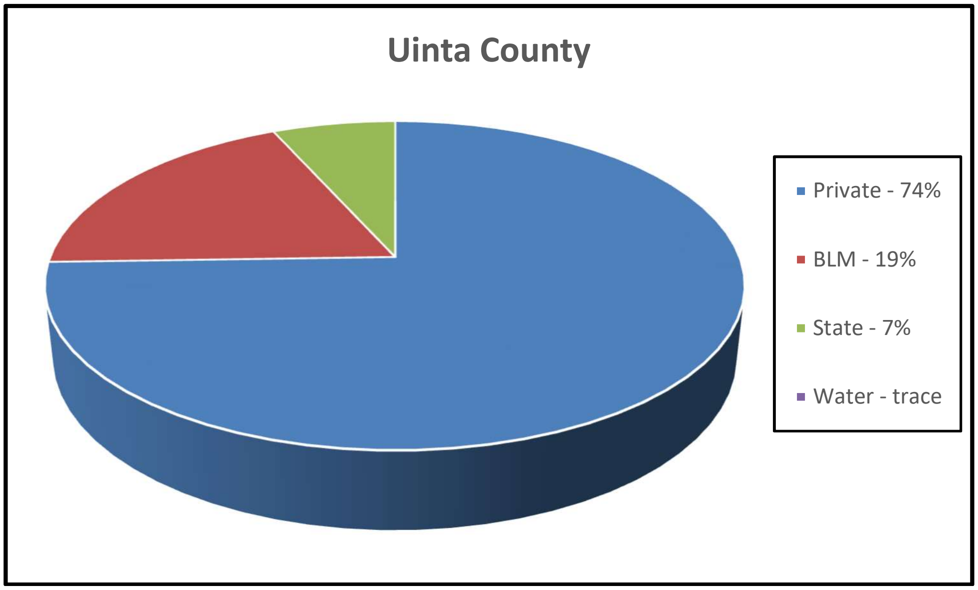
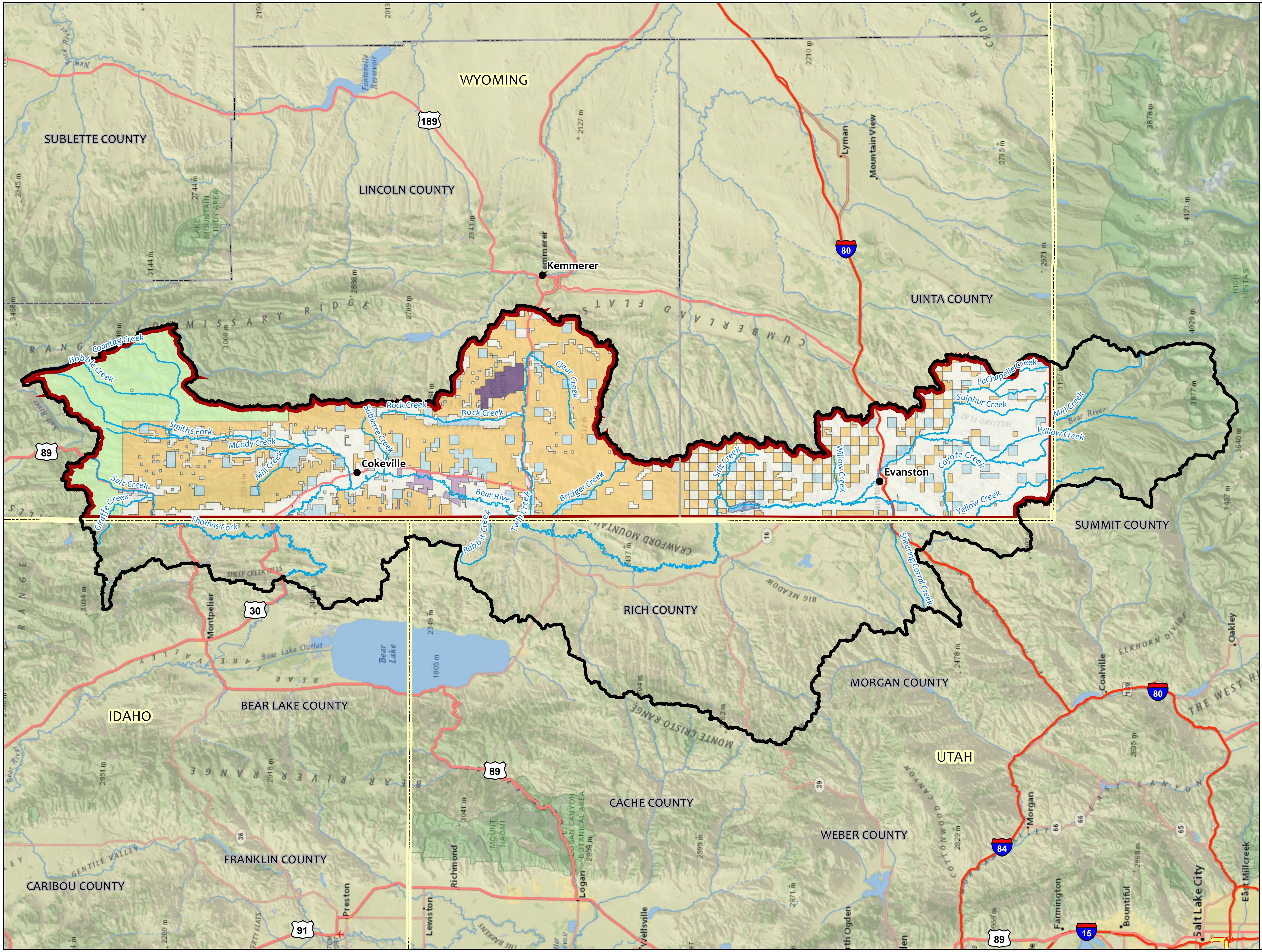


Chart 3.3.1-4. Proportion of land ownership in Uinta County within the Bear River Watershed.



Legend

Ownership

- 🟧 Bureau of Land Management
- 🟪 Fish & Wildlife
- 🟩 Forest Service
- 🟪 National Park Service
- ⬜ Private
- 🟦 State
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

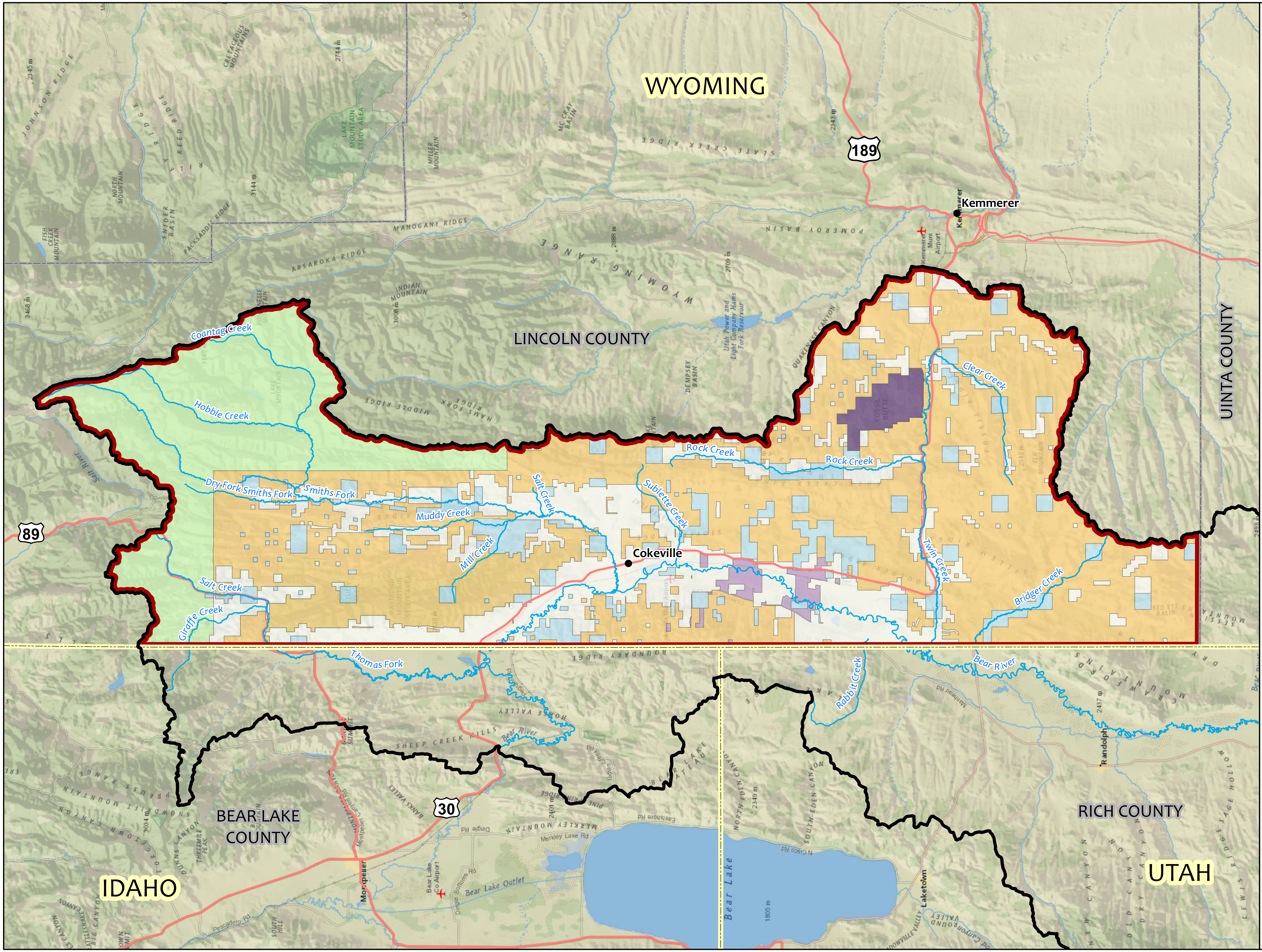
Miles
0 5 10

Projection: NAD 83 - UTM 12N

SUNRISE ENGINEERING

Bear River Watershed

Figure 3.3.1
Land Ownership



N
E
S
W

0 5 10 Miles

Projection: NAD 83 - UTM 12N

Legend

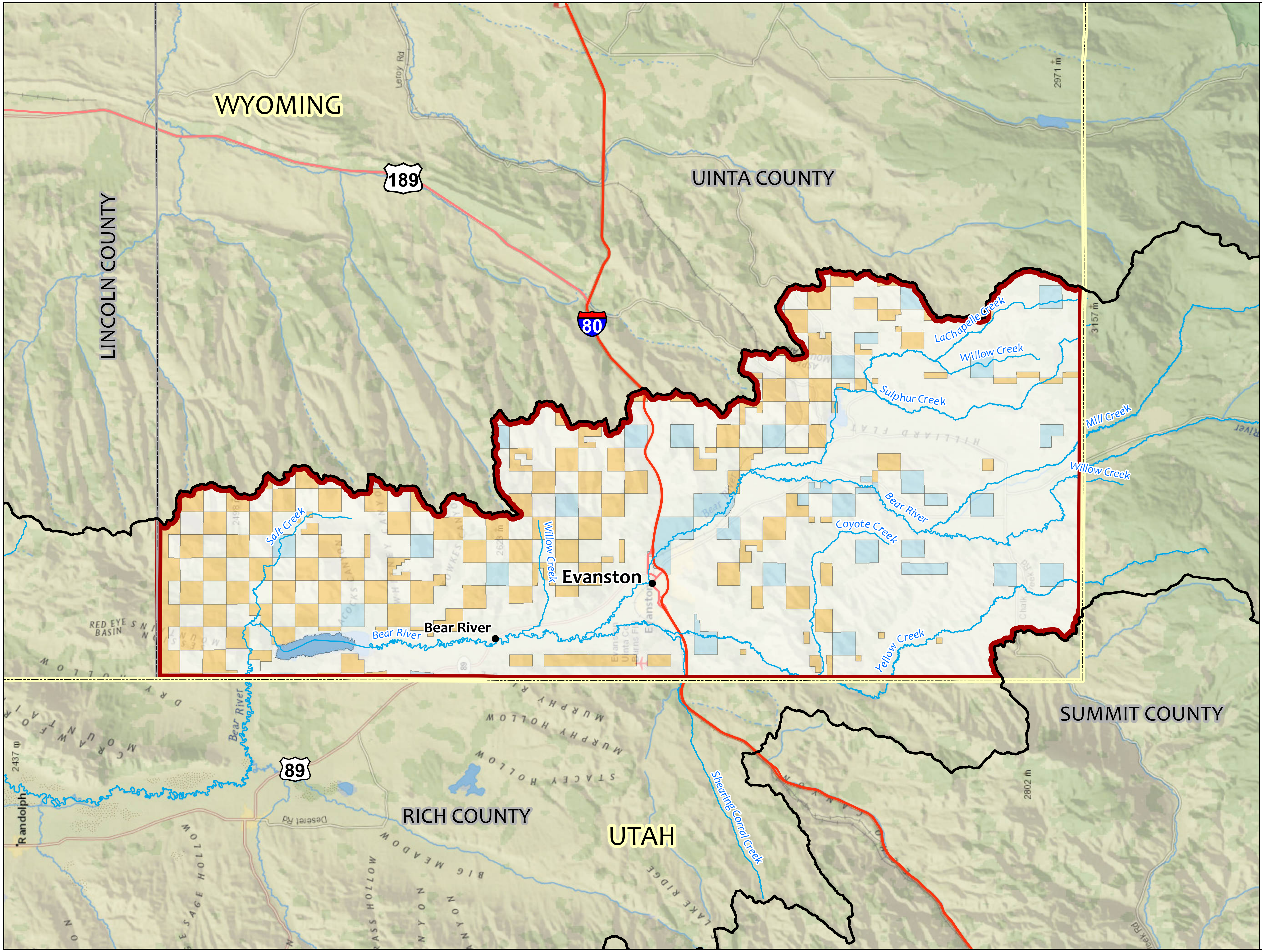
Ownership

- 🟧 Bureau of Land Management
- 🟪 Fish & Wildlife
- 🟩 Forest Service
- 🟪 National Park Service
- ⬜ Private
- 🟦 State
- Bear River Watershed Boundary
- 🟥 Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed
Lincoln County

Figure 3.3.1
Land Ownership



Bear River Watershed
Uinta County

Figure 3.3.1
Land Ownership

3.3.2 TRANSPORTATION, ENERGY & COMMUNICATION INFRASTRUCTURE

The southern portion of the Bear River watershed study area and within Uinta County is served by Interstate 80. The principal two-lane highways within the watershed are U.S. Highways 89 and 30 (Figure 3.3.2). US Highway 89 is located in the northwestern portion of the watershed within Lincoln County. US Highway 30 is located in the southern portion of Lincoln County between Kemmerer and Cokeville and then exits Wyoming near Border. Prominent State Highways consist of Wyoming Highway 89 in the vicinity and overlapping with portions of US Highway 89 in western Lincoln County, and Wyoming Highways 231 and 232 in the vicinity of Cokeville. Various county-maintained roads are also present within the study area. Many unimproved roads are located throughout the study area.

The Union-Pacific Railroad operates 2 sections of rail lines within the watershed study area (Fig. 3.3.2). One rail line is located in the vicinity of Interstate 80 in the Evanston area of Uinta County. The second rail line roughly parallels US Highway 30 between Kemmerer, Cokeville, and Border in Lincoln County.

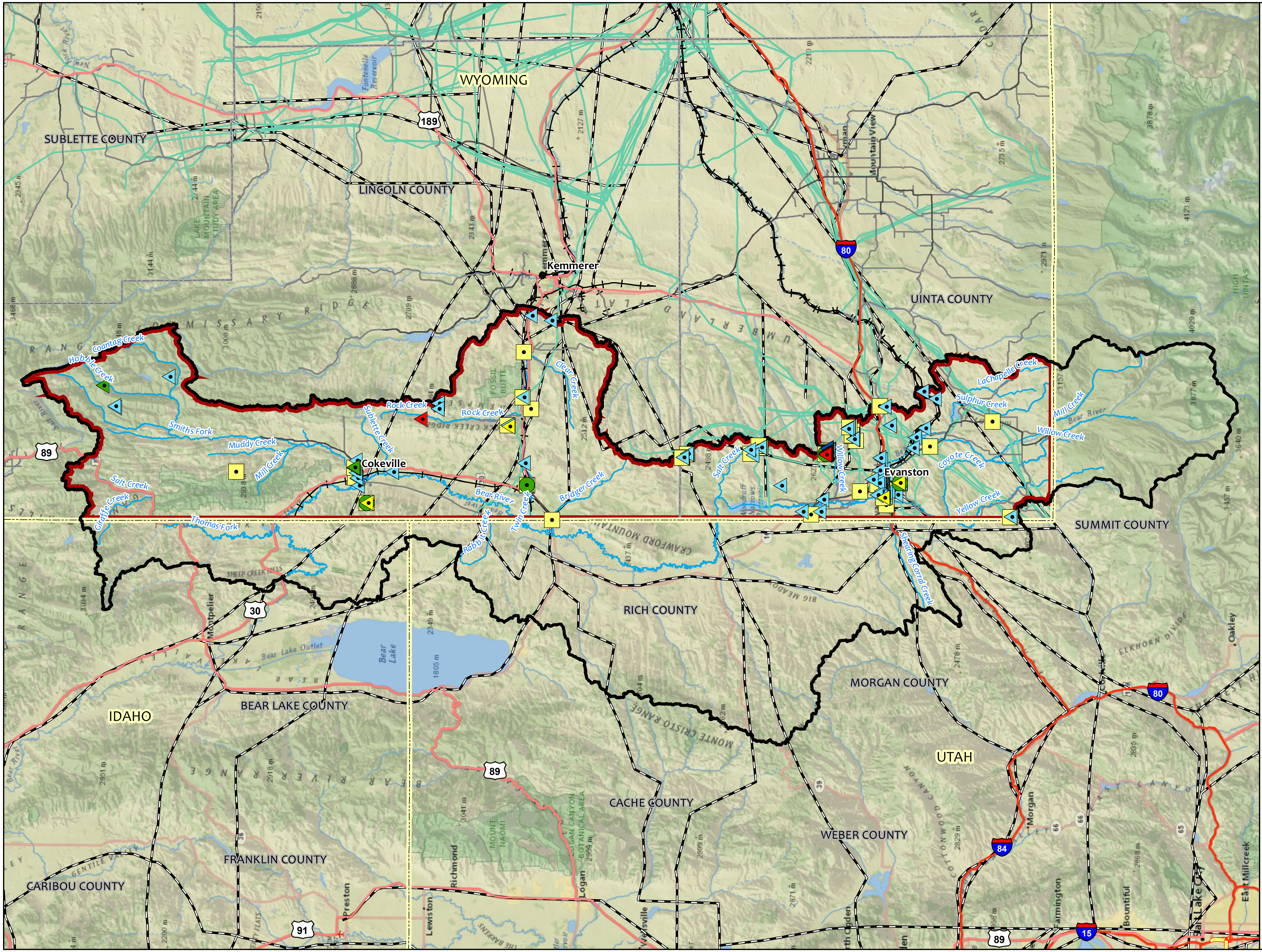
Electric power service within the watershed is primarily provided by PacificCorp and secondarily by Rocky Mountain Power; primary powerlines are depicted in Figure 3.3.2.

A total of 58 pipelines are present within the watershed study area, primarily in the area south of Evanston in Uinta County (Fig. 3.3.2). Fourty of the pipelines convey natural gas; in addition 5 pipelines convey crude oil and 13 pipelines convey products. Seven companies own the majority of these pipelines: Questar Pipeline; Enterprise Products; Kern River; Enron; Northwest Pipeline; Mountain Fuel Supply; and Rocky Mountain Pipeline System. The remainder of the pipelines are owned by five other companies.

Numerous antennae are scattered throughout the watershed (Figure 3.3.2) including cellular (total count = 7) and antenna structure registration (total count = 9); microwave (total count = 74); paging (total count = 2); FM radio (total count = 7); television (total count = 13); liquid metal-commercial (total count = 13) and private (total count = 188).

3.3.3 IRRIGATION

Agricultural water use in the Bear River Basin consists primarily of irrigation and to a lesser degree stock watering. The predominant source of irrigation supply is surface water with 25 main-stem diversions and 262 tributary diversions. A network of canals and ditches were constructed by producers to convey water from the natural tributaries and main stream Bear River to the meadows and cultivated lands. Flood irrigation remains the principal method of applying water to the fields. Center pivots and pressurized irrigation are finding increased application within the basin thanks to NRCS assistance. At present between 130,000 to 140,000 acres are under irrigation depending on water availability. Consumptive use ranges between 130,000 acre-feet in dry years to 150,000 acre-feet in a wet year. Section V of this plan contains detailed irrigation information.



Bear River Watershed

Figure 3.3.2
Transportation, Energy, and Communication Infrastructure

3.3.4 RANGE CONDITIONS/GRAZING PRACTICES

3.3.4.1 GRAZING ALLOTMENT ADMINISTRATION

Background and History. Since the late 1800s, cattlemen have been wintering livestock in the protected valleys of the Bear River basin. Homesteaders began ranching and farming along the major streams and rivers in the 1870s with the railroad arriving in Evanston in 1868 and Cokeville in 1882. The rangeland surrounding the private homesteads remained part of the public domain and was used for pasturing livestock (primarily sheep and cattle) throughout the warmer months of the year. Livestock were driven back to private property to overwinter. After lambing and calving in the spring, livestock would be returned back to public rangeland. This pattern of seasonal livestock grazing on public lands remains much the same today as it was at the beginning of the 20th Century.

The Federal Government passed the Taylor Grazing Act in 1934, which regulated the use of public lands for grazing and limited use to a specific geographic area or grazing allotment. Ranchers were allowed a specific number of livestock for a specific season of use. During the 1930s and 1940s, the Federal Government began to perform surveys to determine the amount of forage available on each allotment. The results of these surveys led to an eventual reduction in grazing permits, the construction of allotment boundary fences, and the development of numerous off-site water projects to improve livestock distribution.

Federal Grazing Allotments. Today, grazing allotments on federal lands within the watershed are administered by the BLM and the USFS. The 12 USFS allotments are located in the mountains in the northern portions of the study area, overlap the hydrographic divides into the Snake and Green River basins. BLM allotments are located along the entire length of the basin and foothills. All BLM allotments are located within the Kemmerer BLM planning area. According to geospatial data provided by the BLM, there are 76 individual allotments on BLM lands within the watershed (Figure 3.3.4). Allotment boundaries are typically not coincident with watershed boundaries; therefore, some of these allotments are not located entirely within the Bear River Watershed.

Since the passage of the Federal Land Policy and Management Act (FLPMA) in 1976, numerous laws, regulations, and policies have directed the BLM to manage its riparian and wetland areas "for the benefit of the nation and its economy". According to the Department of the Interior's final rule on grazing administration, effective August 21, 1995, the Wyoming BLM State Director is responsible for the development of standards for healthy rangelands and guidelines for livestock grazing management on 18 million acres of Wyoming's public rangelands. (BLM 1997). The purpose of these standards and guidelines are to achieve the four fundamentals of rangeland health outlined in the grazing regulations. These are: 1) watersheds are functioning properly; 2) water, nutrients, and energy are cycling properly; 3) water quality meets State standards; and 4) habitat for special status species is protected.

In response to the Department of the Interior's final rule and to address the health, productivity and sustainability of BLM-administered lands in Wyoming, the BLM established 6 Standards for Healthy Rangelands. The standards are outlined below. Additional information on the standards can be found in the BLM Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management document (http://www.blm.gov/pgdata/etc/medialib/blm/wy/wildlife/baldeagle.Par.18820.File.dat/be-appb.pdf).

Standard #1 – Within the potential ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.

Standard #2 – Riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge.

Standard #3 – Upland vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance.

Standard #4 – Rangelands are capable of sustaining viable populations and a diversity of native plant and animal species appropriate to the habitat. Habitats that support or could support threatened species, endangered species, species of special concern, or sensitive species will be maintained or enhanced.

Standard #5 – Water quality meets State standards

Standard #6 – Air quality meets State standards

In addition to these standards, the BLM has developed guidelines for livestock grazing management on BLM-administered lands in the state. Implementation of the standards and guidelines is to be accomplished by reviewing individual allotments based on the BLM's current allotment categorization and prioritization process. The review first determines if an alloment meets each of the six standards. If it does, no further action is necessary. If any of the standards are not met, then rationale explaining the contributing factors is prepared. If livestock grazing practices are found to be among the contributing factors to not meeting a standard, then corrective actions consistent with the livestock management guidelines are developed and implemented.

The BLM utilizes a selective management policy to administer grazing leases. The policy requires that the agency prioritize and direct resources to lands providing the greatest potential for improvement and public benefit. As such, grazing leases are separated into 3 management categories: maintain, improve, and custodial. The "improve" category leases typically include large blocks of public land where resources are far below the desired condition. Current management is typically not sufficient to meet or maintain resource objectives. These larger blocks of public land offer the best opportunity for the BLM to take actions or authorize uses to meet various resource objectives. The "maintain" lands are similar in regards to the amount of public land included in the lease, but these lands are typically near or at the desired condition. The "custodial" category typically includes small, isolated tracts of public land. Resource conditions on "custodial" lands are typically near desired condition, and management actions are comprised of administrative actions such as lease renewals, billings, and transfers.

In the early 1990s, the BLM began using Proper Functioning Condition (PFC) assessments to qualitatively assess the physical function of riparian areas within allotments and to determine if these areas are properly functioning under their current management regime. Using this approach, riparian areas are assigned one of 4 functional ratings. These include: proper functioning condition; functioning – at risk; non-functional; or unknown. A comprehensive PFC survey was completed on all stream reaches on allotments within the Kemmerer planning area from 1994-2001.

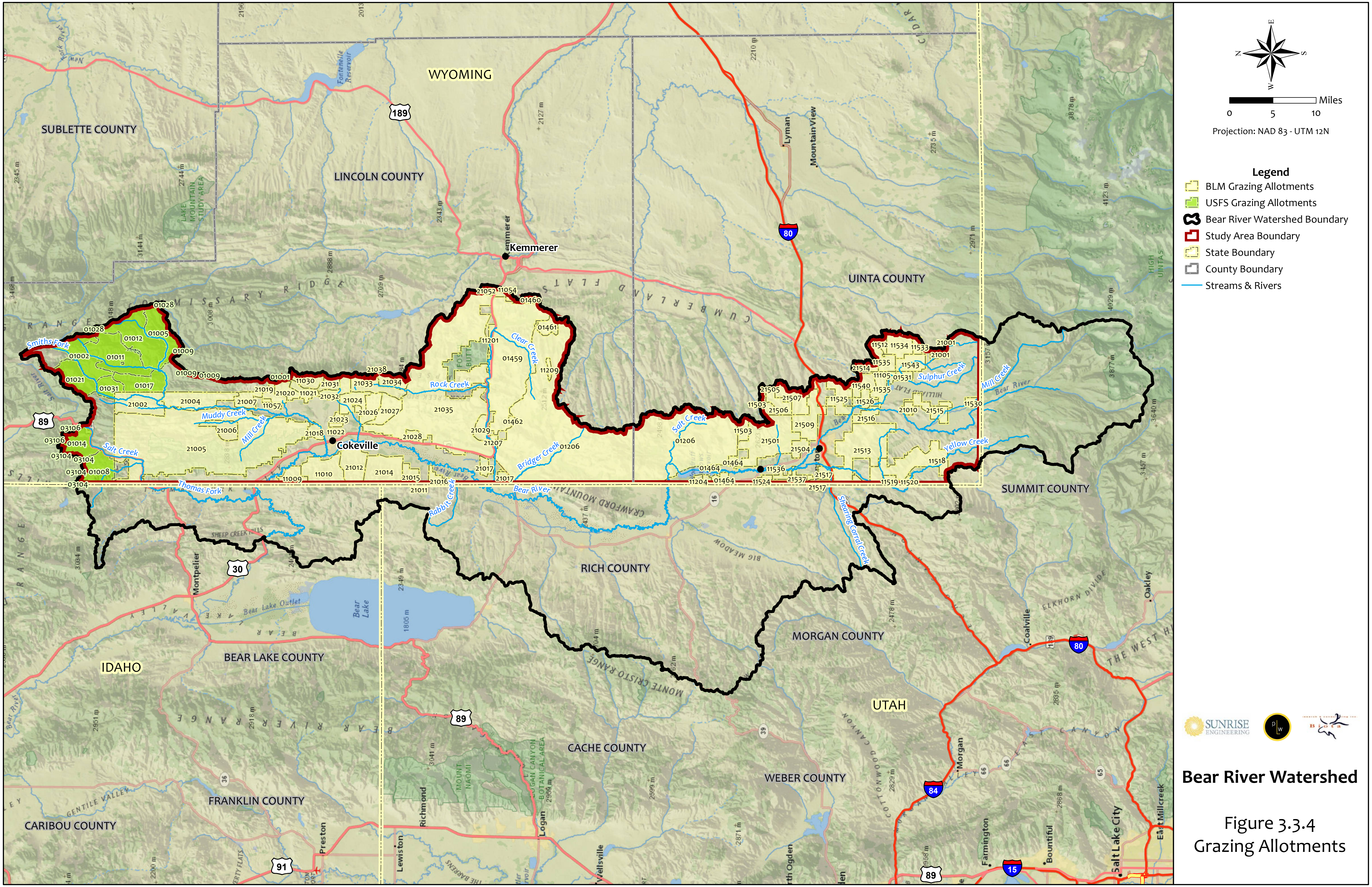
In recent years, the agency has moved towards a more quantitative approach utilizing the Multiple Indicator Monitoring (MIM) protocol (http://www.blm.gov/nstc/library/pdf/MIM.pdf). The MIM protocol is designed to be an objective, efficient, and effective methodology for monitoring streambanks, stream channels, and streamside riparian vegetation. It improves upon previous monitoring approaches by assessing multiple indicators in each monitoring reach. Rather than focusing on one or 2 indicators, the MIM protocol combines observations of up to 10 indicators along the same stream reach into one protocol, using mostly simple adaptations of existing procedures. The 10 indicators include:

1. Stubble height
2. Streambank alteration
3. Woody species use
4. Greenline composition
5. Woody species height class
6. Streambank stability and cover
7. Woody species age class
8. Greenline-to-greenline width
9. Substrate
10. Residual pool depth and pool frequency

The latest data from the USFS indicate that there are currently 14 allotments on lands administered by the USFS in the watershed (Figure 3.3.4), all of which are within the Bridger-Teton National Forest. The Kemmerer Ranger District is responsible for administering leases on these allotments, and several allotments include portions of the surrounding watersheds. The Bridger-Teton National Forest 1990 Forest Plan states that "Stocking rates across the Bridger-Teton National Forest are approximately in line with range capacity; however, some allotments may have to be adjusted downward due to poor range conditions, particularly in riparian areas. Ranchers are working with the Forest Service to improve conditions on these allotments." The Federal Land Policy and Management Act of 1976 requires that all USFS allotments are managed under the direction of allotment management plans (AMPs) that determine range capacity, season of use, range condition and trend, grazing systems, and range improvement priorities. These plans are tailored to specific range conditions in each allotment and are designed to meet the needs of the resource, the livestock, the lessee(s), and the government. Appendix D contains tabulations of USFS and BLM allotments within the watershed.

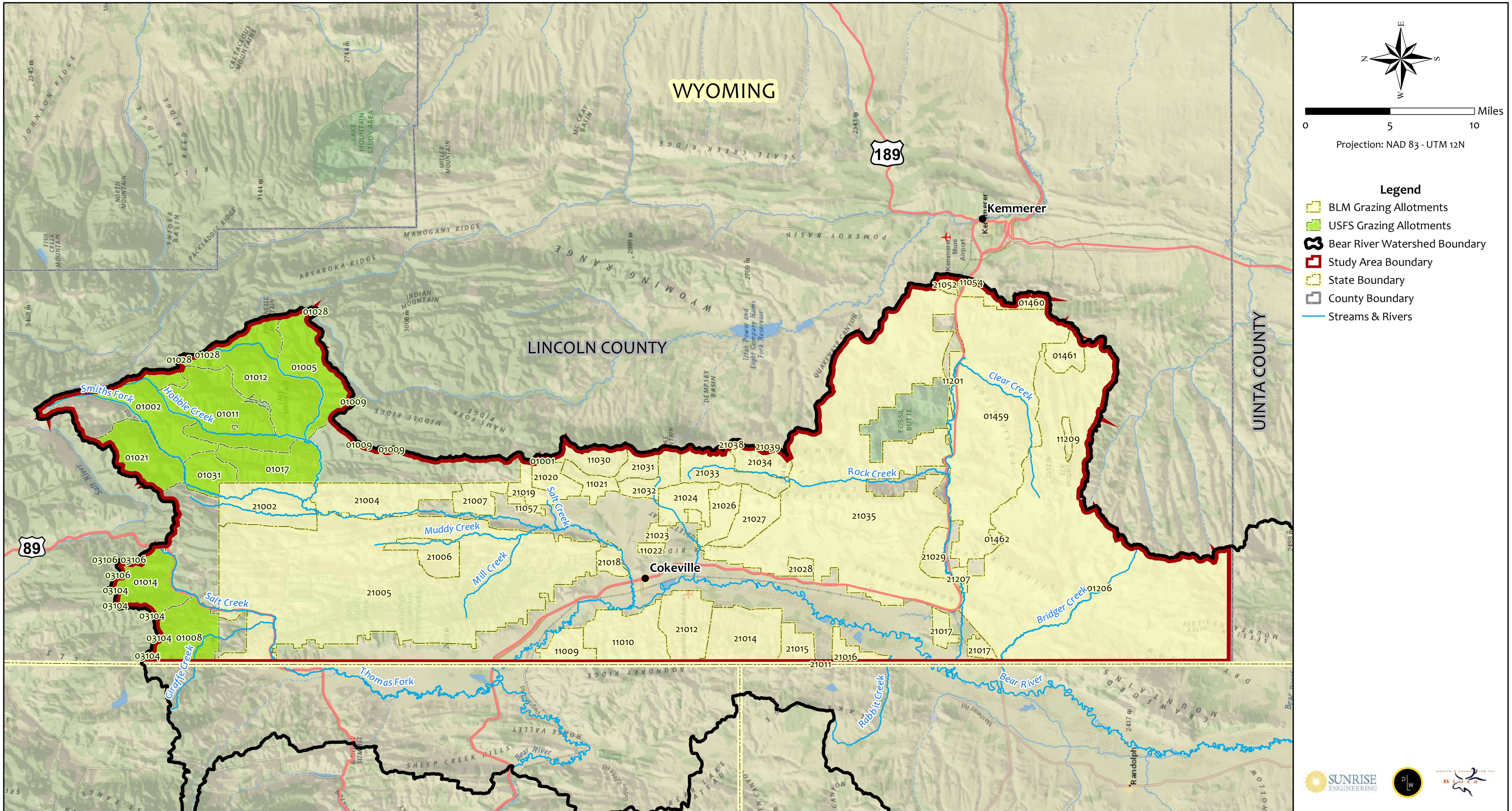
References

U.S. Department of the Interior. Bureau of Land Management. 1997. Standards for healthy rangelands and guidelines for livestock grazing managementfor public lands administered by the BLM in the State of Wyoming. 21pp.



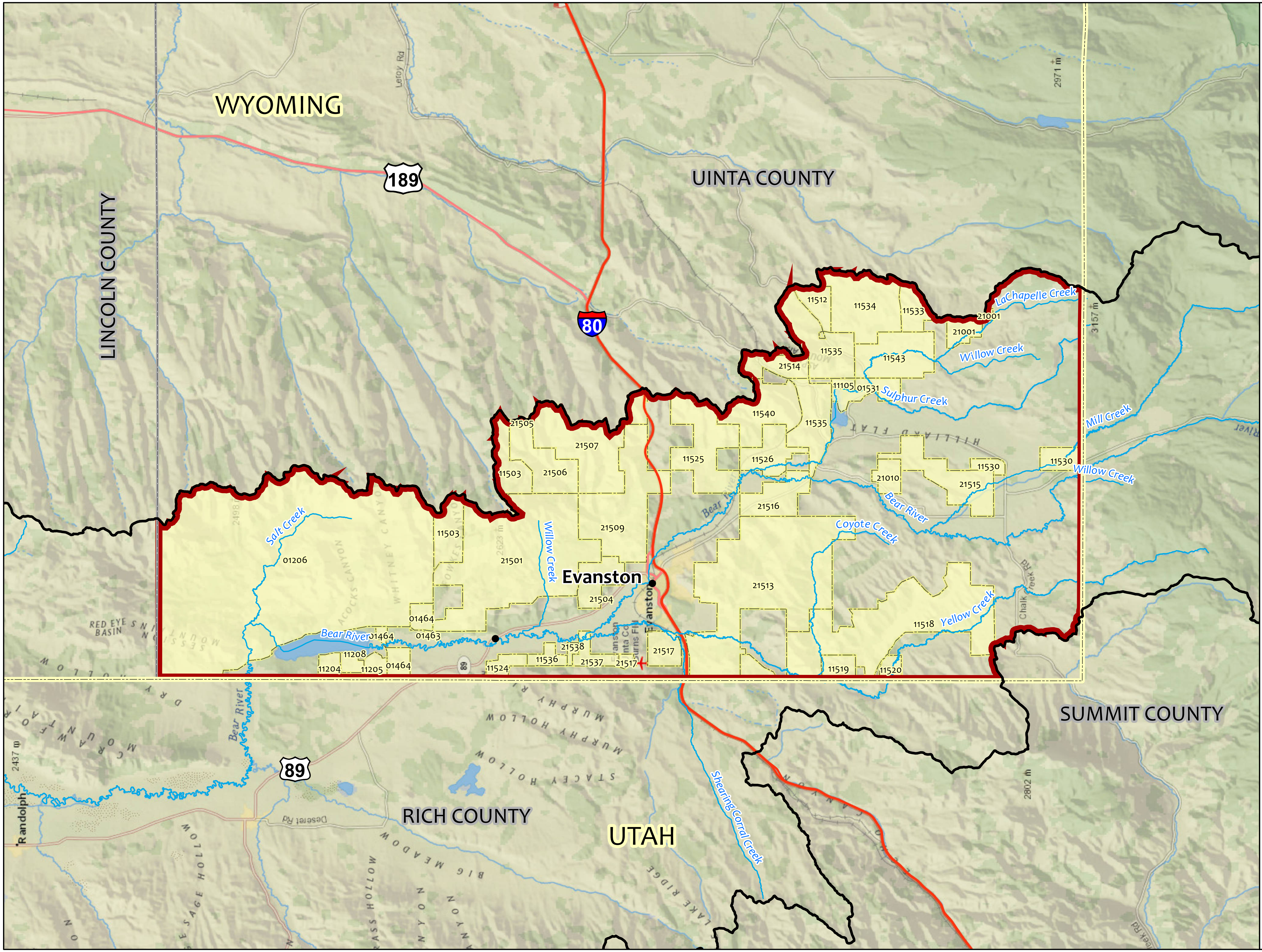
Bear River Watershed

Figure 3.3.4
Grazing Allotments



Bear River Watershed
Lincoln County

Figure 3.3.4
Grazing Allotments



Bear River Watershed
Uinta County

Figure 3.3.4
Grazing Allotments

3.3.4.2 EXISTING WATER SUPPLY

The Bear River has many perennial, seasonal, and intermittent tributary streams and creeks that are well distributed within the Bear River Watershed, although these watercourses are relatively more numerous in the northern portion of Lincoln County and in the southern portion of Uinta County. Many of the mid- to higher elevation perennial streams and creeks have resident beavers that have built and maintain one or more ponds along these watercourses (Table 3.3.4.2-1). Springs are abundant, especially at mid-elevations around Commissary Ridge in Lincoln County, along the Bear River Divide in both Lincoln and Uinta Counties, and in the area between the Bear River and Yellow Creek south of Evanston. Most of the springs are expected to flow year-round during most years. Ponds, lakes, oxbows are scattered throughout the watershed study area in the southern portion of Uinta County (along the foothills of the Uinta Mountains), and in the Commissary Ridge, Gannett Hills, and Sublette Range portions of Lincoln County. In combination, these natural water features provide reliable water sources to both livestock and wildlife.

Table 3.3.4.2-1. Summary of natural water features within the Wyoming portion of the Bear River Watershed study area in Lincoln and Uinta Counties.

Type	Lincoln County	Uinta County
Beaver Ponds	111	111
Oxbows	23	1
Ponds	17	13
Lakes	6	0
Marsh	2	0
Flooded Areas	1	0
Springs	162	147
Total	**322**	**272**

In contrast, the lower-elevation, drier, portions of the watershed, particularly around Fossil Butte National Monument, Fossil Ridge and Nugget Canyon in Lincoln County, and in the Hillard Flats area of Uinta County are dominated by intermittent and ephemeral streams, which do not provide reliable natural water sources. In these areas in particular and in localized areas elsewhere within the watershed, water development features have been constructed in an effort to augment natural water sources. Reservoirs, stock ponds, and to a lesser degree water spreaders and guzzlers/raintraps/water tanks have been constructed within these intermittent and ephemeral drainages in order to capture and store spring snowmelt and runoff during precipitation events. A few stock wells have also been constructed and some springs have been developed to capture and store water in tanks and pits.

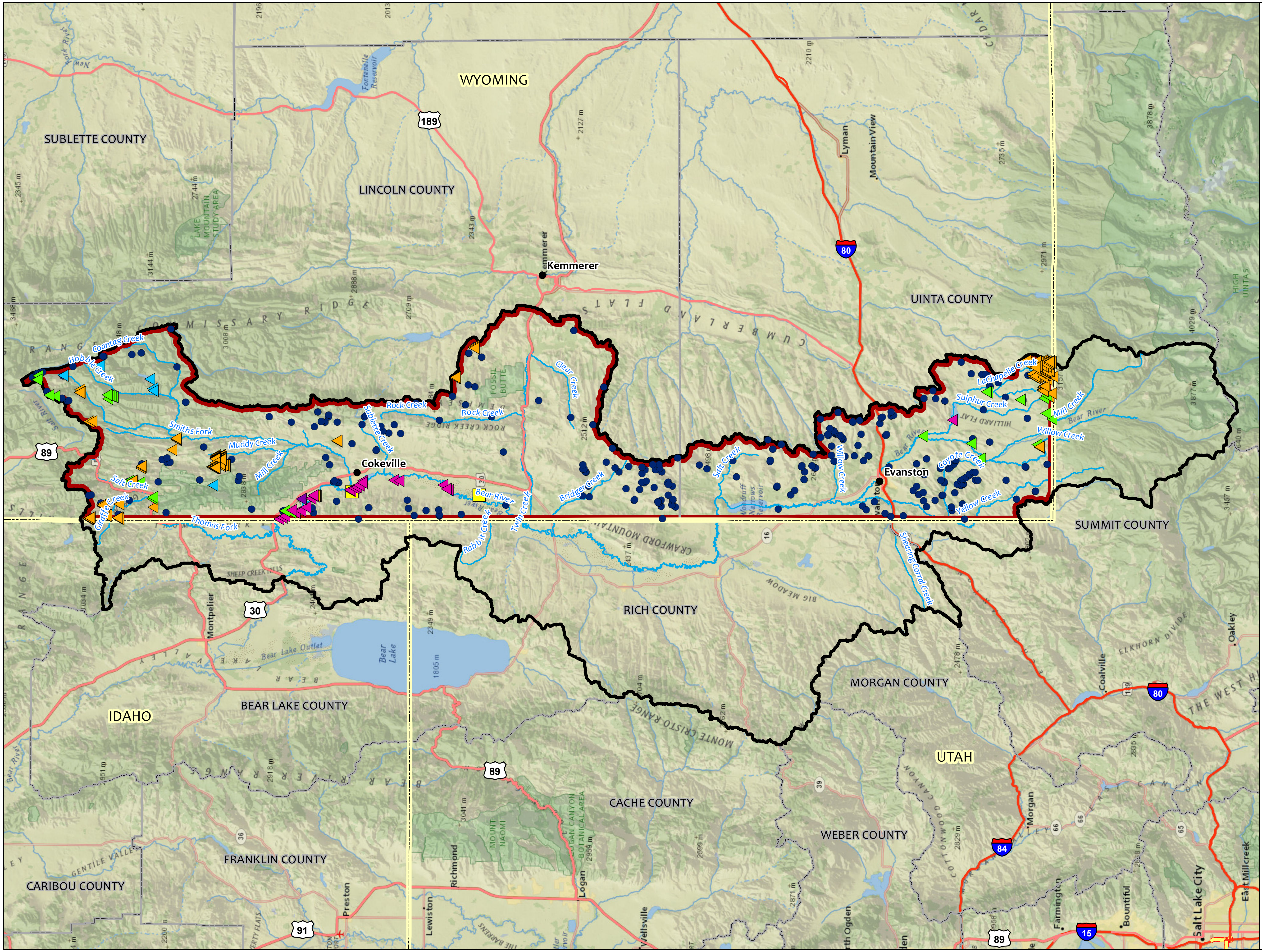
Large reservoirs are sparsely scattered within the watershed. Several smaller reservoirs are located in Lincoln County and the largest named reservoirs are located in Uinta County. A list of the more widely known named reservoirs is provided in Table 3.3.4.2-2. There are also numerous named stock reservoirs (similar to the Larson Reservoir) throughout the entire watershed.

Table 3.3.4.2-2. Summary of larger named reservoirs within the Wyoming portion of the Bear River Watershed study area in Lincoln and Uinta Counties.

Lincoln County	**Surface Area (ac)**	**Acre-Feet**	**Status**	**Latitude**	**Longitude**
Quealy Reservoir	9.9	97.1	Partial Failure	42.122731	-110.926293
Larson Reservoir	5	3.81	Functional	42.074821	-110.896157
Leeds Creek (Holland Res.)	6 +/-	65.32	Failure	41.930000	-110.940955
C.H Smith Reservoir	6.5	84.5	Partial Failure	41.765739	-110.677510
Uinta County	**Surface Area (ac)**	**Acre-Feet**	**Status**	**Latitude**	**Longitude**
Austin Reservoir	31	unknown	Functional	41.063096	-110.795008
Compton Reservoir	71	406.25	Functional	41.290811	-110.960944
Martin Reservoir (Bazoo)	17	87.9	Functional	41.105820	-110.851401
Woodruff Narrows Reservoir	1910	57,300	Functional	41.481604	-111.017233
Sulphur Creek Reservoir	632	19,775	Functional	41.151648	-110.825685
Myers Reservoir	41	556.5	Functional	41.098926	-110.896143
Painter Reservoir	17	167	Functional	41.318220	-110.889438
Broadbent	25.2	505.04	Functional	41.055920	-110.735477
Broadbent 2	1.6	+/- 5	Functional	41.057640	-110.732366

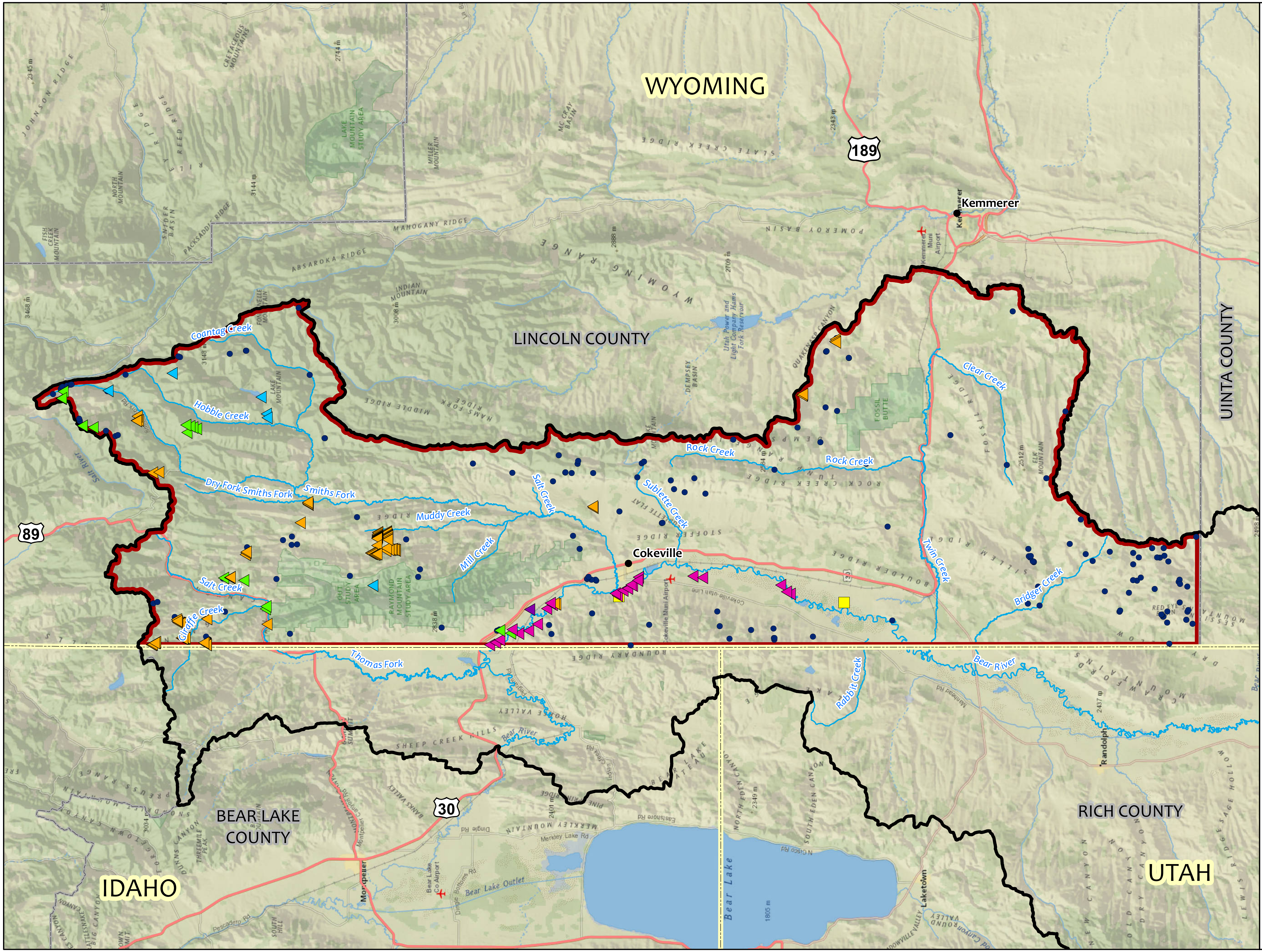
Numerous upland livestock/wildlife water development projects have been constructed within the watershed in coordination and/or cooperation with the Bureau of Land Management, USDA-Forest Service, NRCS, and private landowners. Along with the natural water sources, these features needed to be documented to the greatest extent possible. Efforts to evaluate the general availability of upland water sources began with data requests, to the Bureau of Land Management, the USDA Forest Service, and the Wyoming State Engineers Office (WSEO) for the locations of water development projects. In reviewing the results of these queries, it became clear that a number of water projects have been constructed on private and federal lands that do not show up in datasets provided by these agencies. Efforts were then undertaken to locate additional water features by visually reviewing USGS Quadrangles, true color (NAIP 2012) and color infrared (2001) aerial photography, and Google Earth imagery. This qualitative assessment of natural and water development features yielded a minimum of 617 natural and 975 man-made water features.

Figure 3.3.4.2a depicts the results of this analysis for natural water features and Figure 3.3.4.2b for water development features. Figures 3.4.4.2c and 3.3.4.2d depict WSEO permitted wells and USGS mapped springs, respectively.



Bear River Watershed

Figure 3.3.4.2a
Natural Water
Feature Sites



E N S W

Miles
0 5 10

Projection: NAD 83 - UTM 12N

Legend

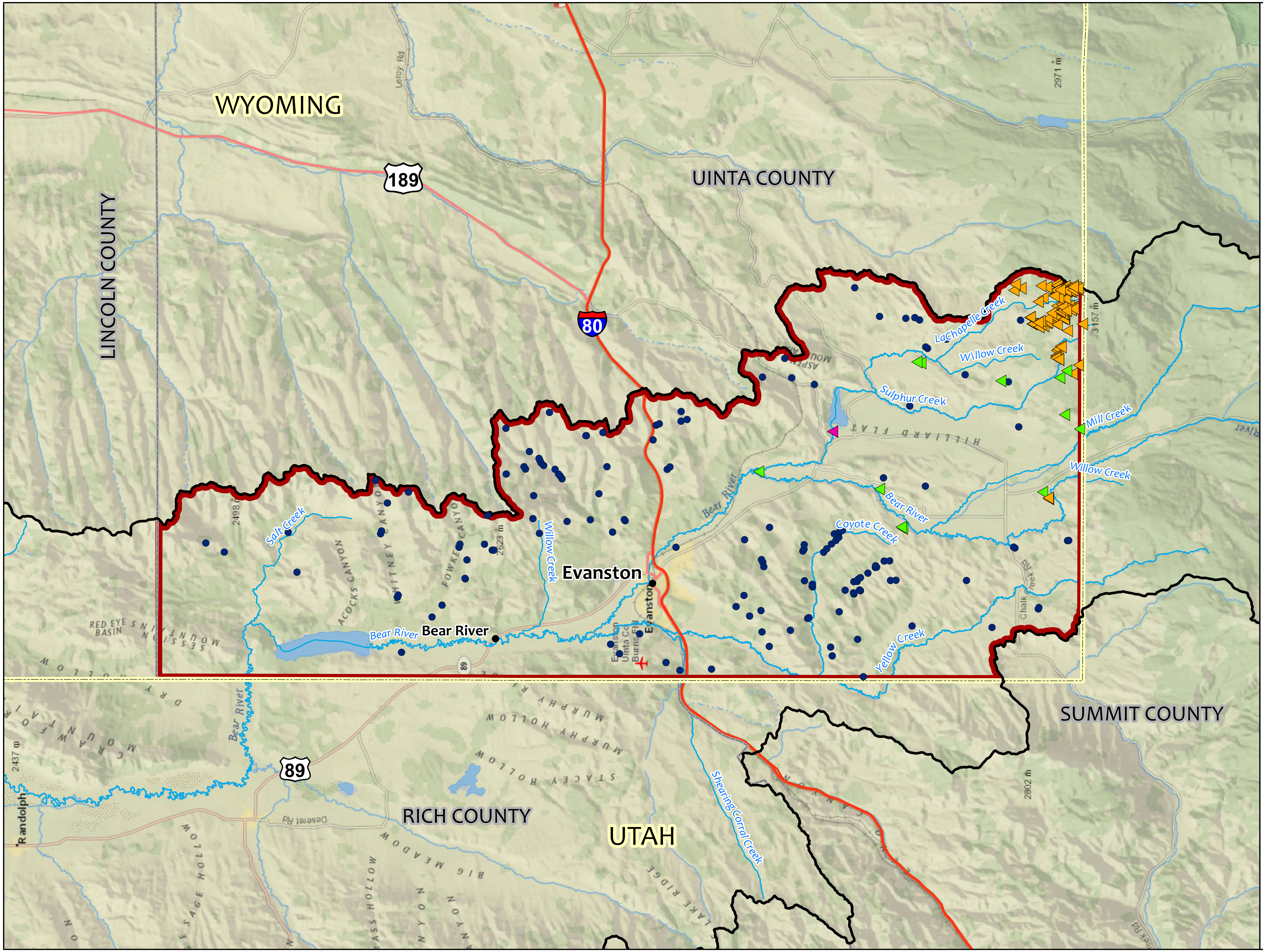
Natural Water Features

- △ Beaver Pond
- △ Flooded
- △ Lake
- ☐ Marsh
- △ Oxbow
- △ Pond
- ● Spring
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

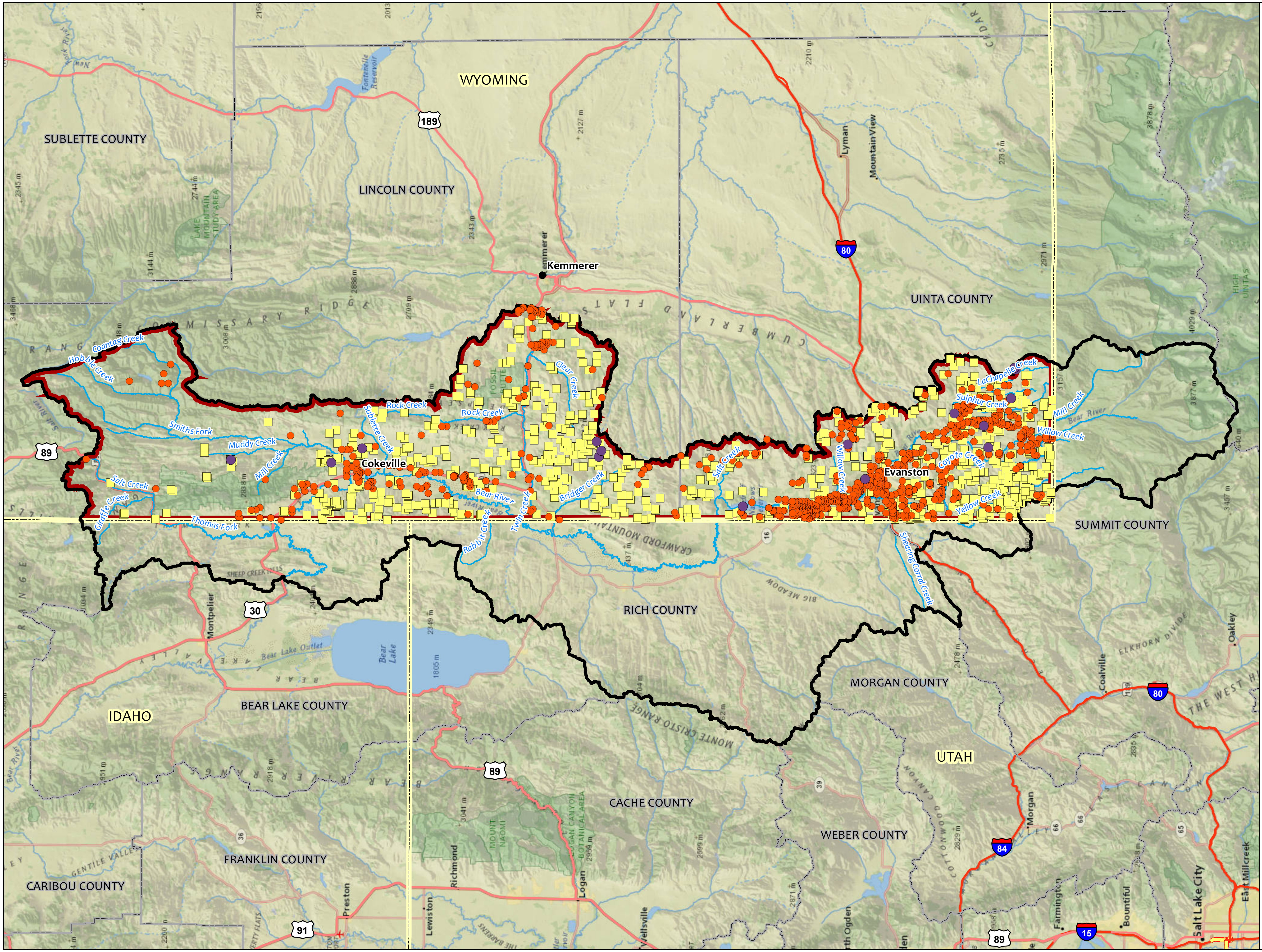
Bear River Watershed Lincoln County

Figure 3.3.4.2a
Natural Water
Feature Sites



Bear River Watershed
Uinta County

Figure 3.3.4.2a
Natural Water
Feature Sites



Projection: NAD 83 - UTM 12N

Legend

Developed Water Features

- 🟨 Stock Pond
- ● Well
- ● Reservoir
- Bear River Watershed Boundary
- 🟥 Study Area Boundary
- ▢ State Boundary
- ▢ County Boundary
- Streams & Rivers

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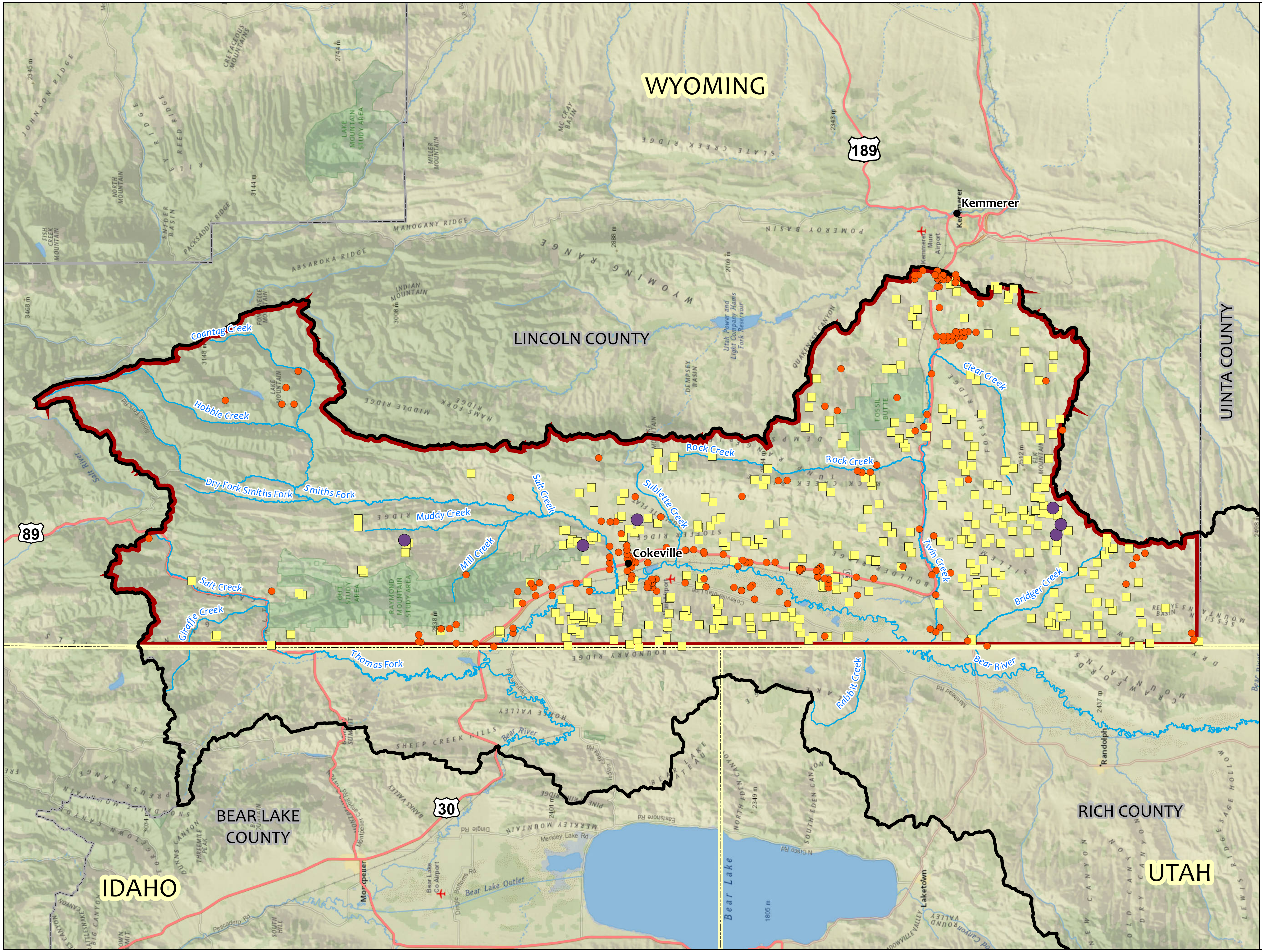
Bear River Watershed

Figure 3.3.4.2b
Developed Water
Features



Miles
0 5 10

Projection: NAD 83 - UTM 12N

Legend

Developed Water Features

● Reservoir

● Well

🟨 Stock Pond

Bear River Watershed Boundary

🟥 Study Area Boundary

State Boundary

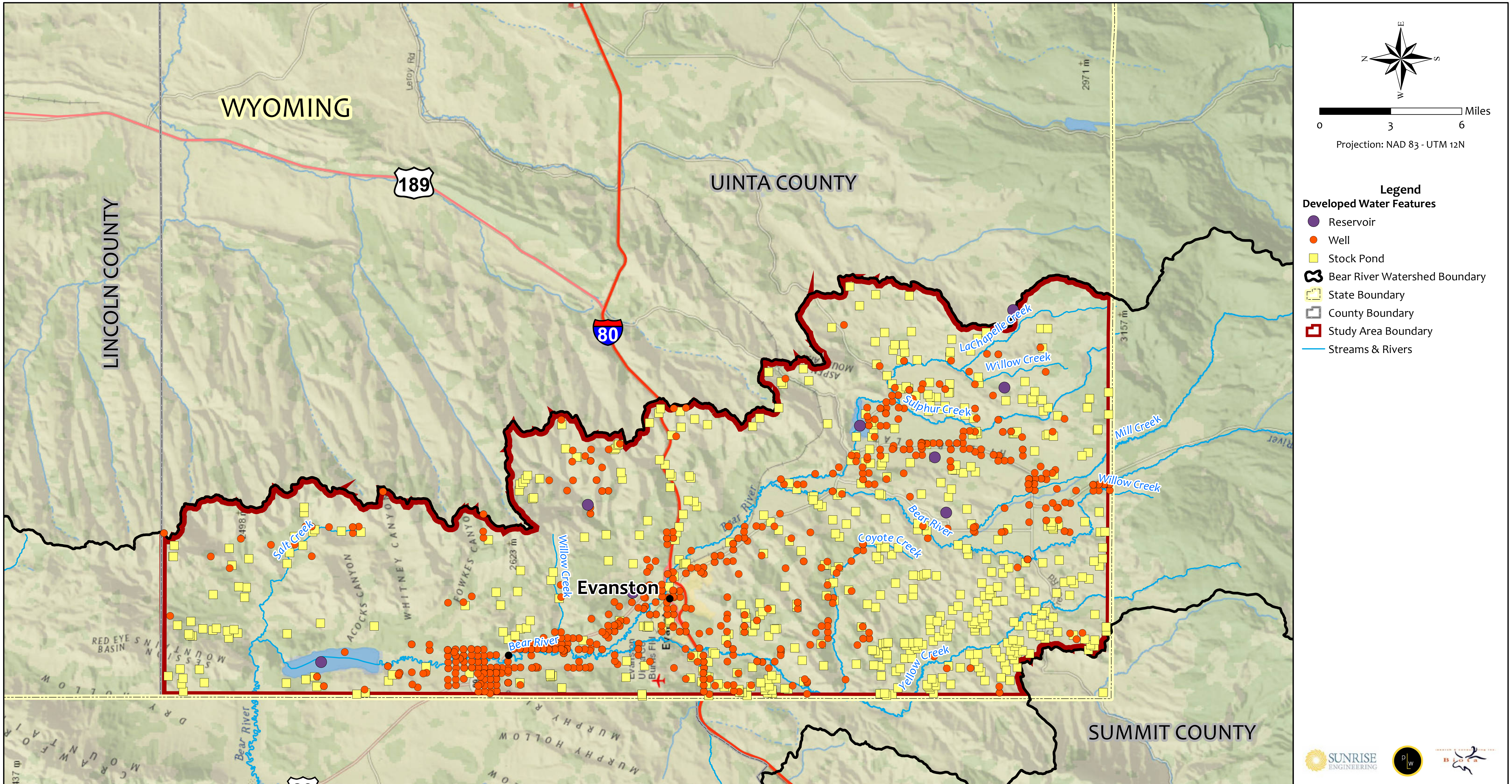
County Boundary

Streams & Rivers

SUNRISE ENGINEERING

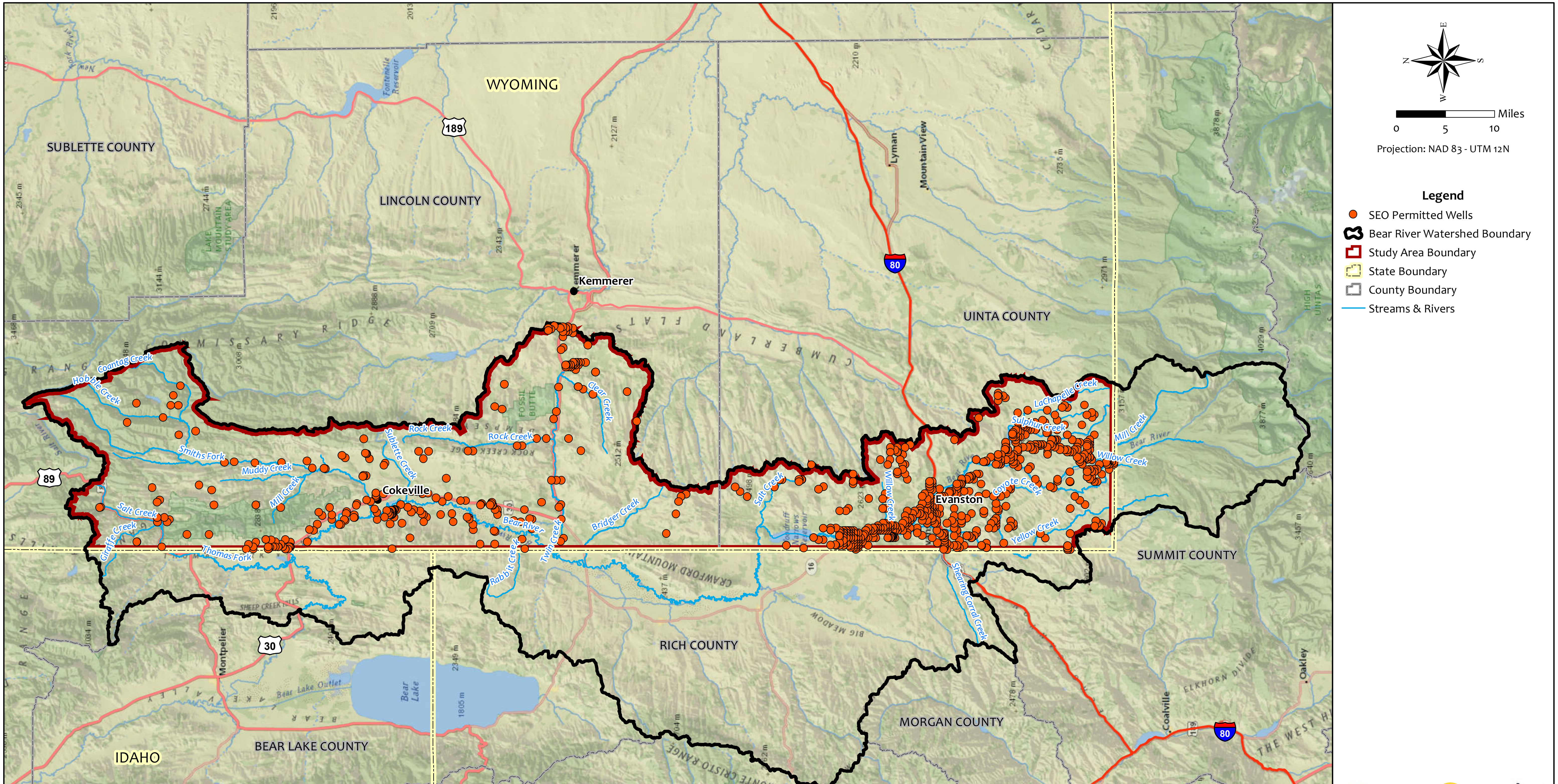
Bear River Watershed Lincoln County

Figure 3.3.4.2b
Developed Water Features



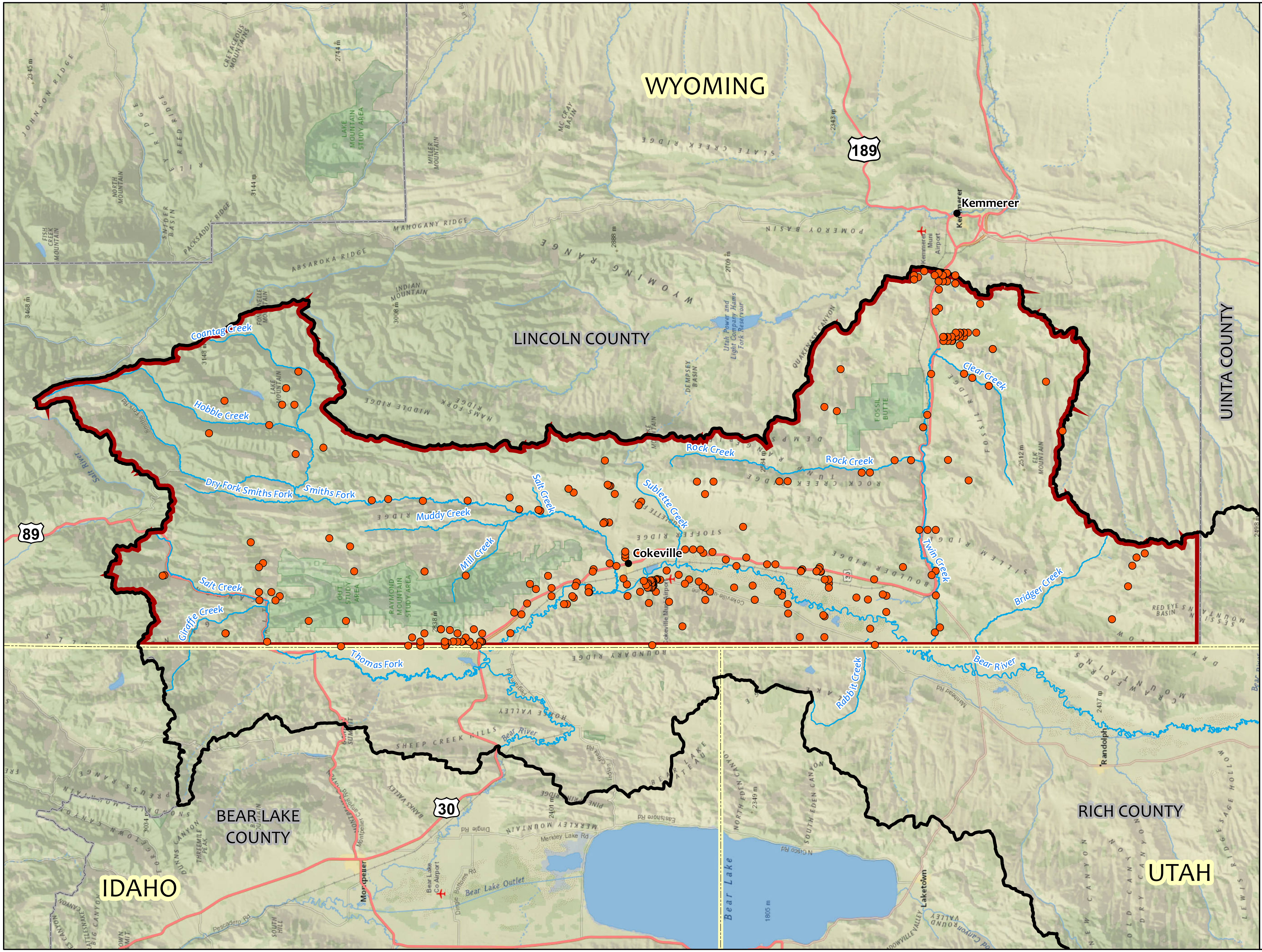
Bear River Watershed
Uinta County

Figure 3.3.4.2b
Developed Water Features



Bear River Watershed

Figure 3.3.4.2c
State Engineers Office
Permitted Wells



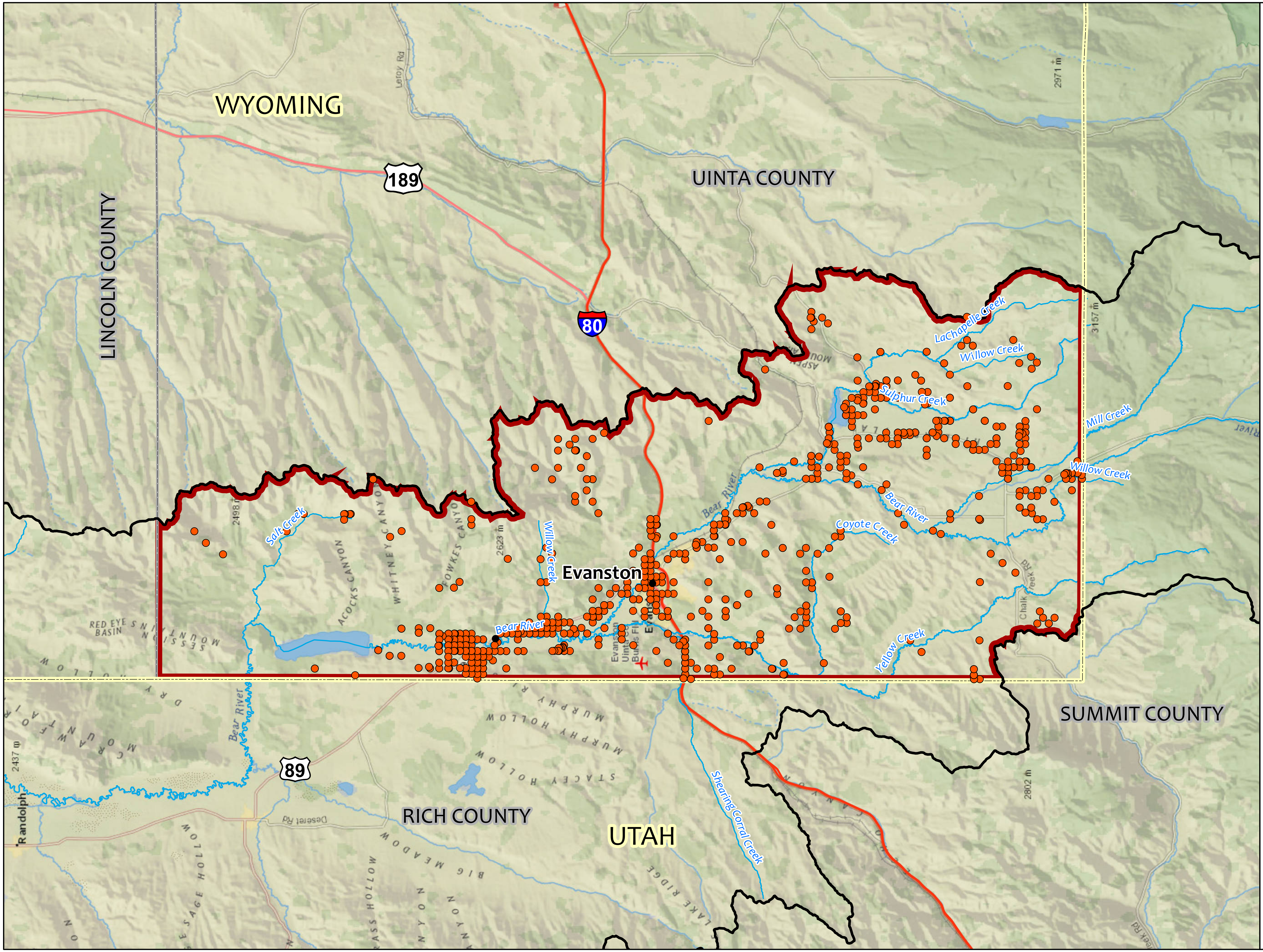
Legend

- ● SEO Permitted Wells
- Bear River Watershed Boundary
- 🟥 Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

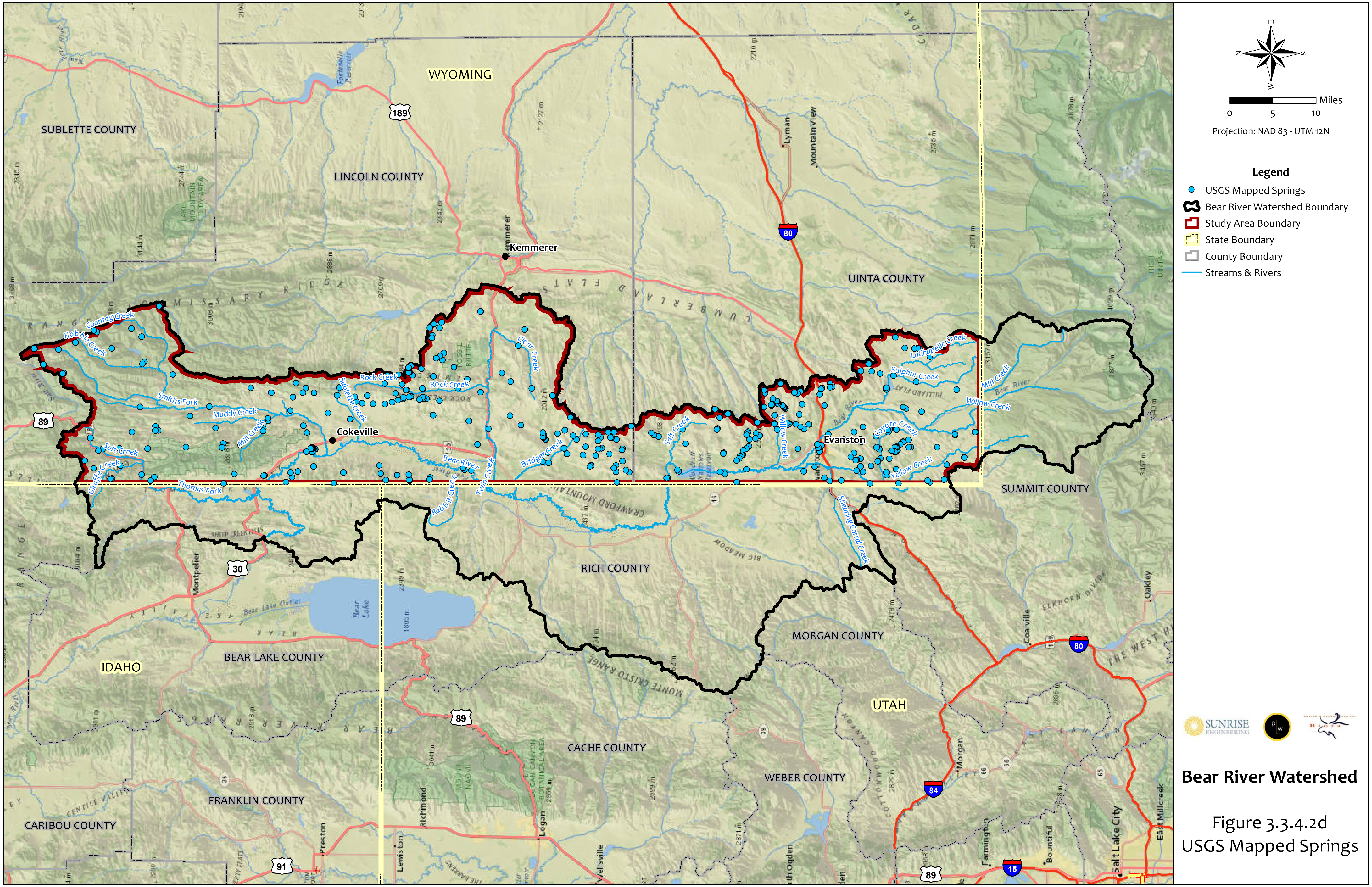
Bear River Watershed Lincoln County

Figure 3.3.4.2c
State Engineers Office
Permitted Wells



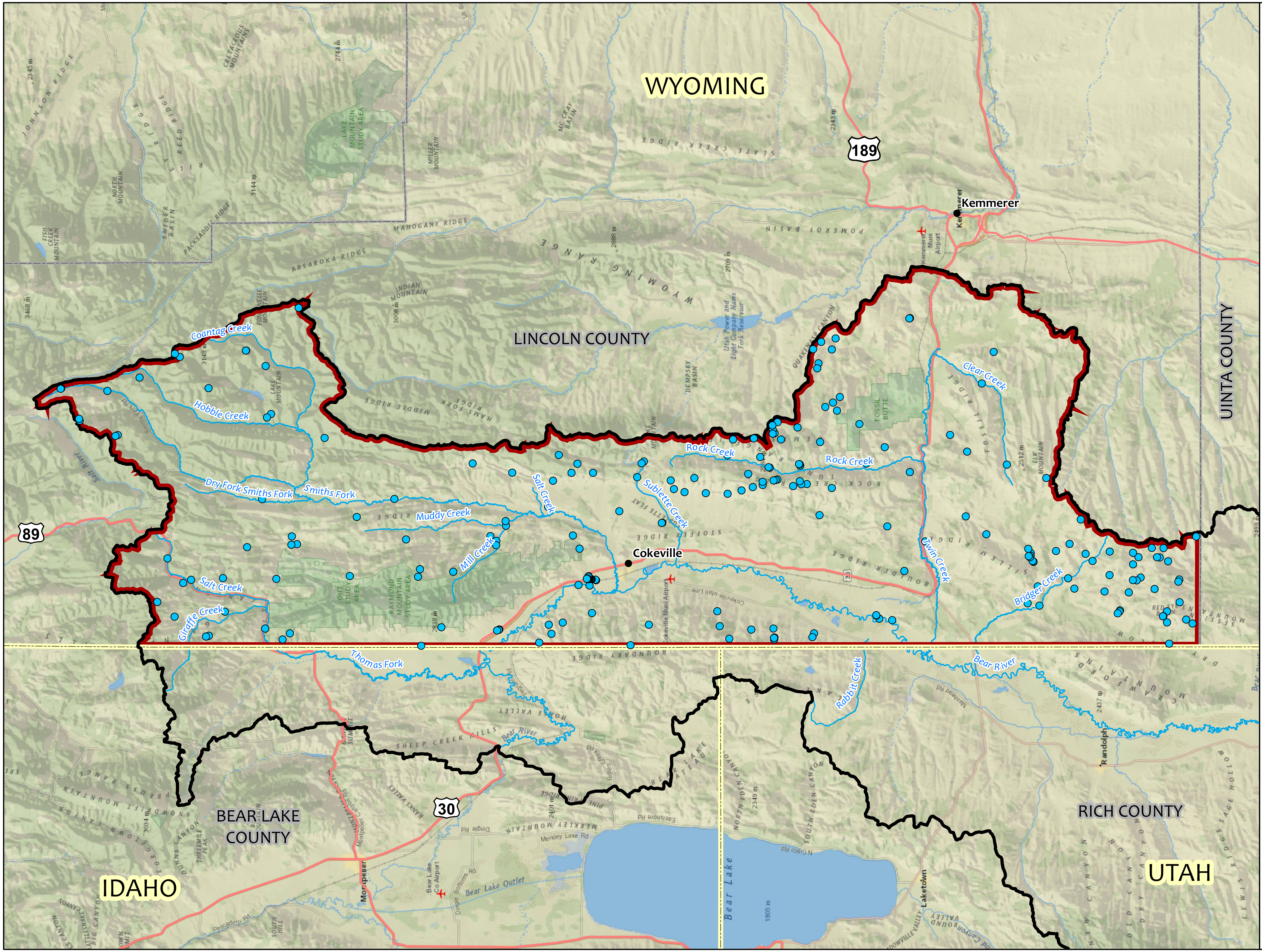
Bear River Watershed
Uinta County

Figure 3.3.4.2c
State Engineers Office
Permitted Wells



Bear River Watershed

Figure 3.3.4.2d
USGS Mapped Springs



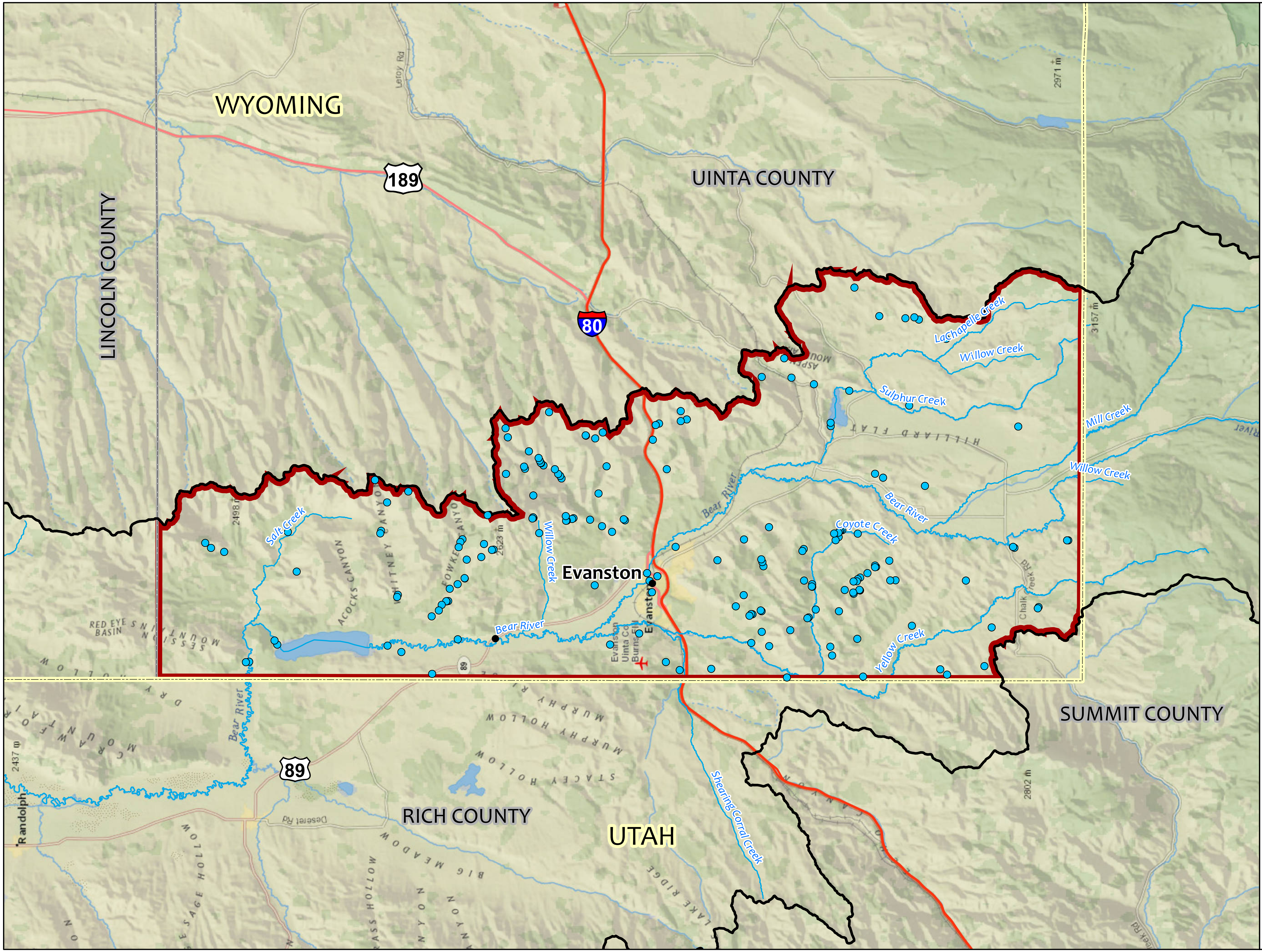
Legend

- ● USGS Mapped Springs
- Bear River Watershed Boundary
- 🟥 Study Area Boundary
- ☐ State Boundary
- ☐ County Boundary
- — Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed
Lincoln County

Figure 3.3.4.2d
USGS Mapped Springs



N
E
S
W

0 3 6 Miles

Projection: NAD 83 - UTM 12N

Legend

- ● USGS Mapped Springs
- Bear River Watershed Boundary
- 🟥 Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed
Uinta County

Figure 3.3.4.2d
USGS Mapped Springs

It is assumed that most of the natural water features remain reliable water sources, seasonally or year-round. However, it is expected that an unknown number of the water development projects within the watershed have either failed or have filled with sediment and are no longer viable sources of livestock and wildlife water. For several reasons, it was impossible to parse out non-viable water features from the functional water development projects with 100% surety. Aerial photography that was used, in part, to locate these features was sometimes dated, of variable resolutions, and may simply have been taken too early or too late in the year to show water presence. Some stock reservoirs may not have shown evidence of water presence due to breaching of the impoundment structure or other form of leakage; being filled within sediment and having no capacity; were not filled because of the time of year the photograph was taken; or other factors.

Acknowledging that any assessment of water development project viability might be flawed for the above reasons and possibly others, a qualitative assessment was performed in order to get an estimation of efficacy of existing water development projects within the watershed. A total of 930 constructed/developed water features were visually examined using aerial photography, including color infrared (2001), NAIP (2006-2012), and Google Earth imagery. Each reservoir that was visually examined was classified as "functional", "non-functional", or "unknown" based on evidence provided by one or more aerial photography sets, beginning with the most recent (see example photos).

Functional Stock Reservoir

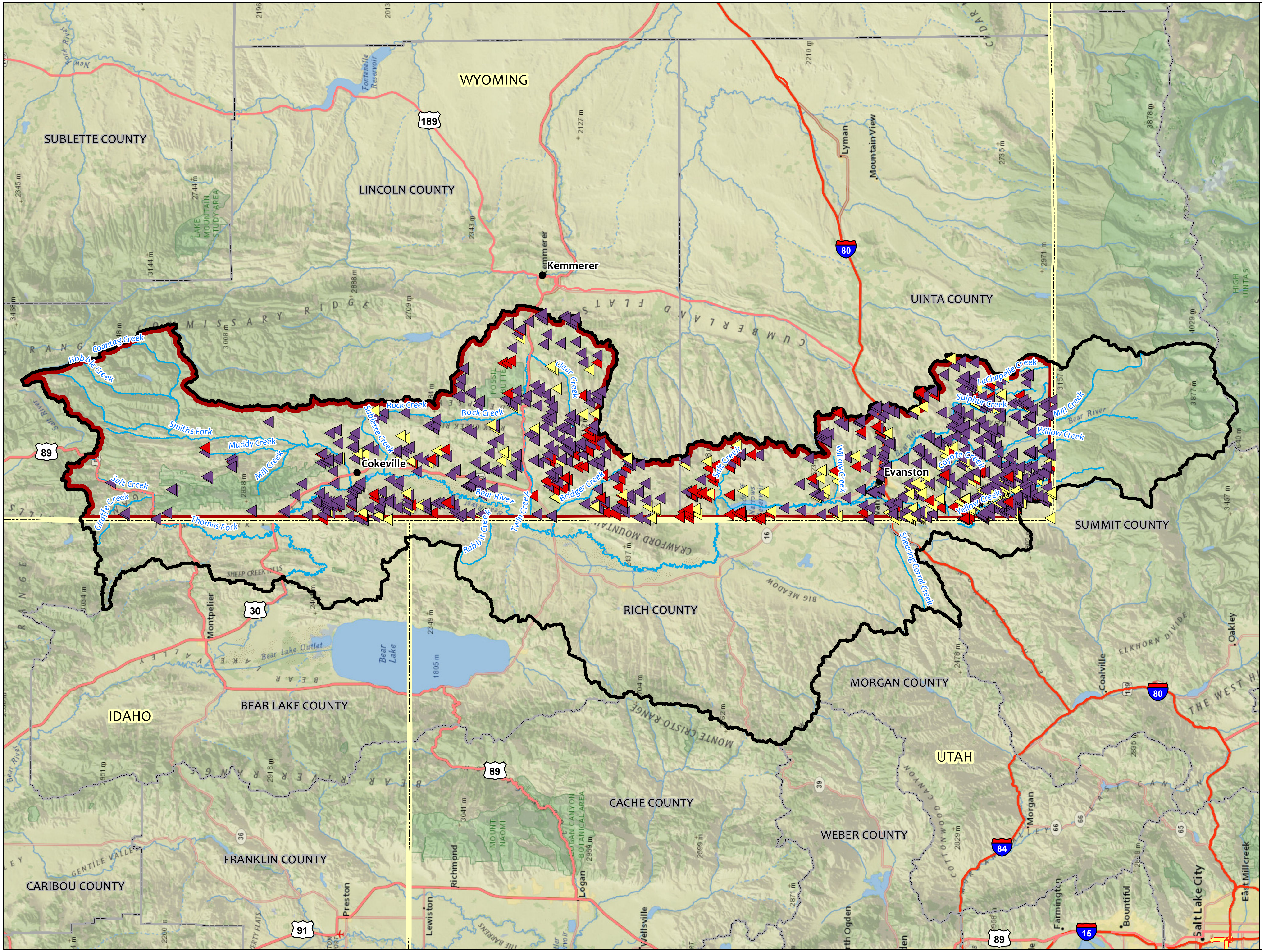
Non-Functional Stock Reservoir

Stock Reservoir – Unknown Functionality

The results of this effort are presented in Table 3.3.4.2-3 and displayed in Figure 3.3.4.2e.

Table 3.3.4.2-3. Summary of developed water features (number and status) within the Wyoming portion of the Bear River Watershed study area in Lincoln and Uinta Counties.

Status	**Lincoln County**	**Uinta County**
Functional	288	362
Non-Functional	58	72
Unknown	41	109
Total	**387**	**543**



N E S W

0 5 10 Miles

Projection: NAD 83 - UTM 12N

Legend

Stock Pond Viability

▲ Functional

▲ Non-Functional

▲ Unknown

□ Bear River Watershed Boundary

□ Study Area Boundary

□ State Boundary

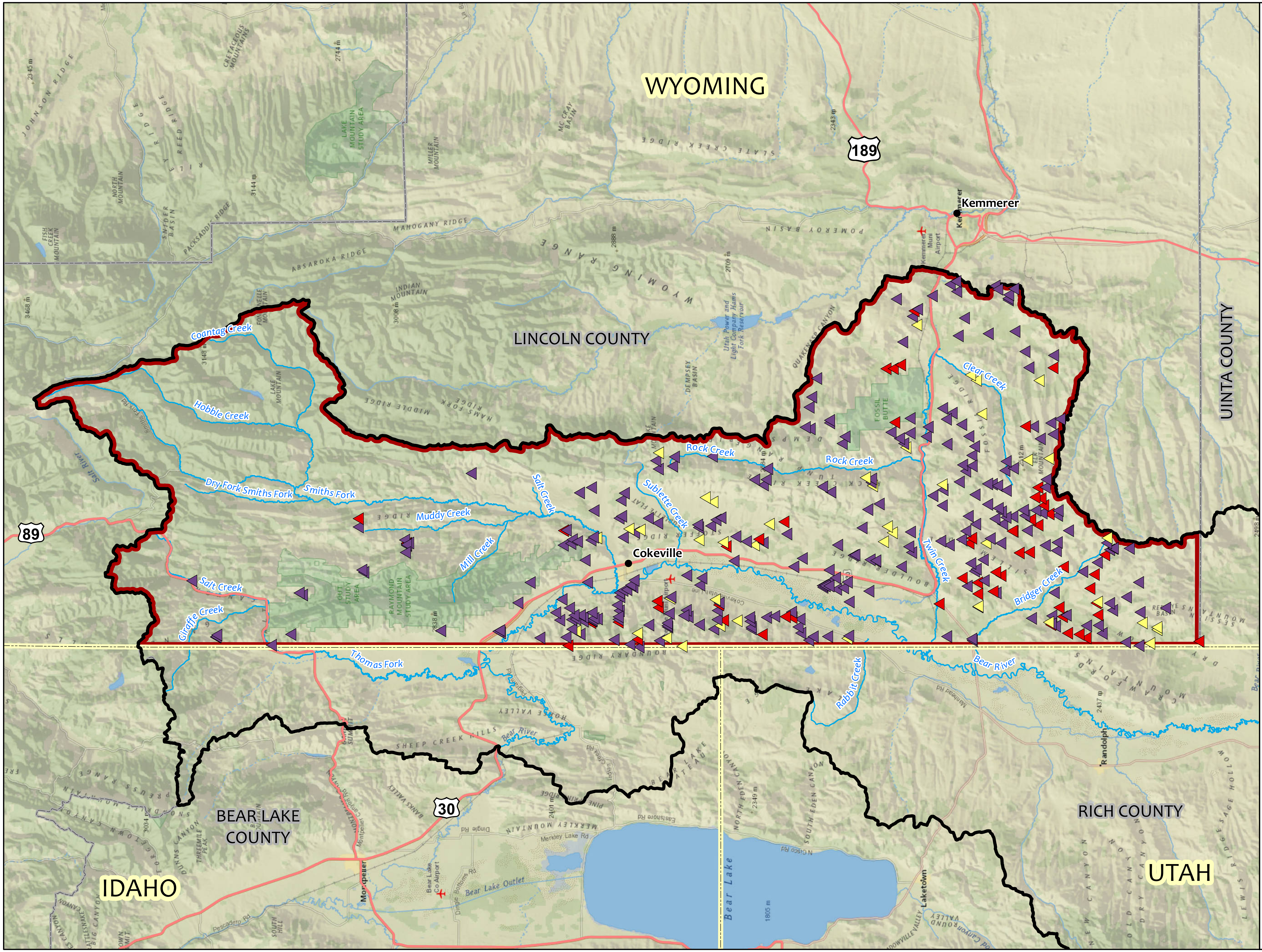
□ County Boundary

— Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed

Figure 3.3.4.2e
Stock Pond Viability



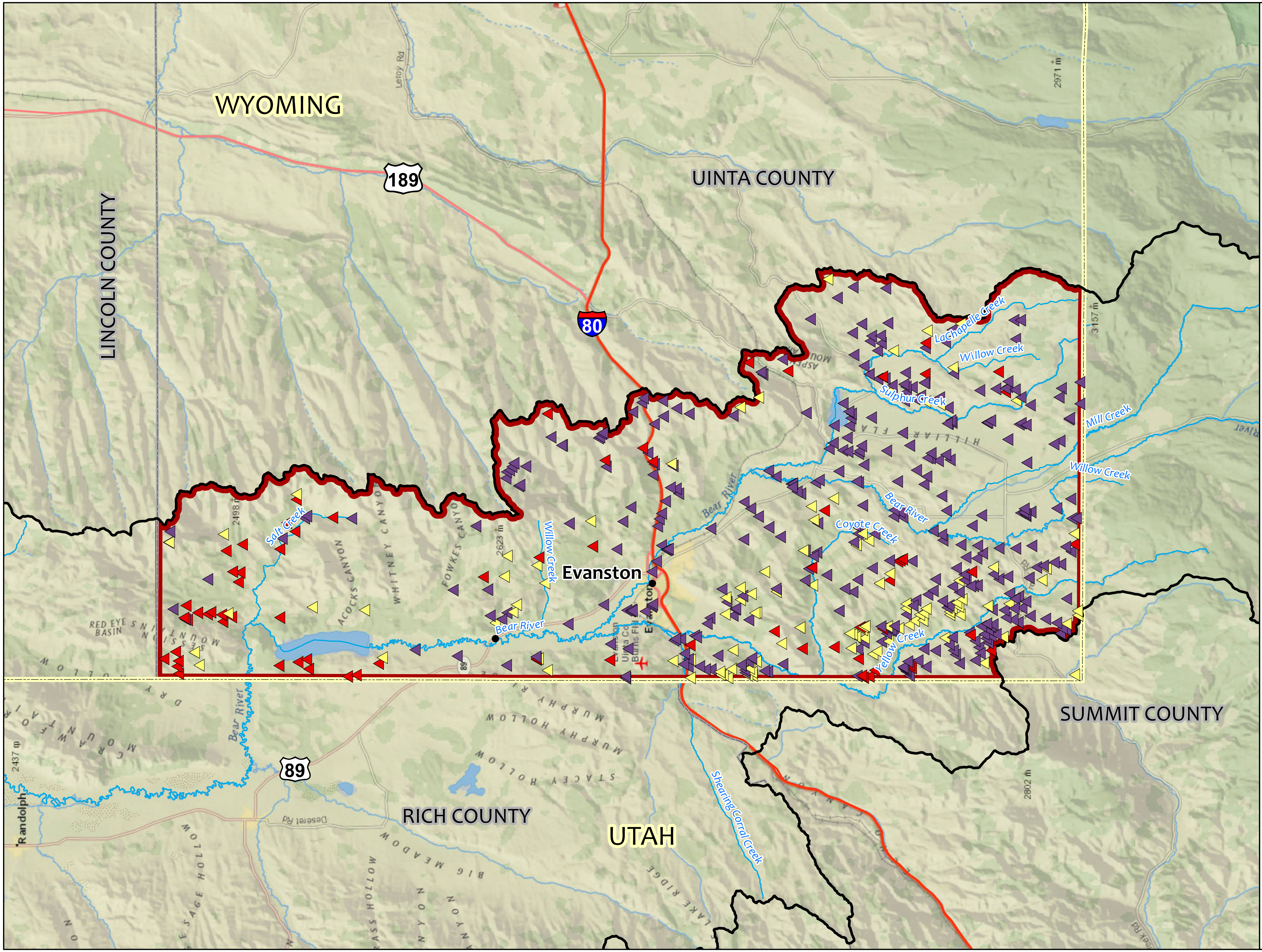
Legend

Stock Pond Viability

- ▲ Functional
- ▲ Non-Functional
- △ Unknown
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

Bear River Watershed
Lincoln County

Figure 3.3.4.2e
Stock Pond Viability



Projection: NAD 83 - UTM 12N

Legend

Stock Pond Viability
- ▲ Functional
- ▲ Non-Functional
- △ Unknown
- Bear River Watershed Boundary
- ☐ Study Area Boundary
- ☐ State Boundary
- ☐ County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed Uinta County

Figure 3.3.4.2e
Stock Pond Viability

3.3.4.3 ECOLOGICAL SITE DESCRIPTIONS

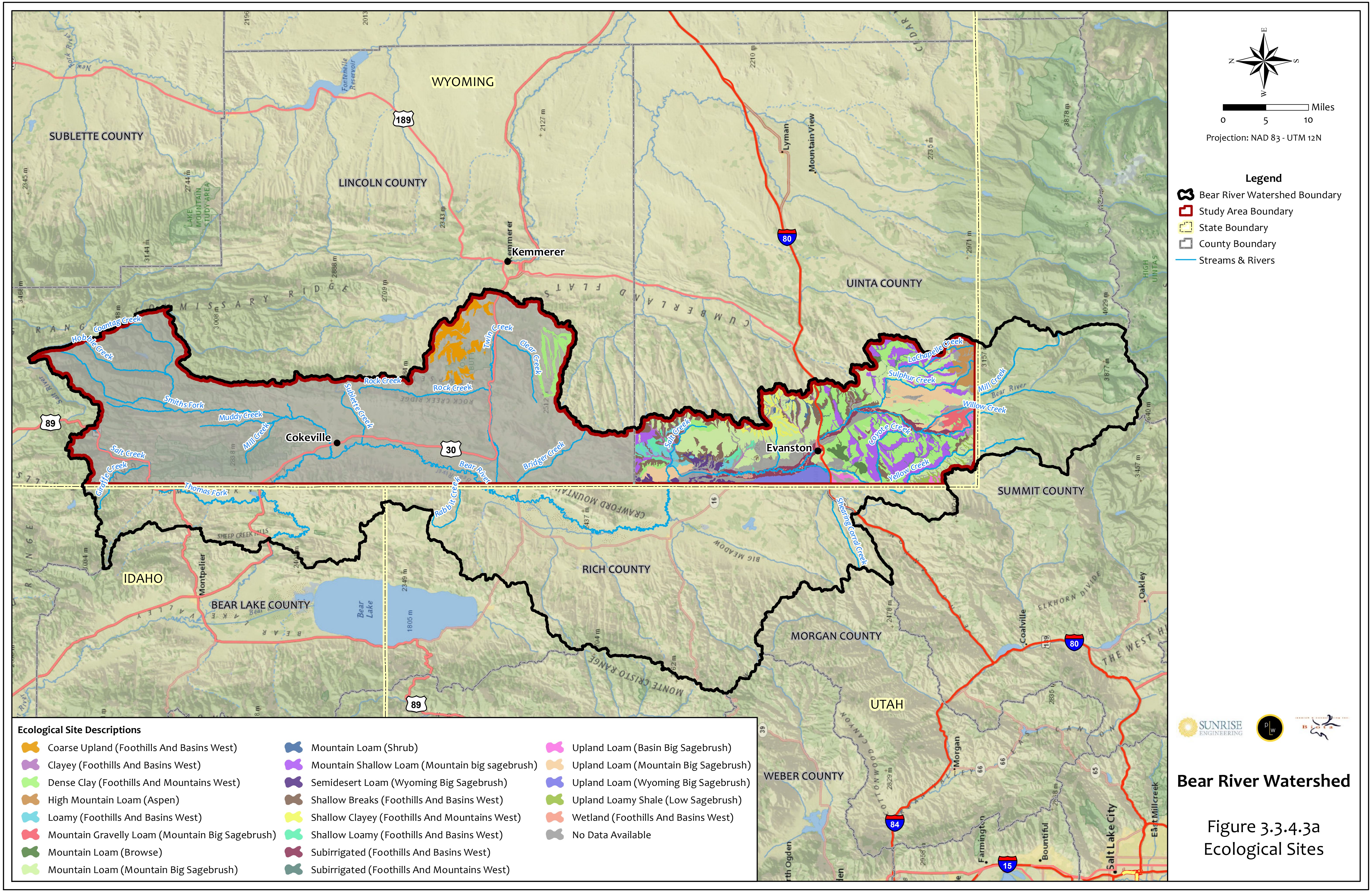
The NRCS defines an ecological site as "*a distinctive kind of land with specific soil and physical characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation, and in its ability to respond similarly to management actions and natural disturbances.*" Ecological sites provide a consistent framework for classifying and describing rangeland and forestland soils and vegetation. Information about individual ecological sites is compiled into an Ecological Site Description (ESD) report, which is used to classify a landscape based on the interaction between soils, vegetation, and land management. Additionally, these reports characterize the ecological potential and ecosystem dynamics of the ecological site.

ESDs are valuable tools that can be used to help landowners and managers make important land management decisions. They provide land managers the information needed for evaluating the land as to suitability for various land-uses; capability to respond to different management activities or disturbances; existing plant community versus potential plant community; and ability to sustain productivity over the long term. Information included in each ESD is categorized into the following sections:

- **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** – Presents 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.

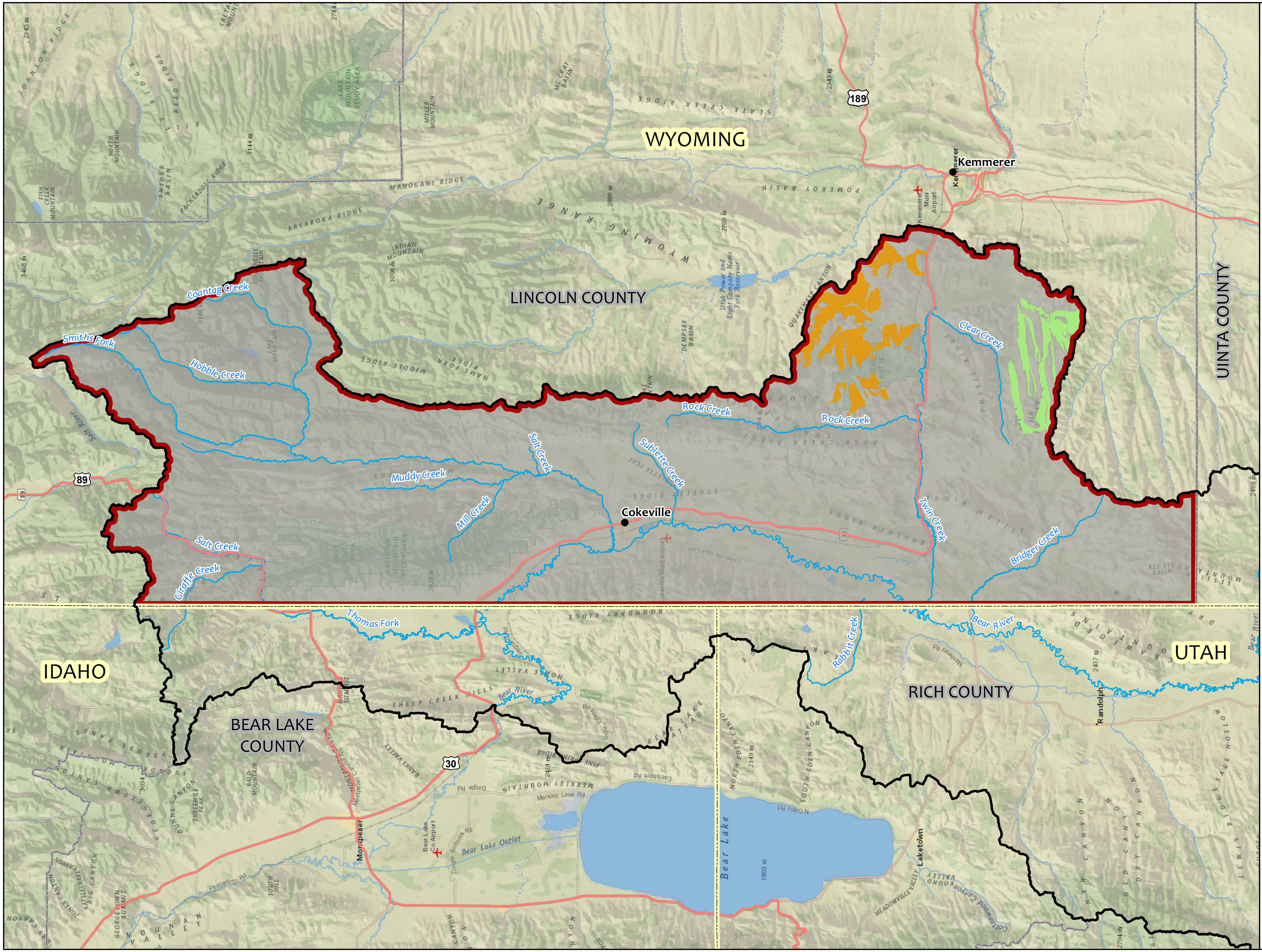
ESD reports can be accessed from the Ecological Site Information System website: https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=%20ESD

Ecological site information is typically included with NRCS soil mapping data; however, soil mapping in certain areas has not been updated and is not yet associated with ecological site data. Only 3% of the Lincoln County portion of the study area has been assigned ecological site data. Ecological site data is available for 95% of the Uinta County portion of the study area. All available ecological site data is depicted in Figure 3.3.4.3a-Ecological Sites. The three most prominent ecological sites in the portion of the study area where mapping is available are: Mountain Loam (Mountain Big Sagebrush), Dense Clay (Foothills and Mountain West), and Mountain Shallow Loam (Mountain Big Sagebrush). A brief description of these ESDs as provided by NRCS is presented below. State and Transition Models and details regarding plant community dynamics for these ESDs are presented in Section 4.4.1.



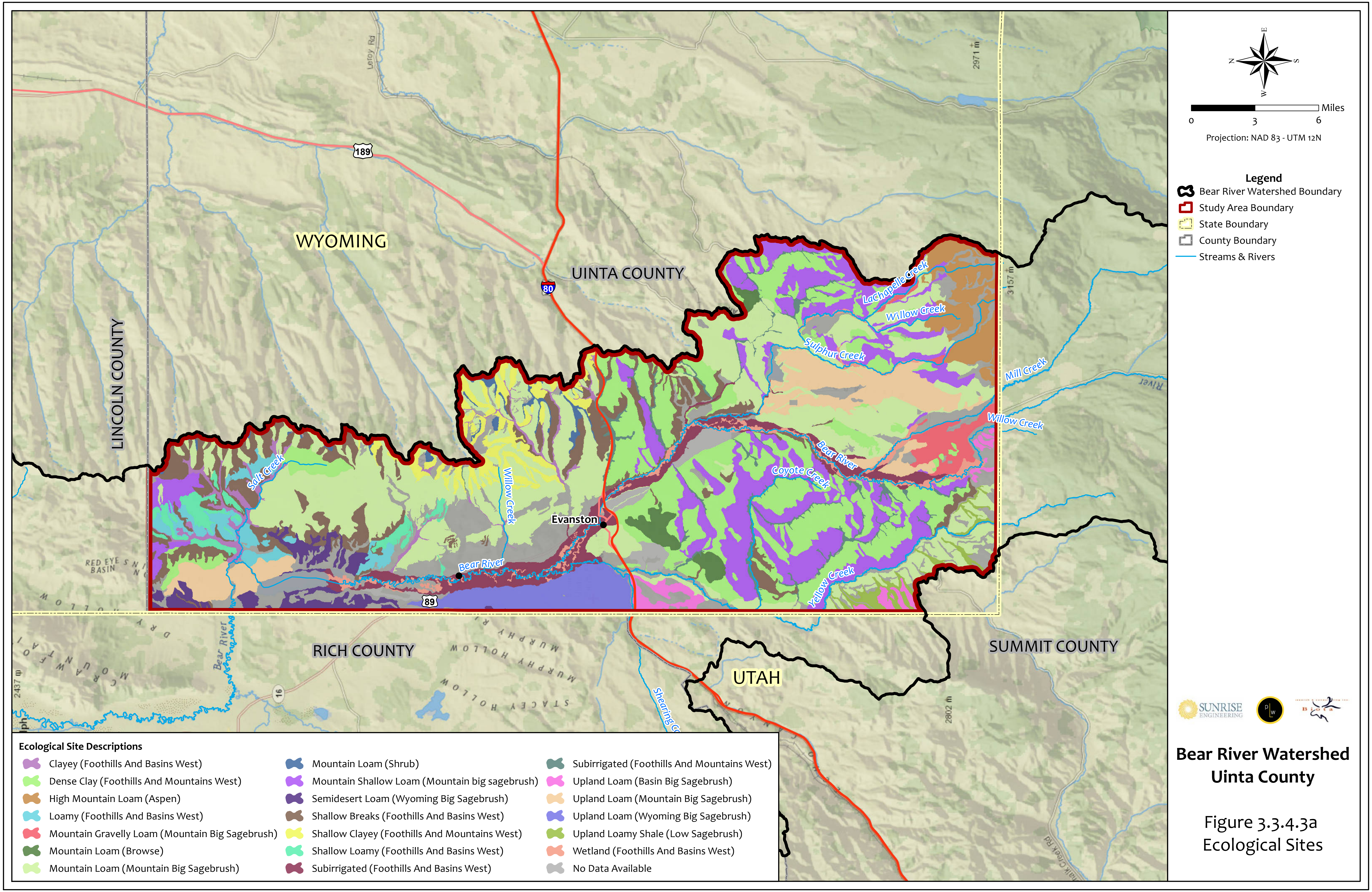
Bear River Watershed

Figure 3.3.4.3a
Ecological Sites



**Bear River Watershed
Lincoln County**

Figure 3.3.4.3a
Ecological Sites



Bear River Watershed
Uinta County

Figure 3.3.4.3a
Ecological Sites

Mountain Loam (Mountain Big Sagebrush)

Site Characteristics

This site is found on mountain slopes and fan remnants with slopes ranging from 2% to 60%. Runoff is medium to high depending on slope and plant basal cover. This site is found on all aspects and at elevations ranging between 5100 to 8400 feet. The climate of this site is typically moist sub-humid or humid, with cold snowy winters and cool dry summers. Distribution of the precipitation is 55% to 60% during the plant dormant period (October to March). Winter snow is the most dependable water supply for plant growth. Low precipitation and high evaporation rates during July, August, and September cause slowing of plant growth for all species and dormancy in many of the grasses and forbs.

The soils in this site are at least 60 inches deep, well-drained and have dark colored surface layers. The underlying layers are medium to fine textured and contain limited gravel and cobble in places. They are weathered from sandstone, shale, limestone, quartzite, volcanic ash and various igneous rocks. Permeability is moderately slow to moderate. Roots penetrate the soils readily. These soils have a high water holding capacity, ranging from about 5 to 8 inches in the upper 40 inches of the profile. Rock fragments are variable throughout the profile, but average less than 15 percent by volume. Under proper management, these soils have little surface runoff and slight or no erosion. The soil moisture regime is xeric and the soil temperature regime is frigid.

Plant Communities

It is impossible to determine in any quantitative detail the historic climax plant community (HCPC) for this ecological site because of the lack of direct historical documentation preceding all human influence. The reference state is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans. The description of the reference state was determined by NRCS Soil Survey Type Site Location information and familiarity with rangeland relict areas where they exist. The least modified plant community would have been co-dominated by mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*) and a mixture of herbaceous species. Dominant grasses would have included bluebunch wheatgrass (*Pseudoroegneria spicata*), and basin wildrye (*Leymus cinereus*), and forbs would have included sticky purple geranium (*Geranium viscosissimum*), shortstem buckwheat (*Eriogonum brevicaule*), and lupines (*Lupinus caudatus ssp. caudatus* and *L. argenteus*), among others.

Site Interpretations

This site is located between upland range sites and woodlands and is extremely valuable for wildlife habitat because of the great variety and abundance of grasses, forbs and shrubs and the interspersion of this site among other types of habitat (e.g., uplands and dry croplands, woodlands and stream-bottoms with the associated riparian vegetation). Resident wildlife on this site include: sage grouse, snowshoe hare, mule deer, elk, and moose. This site also has excellent potential for summer grazing by cattle, sheep, and horses.

This site has aesthetic value and is suitable for hiking and horseback riding. It has a large number of forbs and shrubs in bloom from early spring throughout the summer and into the fall. It has a combination of grasses, forbs, small shrubs and large shrubs which attract snowshoe hare, elk and mule deer for wildlife viewing and hunting.

Dense Clay, 10 to 14-inch Precipitation Zone (Foothills and Basins West)

Site Characteristics

This site will usually occur in a lowland position, on flat to moderately sloping land. It is found on all exposures. Slopes are mostly 5 to 40%. The elevations range from 6500 to 7500 feet, with most of the area above 7000 feet. Annual precipitation ranges from 10 to 14 inches per year. Wide fluctuations may occur in yearly precipitation and result in more dry years than those with more than normal precipitation. Temperatures show a wide range between summer and winter and between daily maximums and minimums. This is predominantly due to the high elevation and dry air, which permits rapid incoming and outgoing radiation. Cold air outbreaks in winter move rapidly from northwest to southeast and account for extreme minimum temperatures. Extreme storms may occur during the winter, but most severely affect ranch operations during late winter and spring. Daytime winds are generally stronger than nighttime and occasional strong storms may bring brief periods of high winds with gusts to more than 50 mph. Growth of native cool season plants begins about April 15 and continues to about August 15. Some green up of cool season plants usually occurs in September depending upon fall moisture occurrences.

The soils of this site are moderately deep to very deep (greater than 20" to bedrock), well to poorly drained soils formed in alluvium. These soils have slow to very slow permeability. The topsoil, except for thin ineffectual layers, will be heavy clays and/or soils that develop large cracks when dry and are very sticky when wet. These soils are not high in salinity and/or alkalinity.

Plant Communities

The HCPC has been determined by study of rangeland relic areas, or areas protected from excessive disturbance. The HCPC for this site is Rhizomatous Wheatgrass/Low Sagebrush. This state evolved with grazing by large herbivores and is suited for grazing by domestic livestock. Potential vegetation is estimated at 70% grasses or grass-like plants, 10% forbs and 20% woody plants. The major grasses include rhizomatous wheatgrasses, bottlebrush squirreltail, and mutton bluegrass. Other grasses and grass-like plants may include prairie junegrass, Indian ricegrass, plains reedgrass, and Canby and Sandberg bluegrass. Low sagebrush is the major woody plant. Other woody plants that may occur include early sagebrush, green rabbitbrush, and winterfat.

A typical plant composition for this state consists of rhizomatous wheatgrass 30 to 40%, bottlebrush squirreltail 5 to 15%, mutton bluegrass 5 to 10%, other grasses and grass-like plants 10 to 20%, perennial forbs 5 to 15%, low sagebrush 10-20%, and 5 to 10% other woody species. Ground cover, by ocular estimate, varies from 55 to 60%. The total annual production (air-dry weight) of this state is about 750 pounds per acre, but it can range from about 450 lbs/acre in unfavorable years to about 1,000 lbs/acre in above average years.

This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Site Interpretations

As this site deteriorates from improper grazing management, low sagebrush and green rabbitbrush will increase. Indian ricegrass will decrease in frequency and production. Transitions or pathways leading to other plant communities are as follows:

- Nonuse will convert this plant community to the Low Sagebush/Bunchgrass State;
- Heavy Continuous Season-long Grazing and/or Severe Hoof Compaction will convert this plant community to the Rhizomatous Wheatgrass State; and
- Heavy Continuous Season-long Grazing will convert this plant community to the Heavy Low Sagebrush State.

Mountain Shallow Loam (Mountain Big Sagebrush)

Site Characteristics

This site is found almost exclusively on mountainsides with gentle to very steep slopes, but can also occur on ridge tops and hills. The site occurs on all aspects, however it is commonly found on relatively dry, south and west facing exposures. This site is often adjacent to the Mountain Loam (Mountain big sagebrush) site where soils are deeper. Runoff is moderate to very high and elevation ranges from 5200 to 8500 feet. Due to its landscape position, this ecological site is not influenced by streams or wetlands.

The climate of this site is cool and quite humid with cold snowy winters and cool dry summers. The average precipitation ranges from 17 to 24 inches annually with 55% to 60% coming during the plant dormant period (October to March). Much of the precipitation comes as snow that acts as a reservoir for water until the growing season begins. This winter moisture is the most dependable supply of water for plant growth. Lower precipitation and higher evapo-transpiration rates during July, August, and September cause a reduction in plant growth for all species and dormancy in many of the grasses and forbs.

The soils in this site were formed from colluvium and residuum that weathered from various parent materials including sandstone, limestone, shale, quartzite and igneous rock. These soils typically formed on steep slopes. They are dark in color and shallow, with bedrock 10 to 20 inches from the soil surface. In most cases the soils in this site are stony or cobbly and are well to somewhat excessively drained. Roots penetrate the soil material readily above the bedrock and into rock fractures, but are restricted where bedrock is solid. Waterholding capacity is low due to the shallow depth and high rock fragment content of the profile. It ranges from 1.0 to 2.5 inches with a water supplying capacity of 5 to 8 inches. Runoff will occur on these soils because soil depth limits water storage capacity. The soil temperature regime is frigid and the soil moisture regime is xeric.

Plant Communities

It is impossible to determine in any quantitative detail the HCPC for this ecological site because of the lack of direct historical documentation preceding all human influence. The reference state is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans. The description of the reference state was determined by NRCS Soil Survey Type Site Location information and familiarity with rangeland relict areas where they exist. The least modified plant community would have been dominated by a scattering of lower-statured mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*) and a mixture of relatively patchy herbaceous species. Antelope bitterbrush (*Purshia tridentata*) and mountain snowberry (*Symphoricarpos oreophilus*) would have been present but less common shrub associates. Dominant grasses would have included bluebunch wheatgrass (*Pseudoroegneria spicata*), muttongrass (*Poa fendleriana*), and Columbia needlegrass (*Achnatherum nelsonii*), and forbs would have included tapertip hawksbeard (*Crepis acuminata*), arrowleaf balsamroot (*Balsamorhiza sagittata*), sticky purple geranium (*Geranium viscosissimum*), and shortstem buckwheat (*Eriogonum brevicaule*), among others.

Site Interpretations

This site has a large amount of grasses and shrubs (about equal amounts by total air-dry production). Diverse species of forbs are found on this site, but make up a relatively small proportion of the total annual production. With this composition, good forage and balanced animal nutrition is provided during spring, summer, and fall. Cattle, sheep, goats, and horses graze this site to good advantage. This site produces excellent forage for deer and elk and is preferred habitat for these species from late fall through early spring. This site is fair habitat for mule deer and other wildlife.

Soil series in this site are grouped mainly into hydrologic group D. They have high runoff potential. When the vegetation is in climax (potential), the hydrologic curves are 76 to 73. Where range condition has declined from climax, field investigation is needed to determine hydrologic curve numbers.

This site has esthetic value and is good for open space, hiking, and horseback riding. Motorized recreation is dependent on road access. Many forbs and shrubs are in bloom from early spring through the summer and often into the fall. Hunting upland game birds, elk and mule deer may be good to excellent on this site.

3.3.4.4 RANGE CONDITION AND NEEDS

Livestock grazing occurs on federal, state, and private land within the study area, and associated land and livestock management practices vary widely. Detailed, site-specific information regarding range condition is outside the scope of this project, and no field investigations were conducted to specifically assess range condition. Data collected on several federal allotments within the study area were acquired, but it is not possible to draw conclusions about overall range condition within the watershed from such a small dataset.

As is typical in sagebrush grasslands of the arid west, livestock and wildlife use is generally concentrated around waterways and riparian areas. Unless measures are taken to disperse livestock and wildlife from riparian areas, range health in these areas often suffers. Riparian vegetation is often overgrazed and/or grazed late in the season when perennial plants need to store and transfer carbohydrate reserves to root systems to prepare for the dormant season. Overgrazing often results in reduced productivity and poor health within these plant communities. Animal concentration in these areas can contribute to soil compaction, which further inhibits plant productivity. Additionally, many upland areas are underutilized due to their relative isolation from watering sites.

A number of management techniques can be used to disperse livestock from riparian zones and encourage grazing in underutilized areas (e.g., fencing, herding, strategic salting), but most are only effective if implemented along with the development of upland watering sites. As such, the development of upland wildlife/livestock watering projects is a key focus of this study.

Fencing is a versatile management tool that can be utilized to protect riparian areas and other sensitive environmental sites from trampling, soil compaction, overgrazing, and other impacts caused by concentrated livestock use. To accomplish this, fence can be constructed in a manner that excludes livestock from these sensitive areas, and off-site watering systems can be developed to provide drinking water for the excluded livestock. The exclusion of livestock from these areas has numerous benefits at a local scale, as well as improving overall watershed function. Once livestock pressure on the riparian plant community within the exclosure fence is eliminated and it is allowed time to recover, the restored plant community will provide a number of benefits including: streambank stabilization, increased water infiltration rates, wildlife cover and forage, woody debris and instream cover for fish, and improved water quality. Although not applicable in some situations, fences can also be used to divide pastures and facilitate rotational grazing systems. If given a choice, cattle will eat the highest quality, most palatable plants in a pasture first, and this can result in inefficient, uneven use of the pasture and increase undesirable weedy species. More efficient livestock use of the available forage can be encouraged through the implementation of a managed rotational grazing system, involving high density stocking for short time periods in smaller pastures.

Rotational grazing systems have been successfully implemented throughout the world, and have also been successfully used to enhance wildlife habitat and rehabilitate desirable vegetation. The basic elements of a rotational grazing system are:

- Proper timing of grazing corresponding to plant physiological stage;
- Proper intensity of grazing and duration in each pasture;
- Substantial residue or plant height remaining after grazing;
- Proper duration of rest to facilitate regrowth.

Rotational grazing involves periodical movement of livestock between smaller pastures, with specific attention paid to pasture health and stubble height. It is necessary to retain adequate leaf area after grazing for subsequent regrowth. Each pasture typically needs 14 to 45 days of rest (depending on plant community and moisture levels) to allow for adequate regrowth.

Active herding and salting can be useful tools to assist with preventing livestock from concentrating in riparian areas and encouraging grazing in underutilized areas. These practices are more practical in large pastures, where fence construction and maintenance is cost prohibitive. Strategic salting involves the placement of salt blocks in underutilized areas and away from riparian areas, with the goal of luring livestock out of the riparian areas. Salting areas should be rotated during the grazing season and from year to year. See Section 4.4.2 of this report for further information on livestock management.

3.3.5 OIL AND GAS RESOURCES

Oil and natural gas have been produced in Wyoming since the mid-1800s. However, increased demand coupled with recent improvements in resource detection and extraction technologies have driven a substantial increase in the volume of production over the last 15 years, primarily due to the growth in the natural gas industry. Southwestern Wyoming is home to the largest contiguous concentration area of onshore oil and gas reserves in the lower 48 states. The Bear River Watershed within Wyoming contains 5 named fields of producing oil and gas wells within the project study area including; Painter Reservoir, Glasscock Hollow, Anschutz Ranch East, Bridger Fork, and Whitney Canyon-Carter Creek. These fields overlay federal, state, and private lands.

Table 3.3.5 Tabulation of Oil and Gas Production through 2014 from the Bear River Watershed Study Area.

Wells	Oil (Bbls)	Gas (Mcf)
480	**141,354,525**	**3,957,806,052**

Oil and gas development within the study area is concentrated in Uinta County along the Eastern edge of the Bear River watershed boundary in association with oil and gas bearing geologic formations. The BLM administers development of the federal subsurface mineral estate, and to a much lesser degree Wyoming Land Quality Division administers development of State Trust mineral revenue. Figure 3.3.5, Oil and Gas Resources, illustrates the well distribution across the basin. The locations of all active and permanently abandoned oil and gas wells were obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC) website: http://wogcc.state.wy.us/.

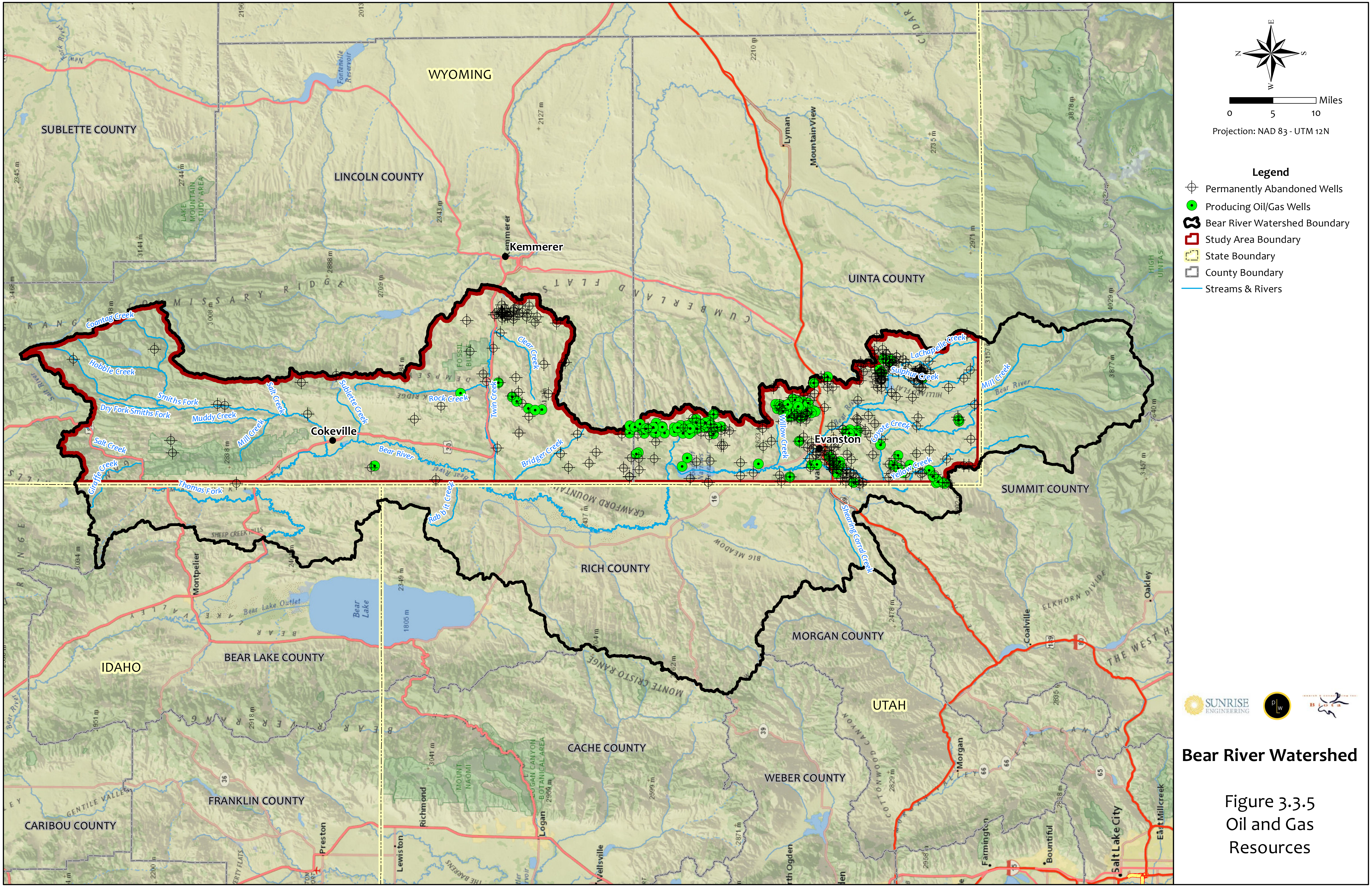
3.3.6 MINING & MINERAL RESOURCES

Coal, potash, uranium, trona, bentonite, rare earth elements and metallic minerals such as gold and copper are important mineral resources in the state of Wyoming. Phosphorous-phosphate mining is the most notable historic mining practice in the project area, while aggregates such as sand and gravel are currently the most commonly mined resources. Extensive deposits of commercial grade sand and gravel can be found in both terrace and alluvial deposits along the Bear River and its major tributaries. At the time of this report, there were 26 mine permits on record with the Wyoming Department of Environmental Quality (WDEQ)-Land Quality Division within the Bear River watershed project area. Twenty-one of these were active permits associated with sand and/or gravel, or clay operations. There were 5 terminated permits, all for gravel mines. Figure 3.3.6 shows the location and target mineral of all mine sites.

In addition to current WDEQ records, there are numerous abandoned mine features within the study area dating back to historic mining operations. The WDEQ-Abandoned Mine Lands Division (AML) mission is to mitigate safety hazards and repair environmental damage from past mining activities, and to assist communities impacted by mining. Many of the sites within the study area are eligible for mitigation through the WDEQ-AML program.

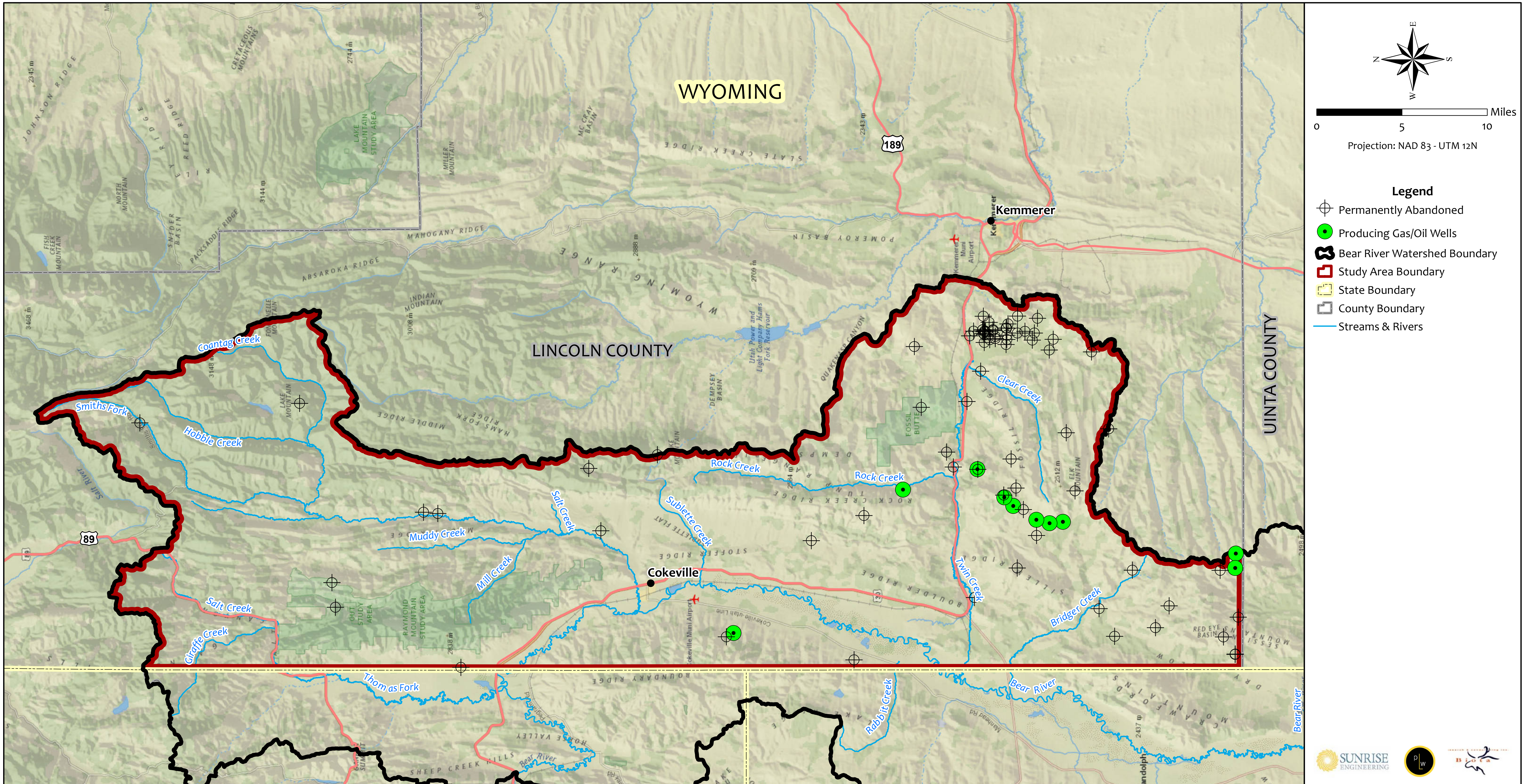
3.3.7 CULTURAL RESOURCES

The Wyoming State Historic Preservation Office (SHPO) maintains a database of inventoried cultural resources and historic sites within Wyoming. In response to a query of cultural resources and historic sites within the Wyoming portion of watershed study area, SHPO provided a spatial data file that provided the general location (to a per section level accuracy) of cultural and historic resources. The attributes recorded for each section include: site count, inventory acres, report numbers, and eligible site number. Figure 3.3.7 depicts the results of the database query, and each



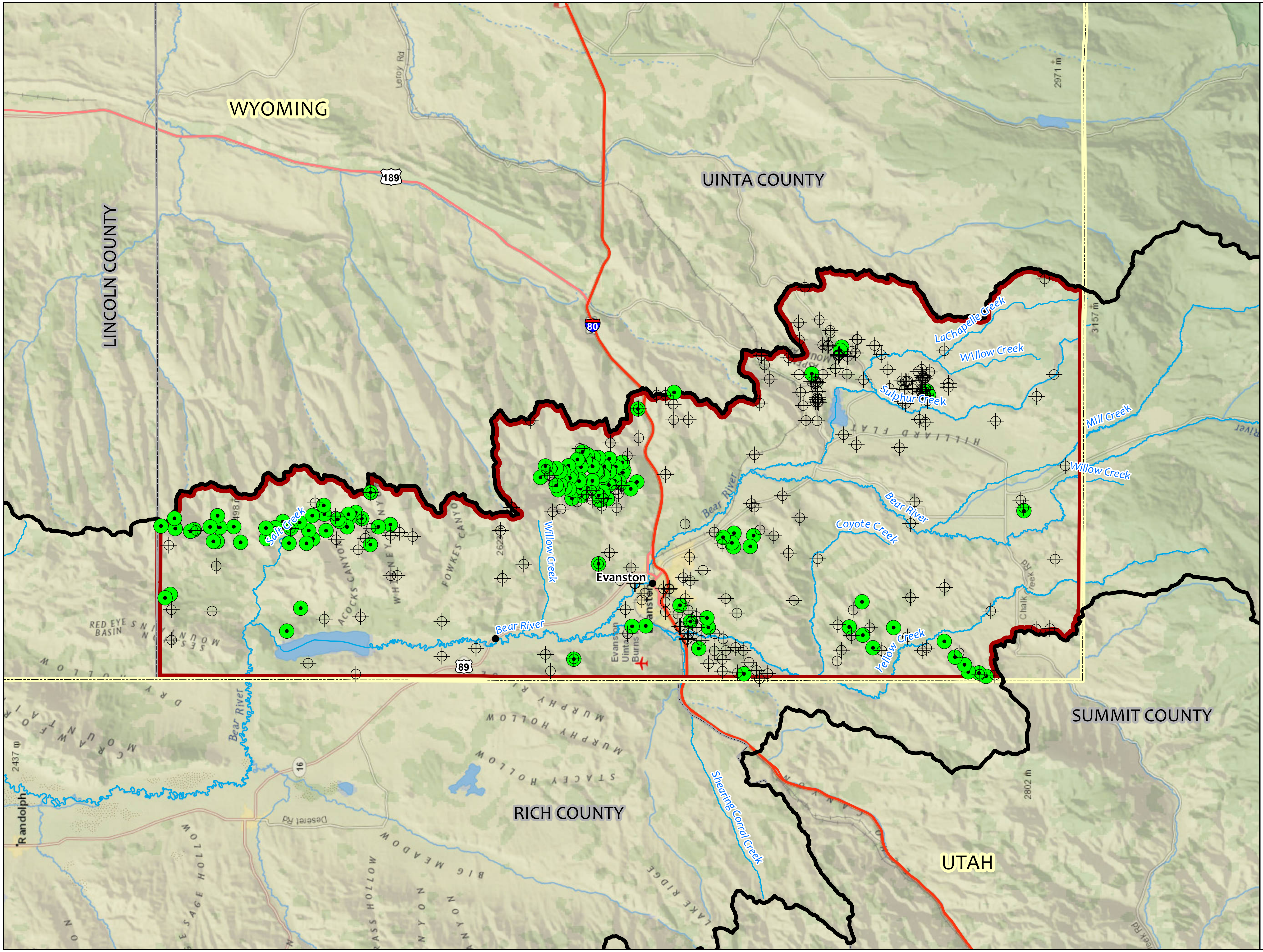
Bear River Watershed

Figure 3.3.5
Oil and Gas Resources



Bear River Watershed
Lincoln County

Figure 3.3.5
Oil and Gas
Resources



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Projection: NAD 83 - UTM 12N

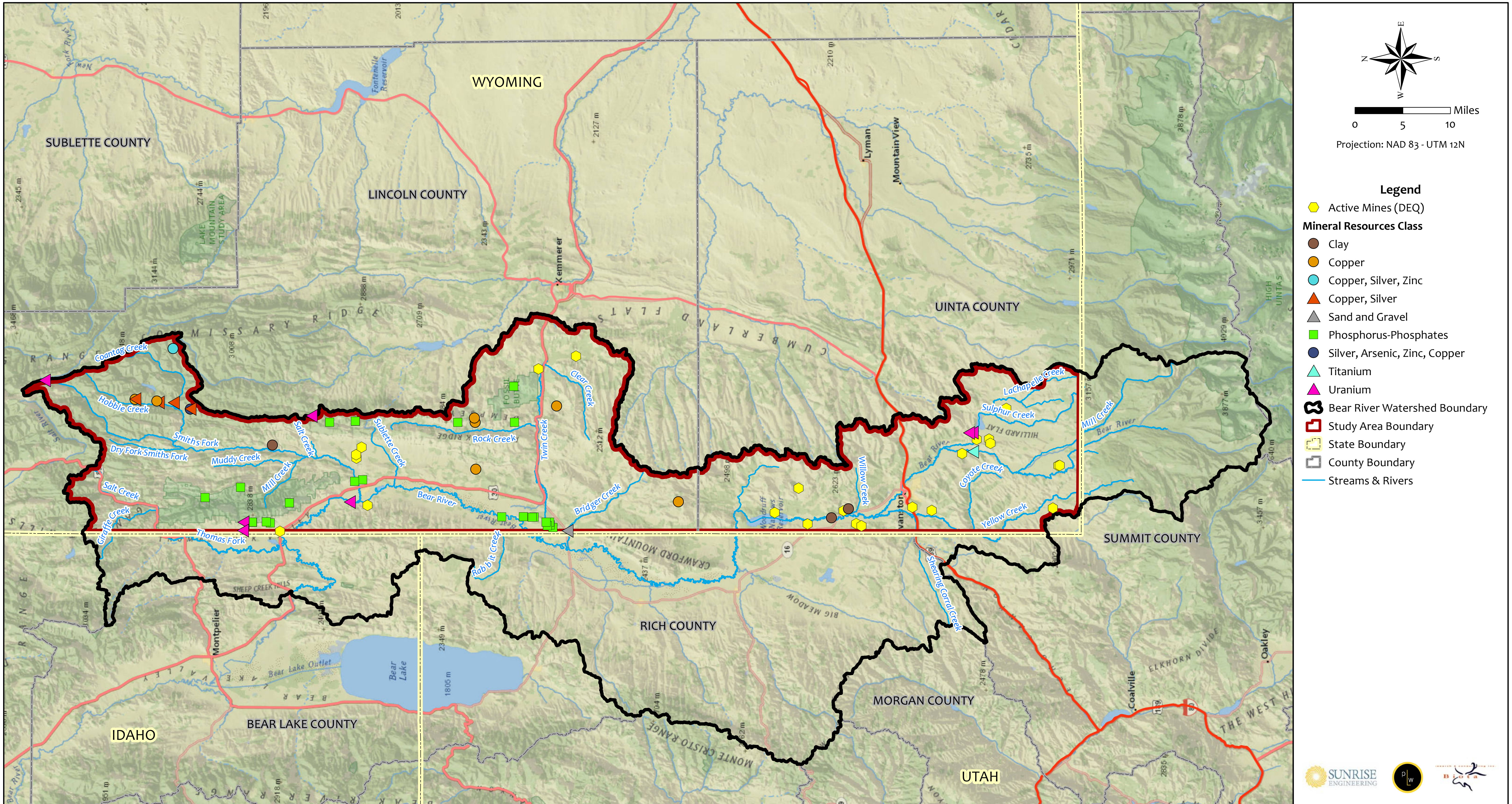
Legend

- ⌖ Permanently Abandoned
- ● Producing Gas/Oil Wells
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

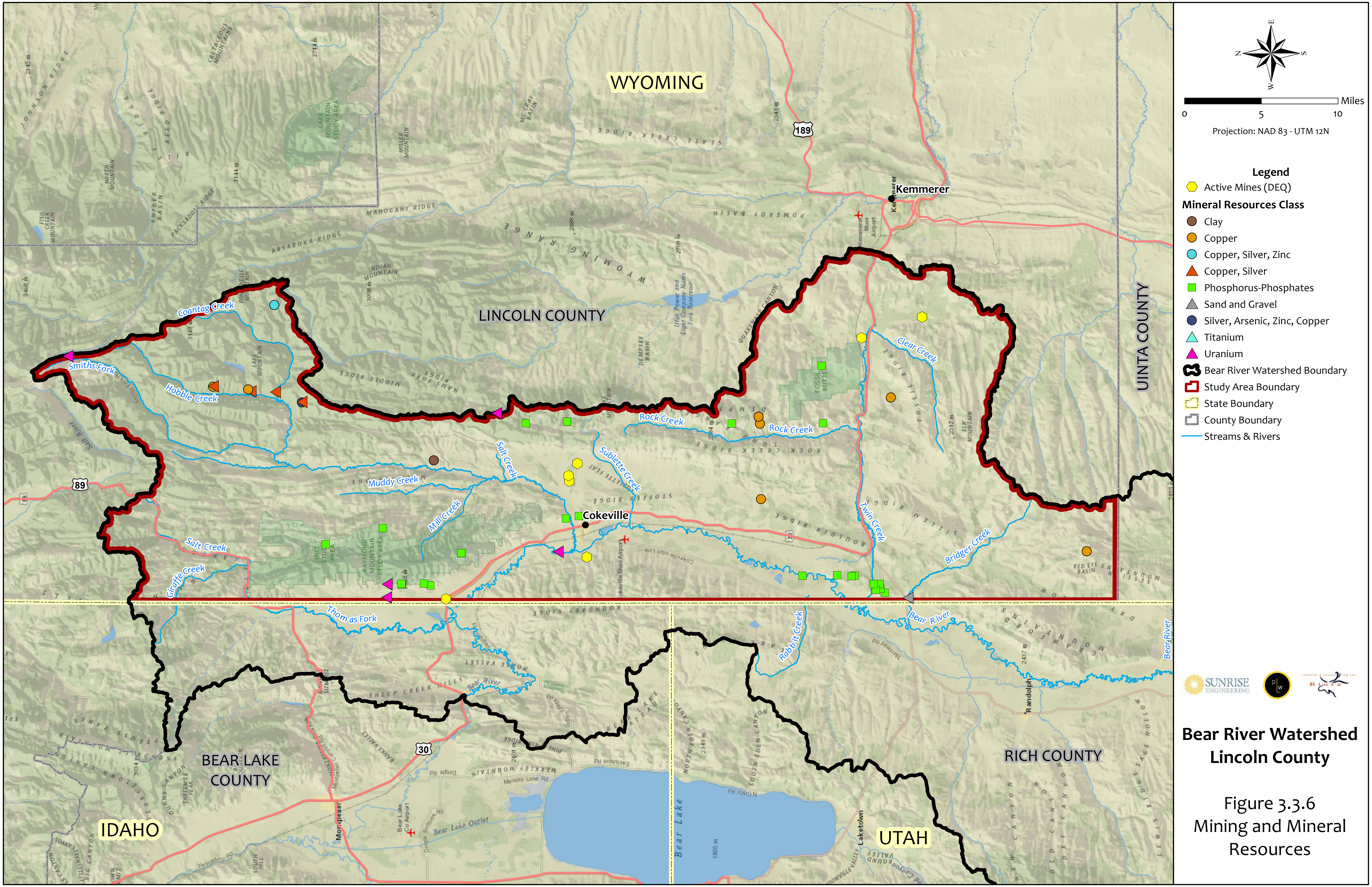
Bear River Watershed
Uinta County

Figure 3.3.5
Oil and Gas Resources



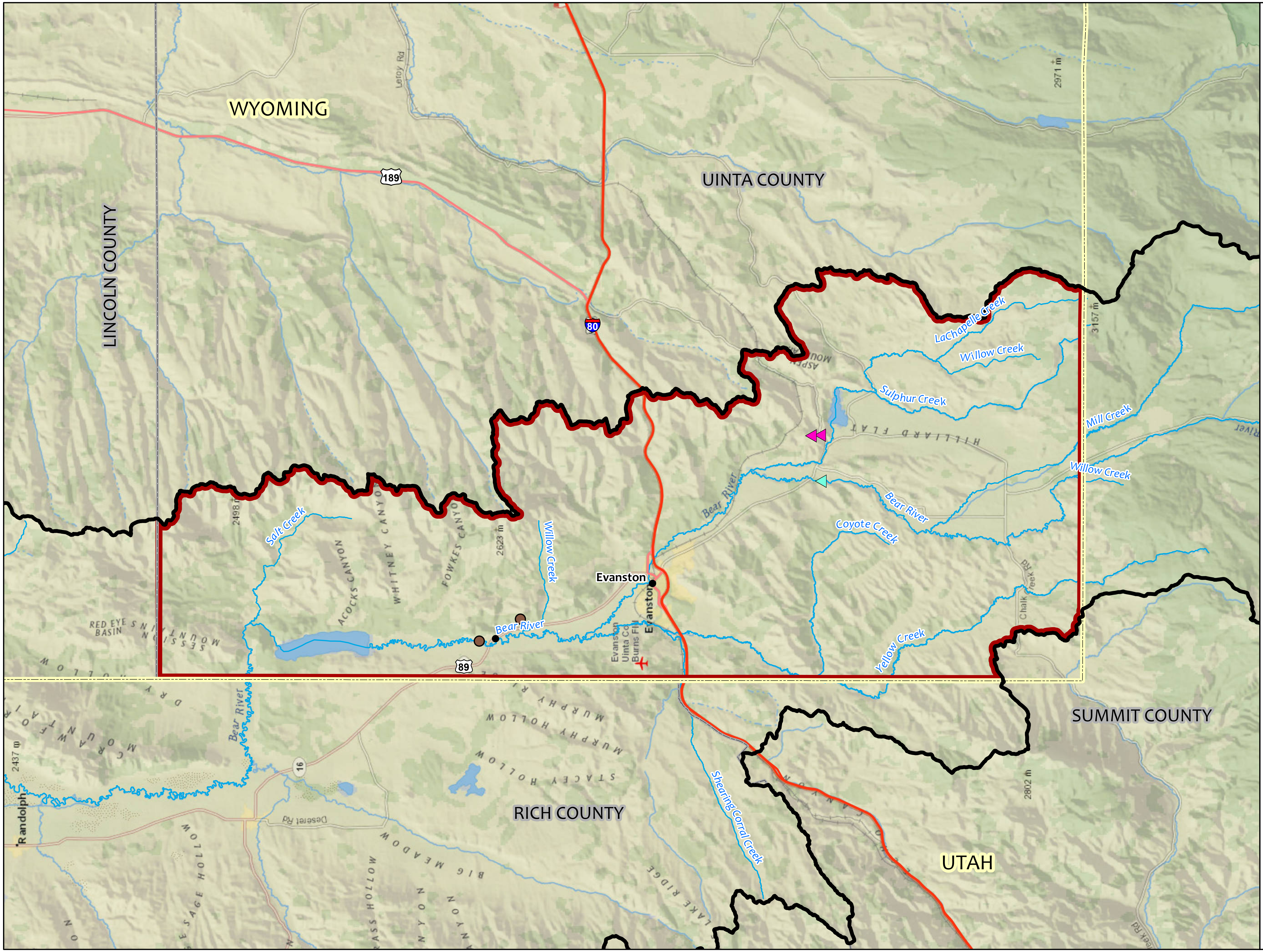
Bear River Watershed

Figure 3.3.6
Mining and Mineral Resources



Bear River Watershed Lincoln County

Figure 3.3.6
Mining and Mineral Resources



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Projection: NAD 83 - UTM 12N

Legend

Mineral Resources Class

- ● Clay
- ▲ Titanium
- ▲ Uranium
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed Uinta County

Figure 3.3.6
Mining and Mineral Resources

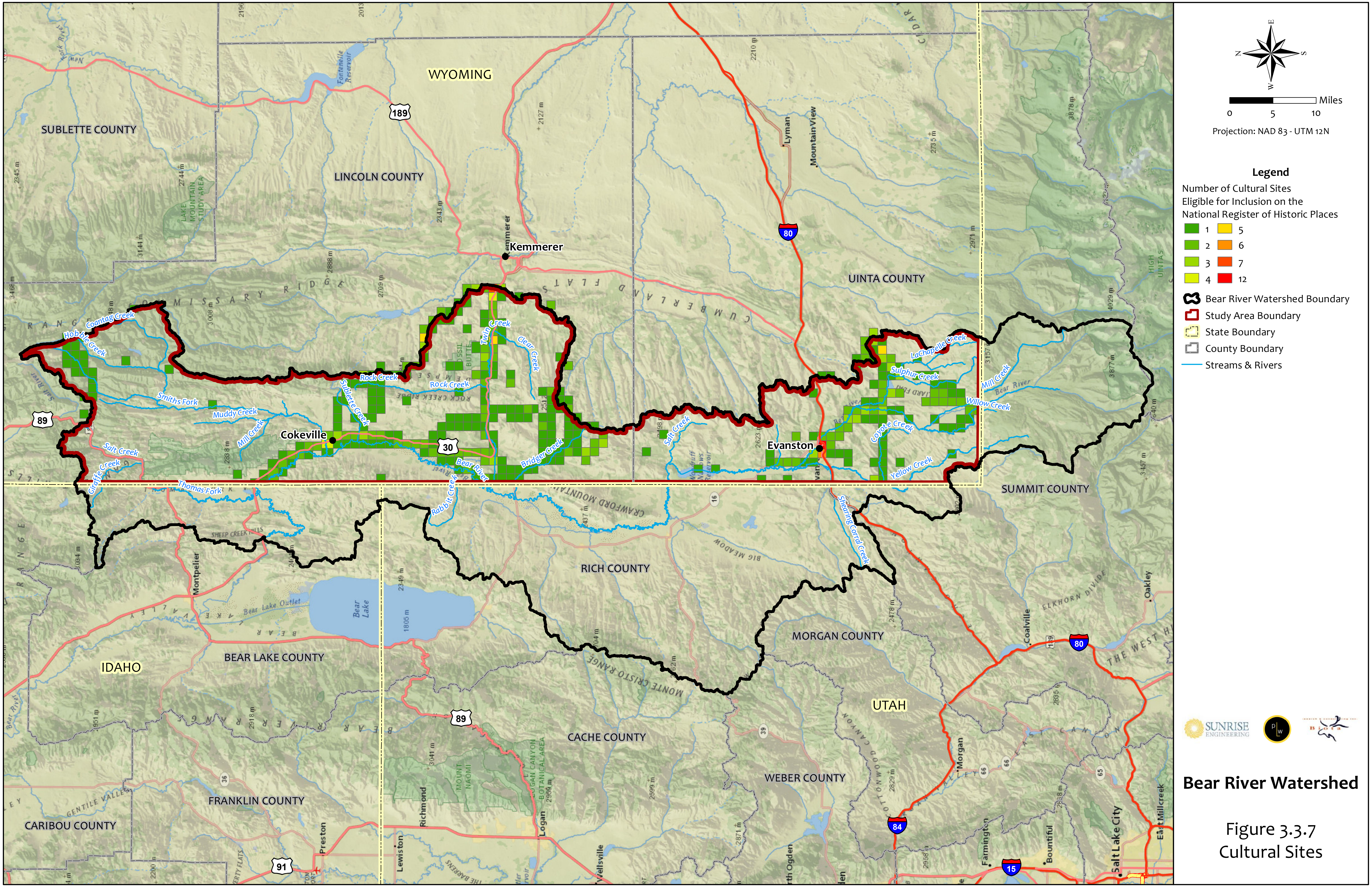
square mile section within the study area has been color-coded based on the number of sites occurring within the area determined to be eligible for inclusion on the Register.

The BLM provided an inventory of historical trails in Wyoming and 6 of these trails bisect the watershed study area: Lander Road; Oregon-California Trail (including the Sublette Cutoff and the Hams Fork Cutoff); and the California-Mormon-Pony Express Trail. Figure 3.3.8.2 depicts these historic trails within the Wyoming portion of the watershed study area.

The National Register of Historic Places (Register) is the nation's official list of cultural resources worthy of preservation. The Register is administered on a federal level by the National Park Service and managed locally by the SHPO. The Register is part of a program to coordinate and support both public and private efforts to identify, evaluate, and protect historic and archeological resources. The Register recognizes the accomplishments of those who have contributed to the history and heritage of the United States, the state, and local communities. A determination of each site's eligibility for inclusion in the Register is included in the database of inventoried cultural resources and historic sites within Wyoming. The Wyoming portion of the Bear River Watershed Study includes portions of Lincoln and Uinta Counties. The registered historic sites within the Wyoming portion of the watershed study area are listed in Table 3.3.7-1 and are depicted in Figure 3.3.8.3. A total of 10 sites within the study area are included in the Register, and a brief description of each site was provided by the Wyoming State Preservation Office website at: http://wyoshpo.state.wy.us/NationalRegister/.

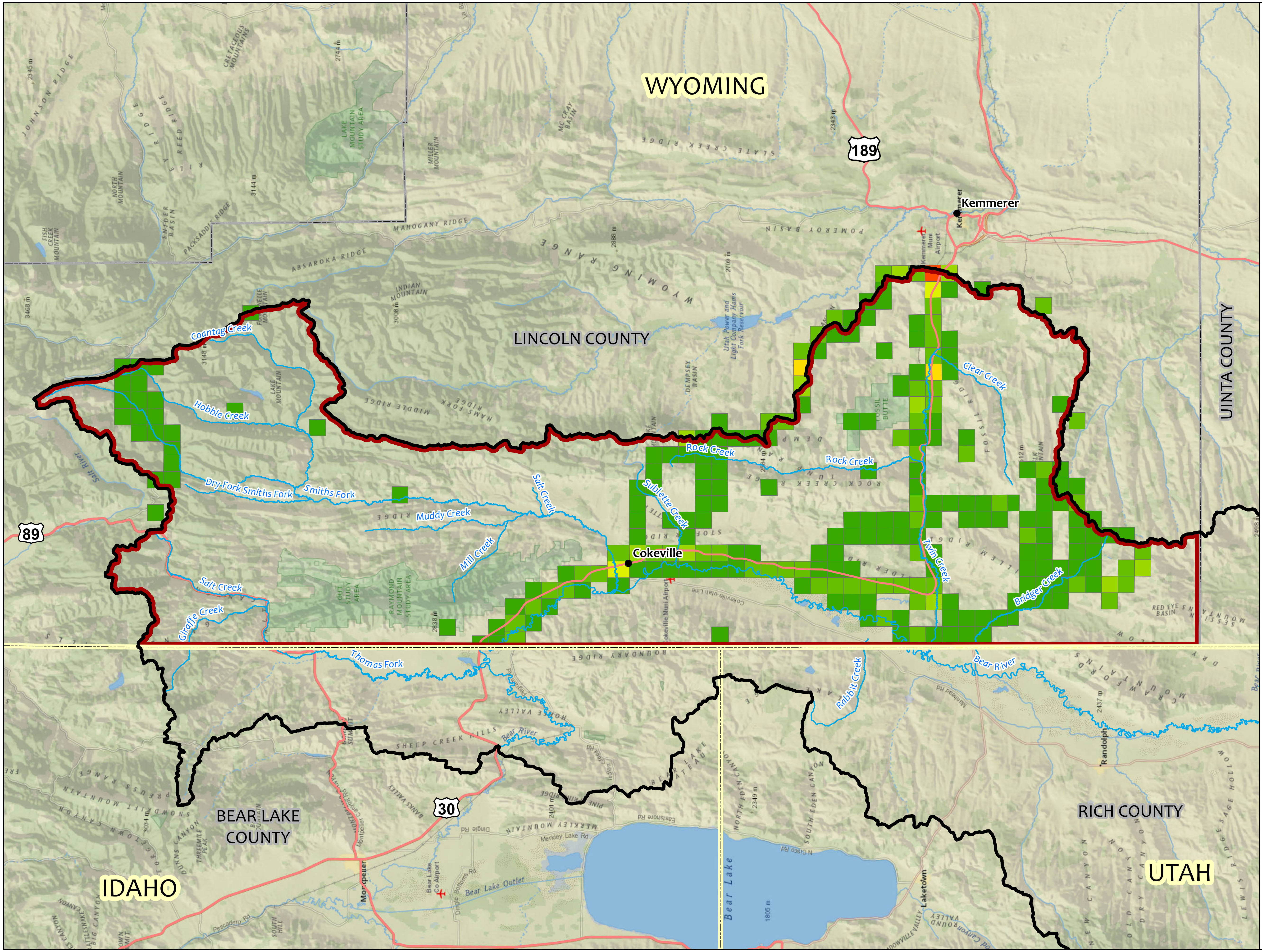
Table 3.3.7-1. Historic sites listed on the National Register of Historic Places.

Site	**County**	**Year**	**Smithsonian #**
Fossil Butte Short Line Depot	Lincoln County	2013	48LN4730
Haddenham Cabin	Lincoln County	2003	48LN2346
A. V. Quinn House	Uinta County	1984	48UT1173
Wyoming State Insane Asylum	Uinta County	2003	48UT266
Brigham Young Oil Well	Uinta County	1985	48UT1174
Downtown Evanston Historic District	Uinta County	1983	48UT1121
St. Paul's Episcopal Church	Uinta County	1980	48UT245
Uinta County Courthouse	Uinta County	1977	48UT208
Union Pacific Railroad Complex	Uinta County	1985	48UT971
Evanston Main Post Office	Uinta County	1987	48UT246



Bear River Watershed

Figure 3.3.7
Cultural Sites



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Projection: NAD 83 - UTM 12N

Legend

Number of Cultural Sites Eligible for Inclusion on the National Register of Historic Places

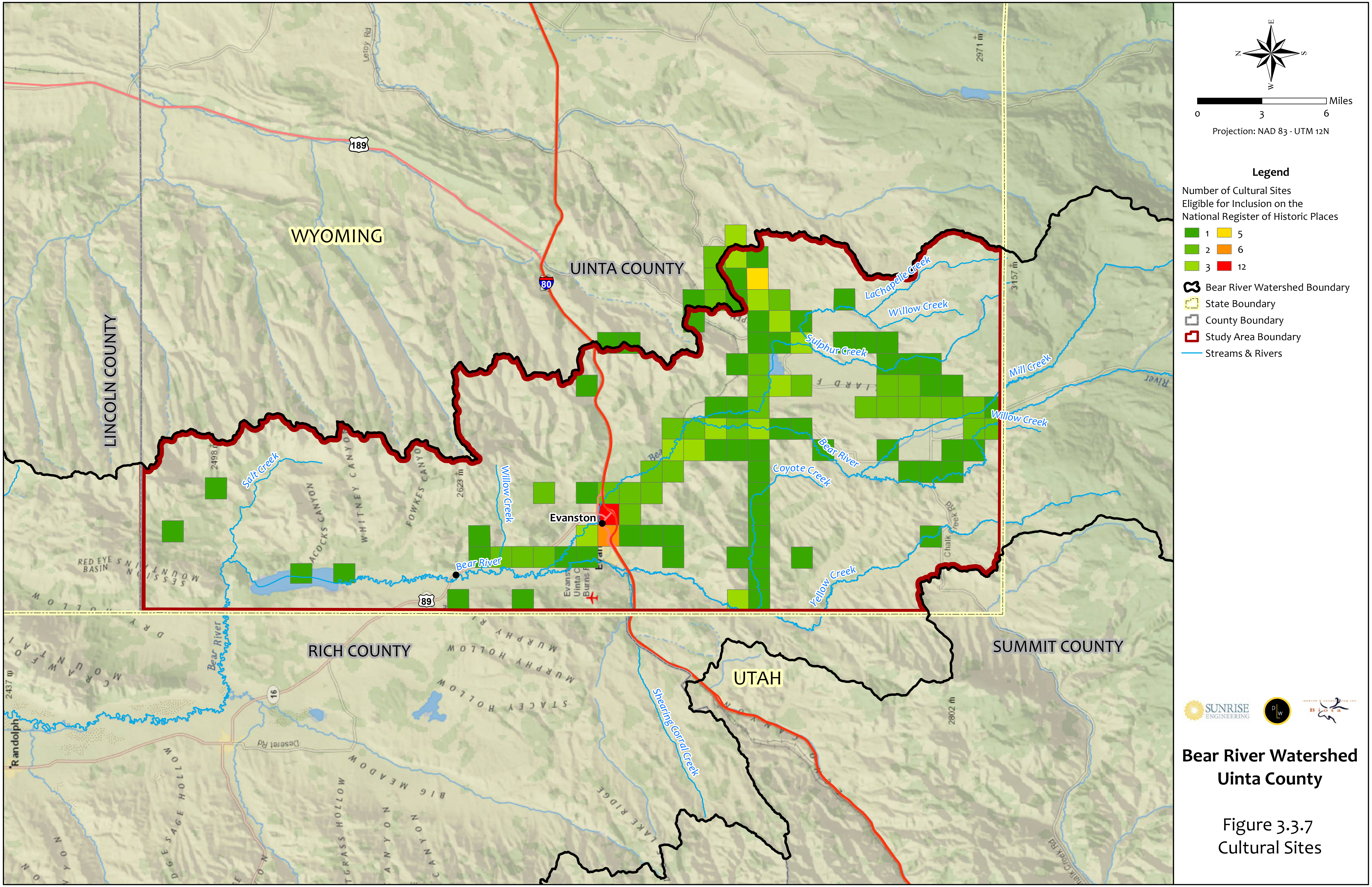
- 🟩 1
- 🟩 2
- 🟩 3
- 🟨 4
- 🟧 5
- 🟥 7

- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

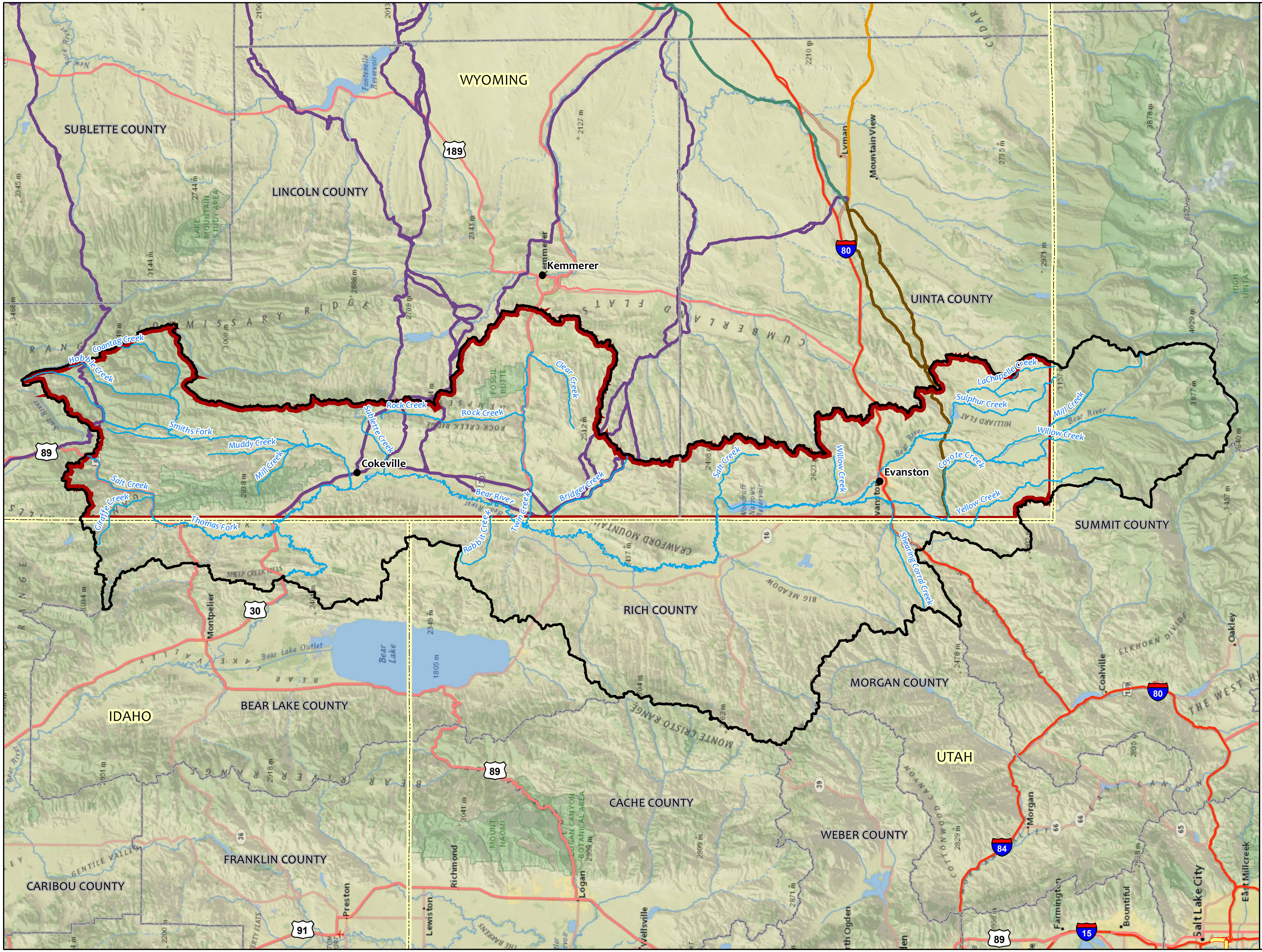
Bear River Watershed Lincoln County

Figure 3.3.7
Cultural Sites



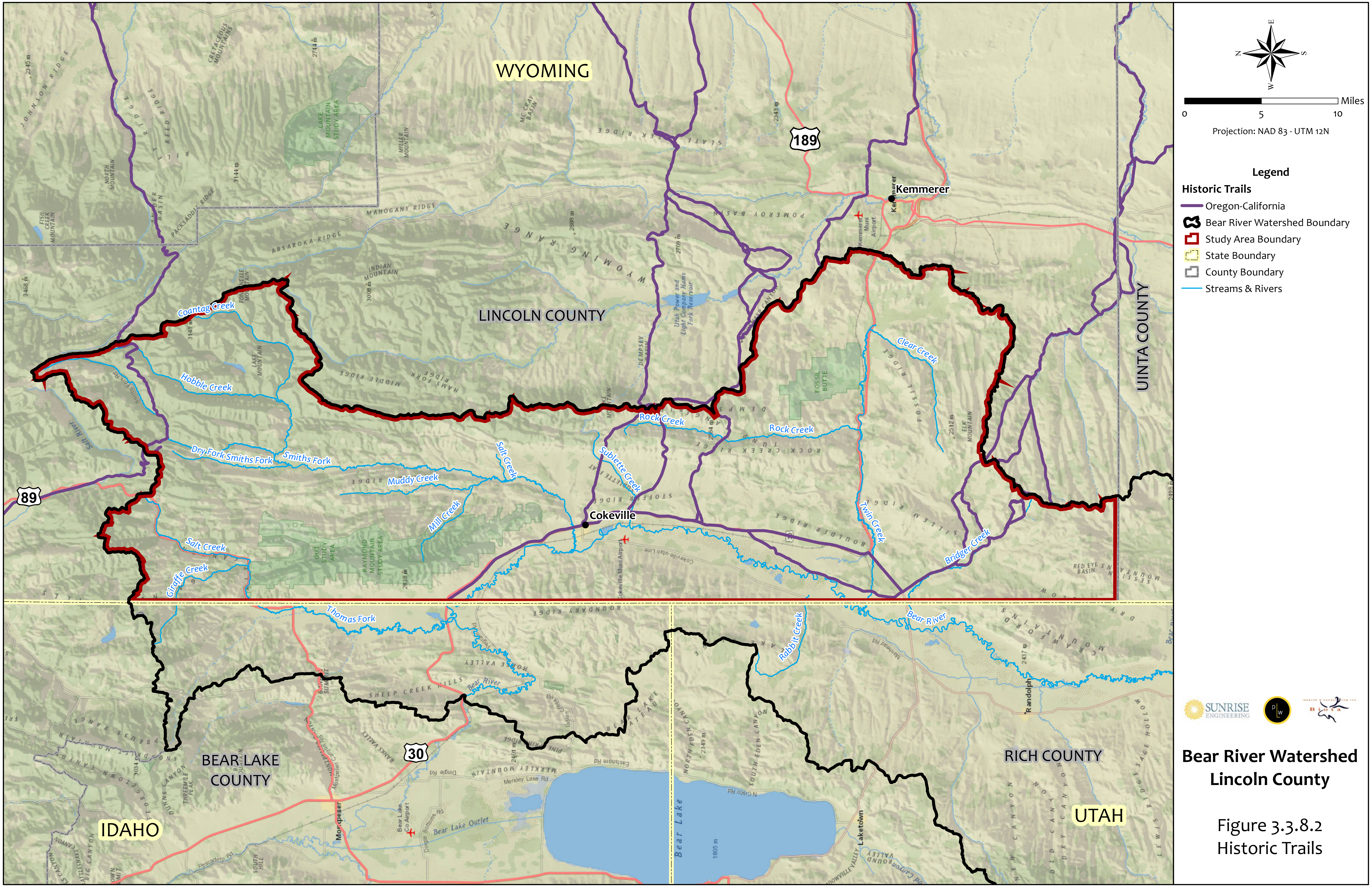
Bear River Watershed
Uinta County

Figure 3.3.7
Cultural Sites



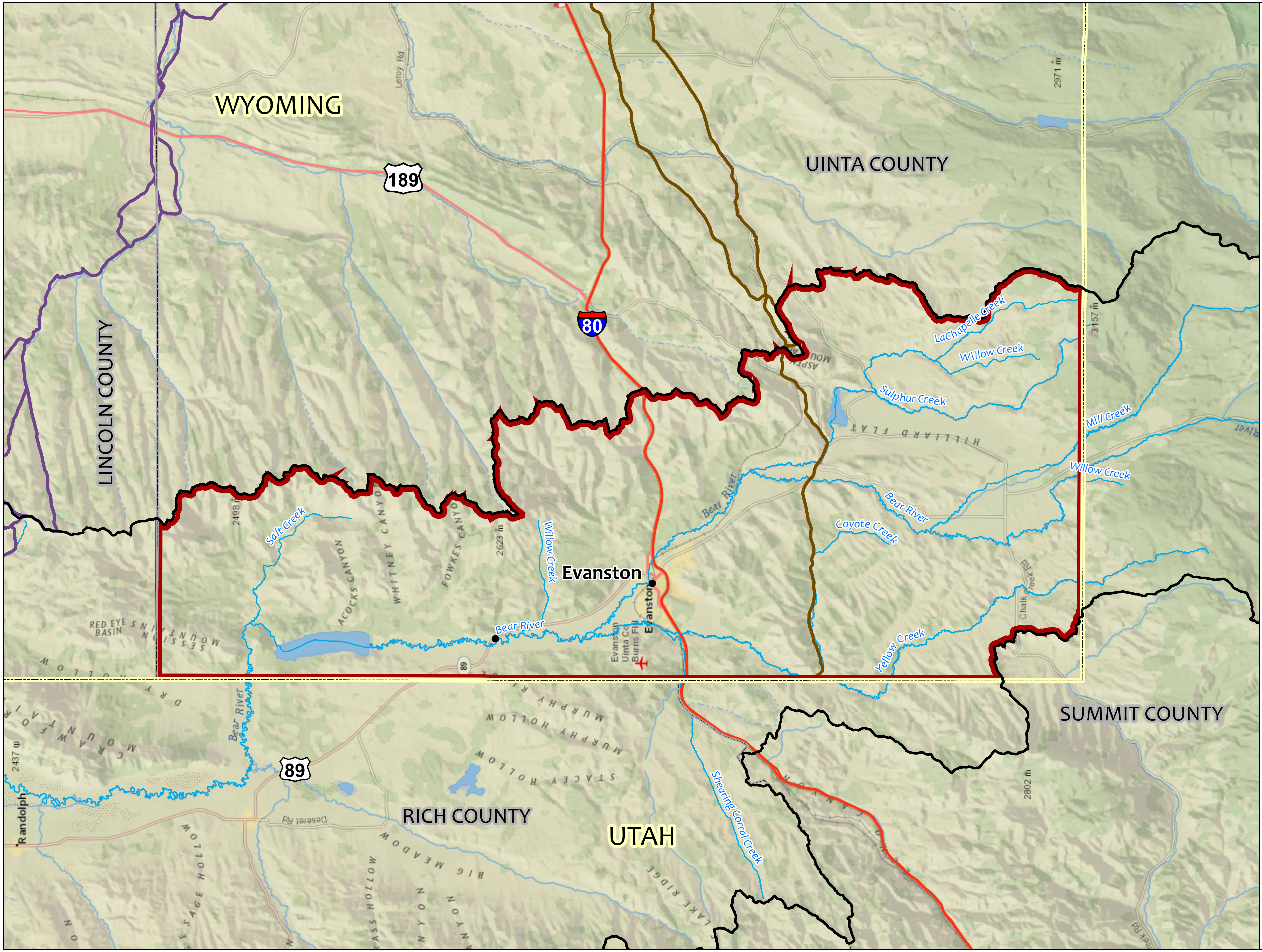
Bear River Watershed

Figure 3.3.8.2
Historic Trails



Bear River Watershed Lincoln County

Figure 3.3.8.2
Historic Trails



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Projection: NAD 83 - UTM 12N

Legend

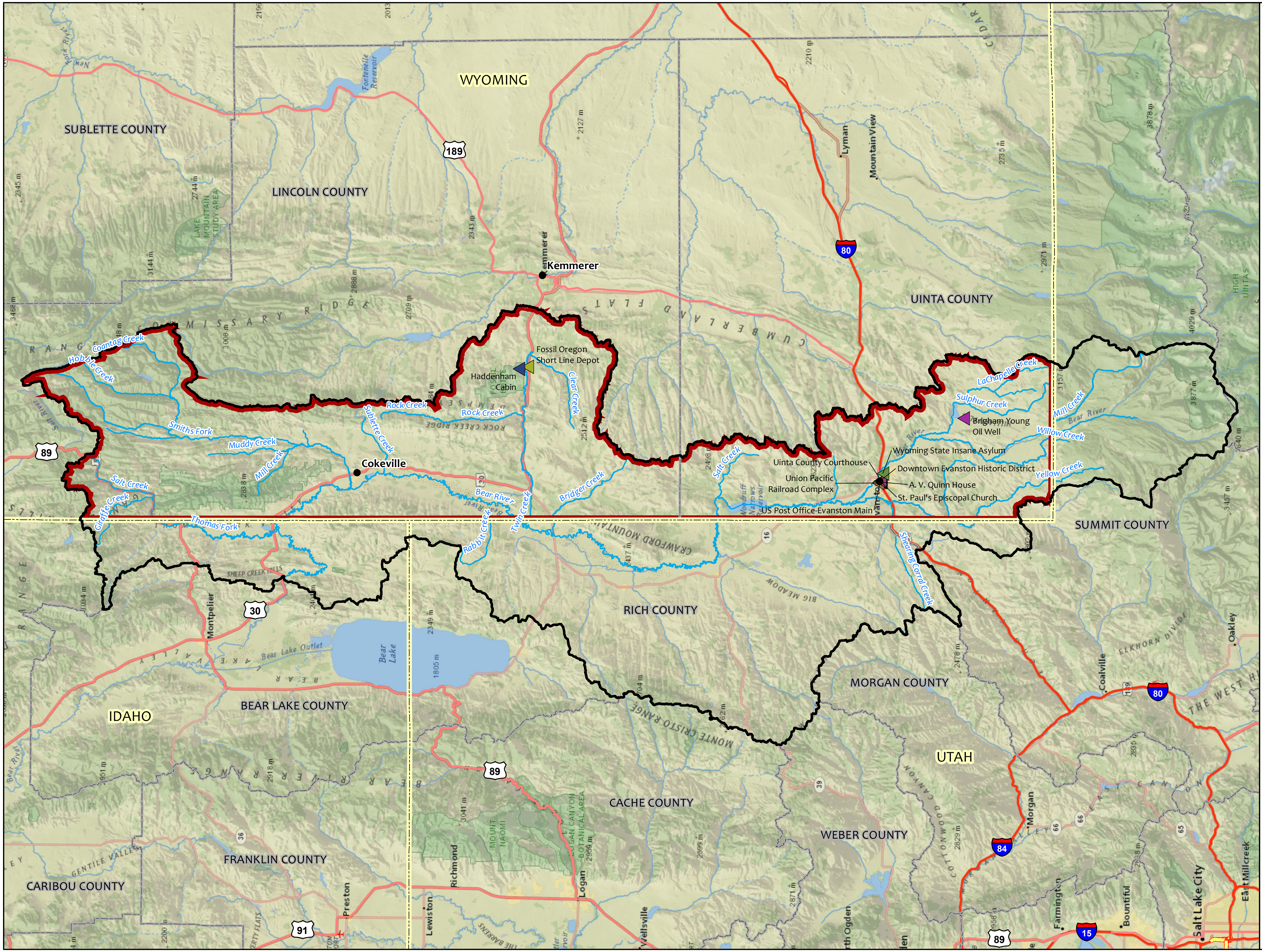
Historic Trails

- California-Mormon-Pony Express
- Oregon-California
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

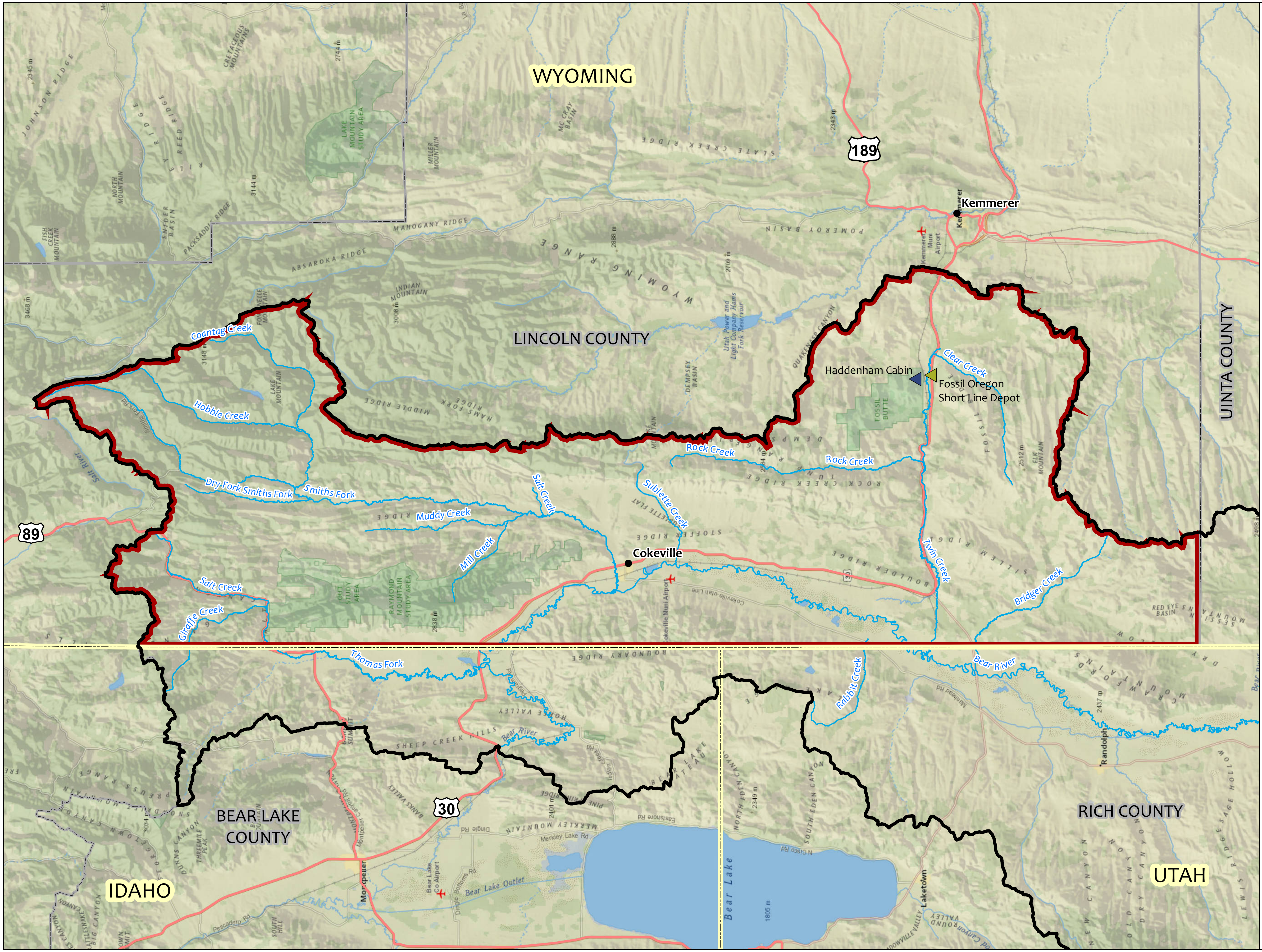
Bear River Watershed Uinta County

Figure 3.3.8.2
Historic Trails



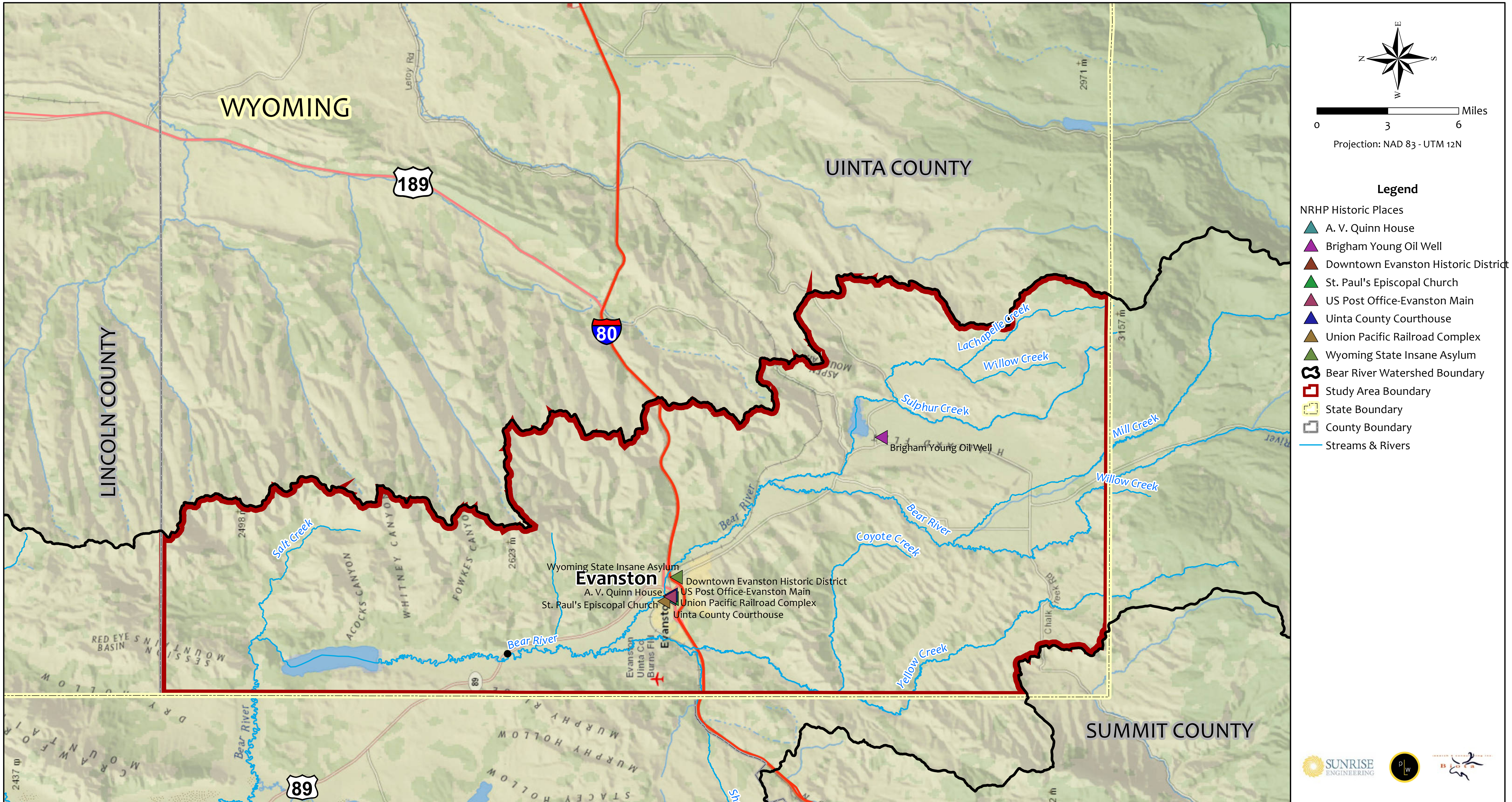
Bear River Watershed

Figure 3.3.8.3
NRHP Historic Places



Bear River Watershed
Lincoln County

Figure 3.3.8.3
NRHP Historic Places



Bear River Watershed
Uinta County

Figure 3.3.8.3
NRHP Historic Places

LINCOLN COUNTY

Fossil Butte Short Line Depot

Added to the Register on December 11, 2013

Smithsonian Number 48LN4730

For a town that owed its existence to the railroad, the Oregon Short Line Depot was a centerpiece of the town of Fossil and stands as one of the last remaining visible elements of the town. The depot and most of the town of Fossil moved to its current location in 1902. Also at this time the freight room addition was built onto the building. The depot was a center of activity as freight, mail, and passenger train service linked the town's residents and trade to other regional centers. During the first half of the twentieth century Fossil was an important shipping center for local cattle and sheep activities. At one time, the town had two hotels, a restaurant, and a school, and had a peak population of 151.

Haddenham Cabin

Added to the Register on December 23, 2003

Smithsonian Number 48LN2346

The Haddenham Cabin is located in the southeast portion of Fossil Butte National Monument, 10 miles west of Kemmerer, Wyoming. It is located on the Quarry Trail, which is a 2.5-mile loop leading to the south face of Fossil Butte. The cabin has local significance for its association with the quarrying of fossils in the Green River Formation. The cabin was built by David C. Haddenham ca. 1918 to serve as on-site shelter for himself and his family during their seasonal quarrying work. He actively quarried in the area of the present monument from the late nineteenth century to his death in 1968. From this work he provided universities, museums, and private collectors with specimens of rare fossils dating back 40 million years. The period of significance dates from 1918 to 1950. The cabin was used after the historic era into the 1960s.

UINTA COUNTY

A. V. Quinn House

Added to the Register on September 13, 1984

Smithsonian Number 48UT1173

The Quinn House, also referred to as Pine Gables, is a frame one and one-half story residential structure that sits on the edge of the Downtown Evanston Historic District. Constructed in 1883 for A.V. (Anthony) Quinn, it is one of the older and larger Victorian homes in Evanston. Quinn was a nineteenth century entrepreneur who first came west for the California gold rush. He moved east with the building of the Central Pacific Railroad and finally settled in Evanston in the 1870s. He opened the town's first bank, became a prosperous merchant, acquired extensive land holdings and participated in territorial politics. His wife, Mattie, was involved with the Women's Temperance Movement and the University of Wyoming Board of Trustees. The Quinn House embodies characteristics of traditional late 19th century Victorian architecture as constructed in small western town. The house is a fine example of architectural trends of the merchant class in thriving railroad communities such as Evanston.

Wyoming State Insane Asylum

Added to the Register on February 27, 2003

Smithsonian Number 48UT266

Also known as the Wyoming State Hospital, the Wyoming State Insane Asylum encompasses 24 of the 154 current campus acres and is owned by the State of Wyoming. The district consists of fifteen contributing buildings, two noncontributing buildings and one contributing object. The buildings include the main administration building with patient dormitory wings, four separate patient dormitories, employee dormitory, staff apartment complex, three staff houses, cafeteria, two farm outbuildings, three maintenance buildings, and a noncontributing recreation center. The object is a cobble rock entrance at the main entrance to the hospital. The buildings show influences of late Victorian, and/or late Nineteenth and early Twentieth Century Revival styles. The farm outbuildings and utilitarian buildings are vernacular. The hospital was established in 1887. Its remaining historic resources were constructed over a course of forty years beginning with the oldest dormitory on campus dating to 1907/1908 and ending with the staff apartment complex, two staff houses, and cafeteria that all date to 1948. Cheyenne architect William Dubois is responsible for the design of six separate large dormitories dating from 1907-1935.

The Wyoming State Insane Asylum has historical significance on several counts. First, the Asylum has state significance, both as an institution for the care of the mentally ill and in the organization and architecture of its buildings because, during the period of significance, the Asylum reflected contemporary thinking about and trends in the treatment of mental illness. Second, the Asylum is significant to the State of Wyoming because, from its inception to the present, the institution has served the population of the entire state of Wyoming as its only institution for the treatment of the mentally ill. In addition, several of the contributing structures in the district were designed by distinguished Wyoming architect William Dubois. Finally, the Asylum has great significance on the local level, as it has been a dominant feature of the Evanston landscape--physically, socially, and economically--since 1887.

Brigham Young Oil Well
Added to the Register on April 25, 1985

Smithsonian Number 48UT1174

The Brigham Young Oil Well is a site that serves as a reminder of the thousands of Mormons who made the trek from the east to their new home in the Great Salt Lake Valley of Utah between 1847-1869. This oil seep was discovered by the initial party of Mormon migrants who, under the leadership of Brigham Young, reached this spot in 1847 and used the petroleum they found here to lubricate their worn-out wagons, polish gunstocks, and even heal sores on livestock. After reaching Salt Lake, a party of Mormons returned to this site to dig a well at the oil seep so that later travelers would also be able to use the oil. In addition, the well operated as a source of petroleum for the Salt Lake City community until 1869 when the newly completed Union Pacific Railroad began to bring in a higher quality oil. The Brigham Young Oil Well thus played a vital role in the Mormon migration to the West and in the early settlement of Salt Lake City.

Downtown Evanston Historic District
Added to the Register on November 25, 1983

Smithsonian Number 48UT1121

Evanston, located along the Union Pacific's tracks in southwest Wyoming, began as an ordinary nineteenth century boomtown in 1868 and eventually became the business center for southwest Wyoming. During the late nineteenth and early twentieth century until the twenties, Evanston was the major maintenance facility for the railroad between Green River, Wyoming and Ogden, Utah. The town continued to grow because coal, a necessary component for the railroad, was discovered north of Evanston in 1868. Within walking distance of the Union Pacific depot, Evanston's commercial enterprises that served local miners and railroaders grew along Front and Main Streets. The downtown became a center for commercial and governmental activities when Evanston became the county seat in 1870. Evanston's commercial area began to take on a more substantial and permanent appearance during the 1880s and 1890s as prosperous merchants constructed stores such as Ferd's Hardware and the Blyth and Fargo. Throughout the 1880s and 1890s Evanston's commercial core continued to change. Although the local coal mines for the Union Pacific began to decline after 1900, oil was soon discovered and a renewed energy boom helped to maintain Evanston's economic base.

The Federal government constructed an impressive courthouse-post office in the town. Opera, and then movie houses, located in the commercial area became a significant point for the downtown. In 1915 the town of Evanston constructed a large city hall on the edge of the commercial area. Within Evanston's compact downtown, the town hall, post office, library, and county courthouse were all located within a three block area. Agricultural, railroad, timber and energy interests helped the commercial area maintain its continued growth from 1900 to 1930. Yet, national and local economic factors brought a halt to Evanston's prosperity in the late twenties. The Union Pacific closed its maintenance facility and the worldwide depression effectively stopped Evanston's fifty years of building.

As a social, commercial and government center, downtown Evanston made significant contributions to the development of southwest Wyoming. The fine commercial and governmental structures within the district embody distinctive characteristics that are typical of a successful downtown area constructed between 1880 and 1930. The district retains many visual reminders of the town's early growth. Many buildings still have original iron fronts; others have modern facades, while the original buildings remain intact behind these coverings.

St. Paul's Episcopal Church

Added to the Register on November 17, 1980

Smithsonian Number 48UT245

St. Paul's Episcopal Church is a picturesque example of the Carpenter Gothic style as it was expressed by protestant communities throughout rural Wyoming. Constructed in 1884-1885, it features the basic floor plan of 19th century parish churches with standard Gothic treatments such as gabled roof, lancet windows of stained glass and tracery bargeboards in the gable. The bell tower is situated atop the intersecting gables of the narthex and features an octagonal witches cap with rectangular window louvers at its base.

In the mid 19th century many American church architects were strongly influenced by a group of English Ecclesiologists who actively promoted the construction of Gothic parish churches as the only suitable structure for Christian worship. This influence was enhanced by an increasing demand by designers and parishioners alike that church buildings reflect their use. Innovative Americans adapted the best of the sanctioned English styles to the needs and capabilities of their own religious communities; an architectural principle that is to be considered one of the Gothic revivals most lasting contributions to the development of a new aesthetic in American architecture.

St. Paul's is exemplary of that new aesthetic. It is a religious property deriving its primary significance from architectural distinction because it embodies the distinctive characteristics of a type, period and method of construction prevalent in small frontier communities of the late 19th century. St. Paul's is also important because it was the only Episcopalian church in the county, and the only Protestant church in the community.

Uinta County Courthouse

Added to the Register on July 14, 1977

Smithsonian Number 48UT208

The Uinta County Courthouse is actually the result of three stages of development. The first is the 1873 jail, a two-story brick structure built in the center of the town square. It was not intended to be freestanding for any length of time and was a simple structure devoid of ornamentation. The second part of the courthouse was built onto the jail in 1874. In 1910, a two-story brick addition was constructed at the front, or west end, of the courthouse. It changed the scale and character of the courthouse from that of a relatively simple, territorial building to a more pretentious, more national building. The addition is essentially Georgian Revival style.

The significance of the Uinta County Courthouse is based not only upon its architecture, but also upon its age and its place in the history of Uinta County. Uinta County is one of the oldest counties in Wyoming. It was the first new county created by Wyoming laws, established by the First Wyoming Territorial Legislature on December 1, 1869, and organized on April 7, 1870. In 1873, Governor John A. Campbell, Wyoming's first Territorial Governor, approved an act of the legislature authorizing the commissioners of Uinta County to erect a jail and courthouse to cost not more than $25,000. The jail portion of the courthouse was to be built first while the courthouse proper was to be completed by the following year. In 1887 a new jail was built and the jail portion of the courthouse was converted into office space and a storage area. The Uinta County Courthouse is the oldest courthouse building in the state of Wyoming.

Union Pacific Railroad Complex
Added to the Register on February 26, 1985

Smithsonian Number 48UT971

The main Union Pacific tracks, as well as numerous spurs, bisect the railroad complex in Evanston, Wyoming. The complex contains frame and brick industrial buildings located in their original surroundings on the northeast side of Evanston. Most of the brick buildings were constructed in 1912-1913 while the frame structures date from the late nineteenth century to the 1920s. The construction materials and architectural designs act as unifying elements within the Union Pacific industrial yard. Today the names of the architects and builders remain unknown, yet each building represents typical construction techniques and designs for industrial buildings such as the roundhouse.

Construction on the Union Pacific Railroad began in 1863. On November 23, 1868, Harvey Booth erected a tent on what is known as Front Street in Evanston, Wyoming. There he opened a restaurant and saloon in anticipation of the arrival of the Union Pacific Railway. The first cars reached Evanston in December, 1868 and, in the space of a few weeks, nearly 600 people, some living in tents, populated the area. Then came an order from the railway managers to move the end of the line and the base of supplies to Wasatch, twelve miles further west. The shanties and tents were torn down and within 24 hours, most of the citizens of Evanston picked up and moved to Wasatch. Within three days, the town was entirely depopulated. Evanston appeared to be destined to suffer the same fate of other "end of the tracks" towns.

The following June, however, the headquarters moved back to Evanston and the town began to grow. The Union Pacific Railway provided a dependable economic base for the resident population, and the opening of the coal mines near Evanston at Almy provided also a source of regular income for workers. The Union Pacific roundhouse and shop complex was completed on July 4, 1871. With the completion, Evanston became the major maintenance facility for the U.P. Division between Green River, Wyoming and Ogden, Utah. In 1912-1913 new, larger facilities were built. A new roundhouse was erected, consisting of 27 stalls, each 100 feet deep, along with a steam heating plant, electric lights, and a new turntable.

The development of diesel engines made the Evanston facility obsolete, and the roundhouse and shops were closed. Union Pacific maintenance crews were transferred to Green River. In 1927, the Union Pacific Reclamation Plant opened at the Evanston complex. There, rolling stock was repaired and refurbished. This plant employed over 300 men, making it Evanston's largest employer. In 1971, modern production methods and lower prices for new equipment caused the final closure of the roundhouse as a Union Pacific facility.

In 1974, the railroad deeded the land and facilities to the City of Evanston; local businessmen formed a corporation to develop the area. The same year, the plant was leased by the Wyoming Railway Car Corporation, for the purpose of preventive maintenance, painting, sandblasting, and designing of railroad cars. More than seventeen railway companies sent cars to Evanston for repairs. In 1979, the Lithcote Company purchased Wyoming Railway Car Corporation.

The Union Pacific Railroad saved Evanston from becoming another "end of the tracks" town. The remaining roundhouse and associated structures serve as a visible reminder of the important role played by the railway in the growth and development of Evanston.

Evanston Main Post Office
Added to the Register on May 19, 1987

Smithsonian Number 48UT246

This thematic study includes twelve post offices owned and administered by the U.S. Postal Service (USPS) throughout the State of Wyoming. These include the Basin, Greybull, Douglas, Lander, Torrington, Thermopolis, Buffalo, Kemmerer, Powell, Yellowstone, Evanston, and Newcastle Main Post Offices. The buildings represent a continuum of federally constructed post offices allocated to the state between the turn of the century and 1941. The buildings exhibit a variety of styles and sizes but maintain a common demeanor representative of the federal presence. All of the buildings were constructed from standardized plans developed from guidelines provided by the Office of the Supervising Architect in the Treasury Department. Variations in design styles reflect both the transition in the design philosophies of the Supervising Architect and the requirements developed in response to the Depression. These variations in design, as well as functions are also somewhat related to the communities in which they were placed and reflect the economic, political, and governmental context of those communities.

3.4 NATURAL ENVIRONMENT

3.4.1 CLIMATE

The climate in the Bear River Watershed study area is varied based on the diverse topography and elevation. Elevations range from 6,000 feet in the downstream portion of the study area to 12,712 feet at Yard Peak in the Uinta Mountains. Climate classification ranges from alpine to semiarid. Within the watershed, 6 weather stations are maintained through cooperative agreements with the National Weather Service (NWS) and 3 SNOTEL sites are maintained in the watershed by the Natural Resources Conservation Service (NRCS).

National Weather Stations	SNOTEL Sites
Evanston (Uinta Co)	Cottonwood Creek (Lincoln Co)
Woodruff (near Uinta Co)	Lily Lake (Summit Co UT)
Sage 4 NNW (Lincoln Co)	Hayden Fork (Summit Co UT)
Border 3 N (Lincoln Co)	
Randolph (near Lincoln Co)	
Uintalands (Uinta Co)	

The locations of the 6 NWS weather stations along with average annual precipitation data between 1981 and 2010 are depicted in Figure 3.4.1. Data used to generate this figure were obtained from the PRISM Climate Group at Oregon State University using the Parameter-elevation Regressions on Independent Slopes Model (PRISM) climate mapping system. Lower elevations along the main-stem of the Bear River receive 9 to 12 inches of precipitation per year. Annual precipitation increases with elevation averaging up to 45 inches per year in the highest regions of the watershed.

Data recorded at NWS stations were obtained from the Western Regional Climate Center and the NRCS. Table 3.4.1-1 provides a summary of temperature and precipitation data collected at the 6 NWS weather stations, and Table 3.4.1-2 provides a summary of precipitation data collected at the 3 SNOTEL stations.

Table 3.4.1-1 Summary of temperature and precipitation climate data from NWS Stations.

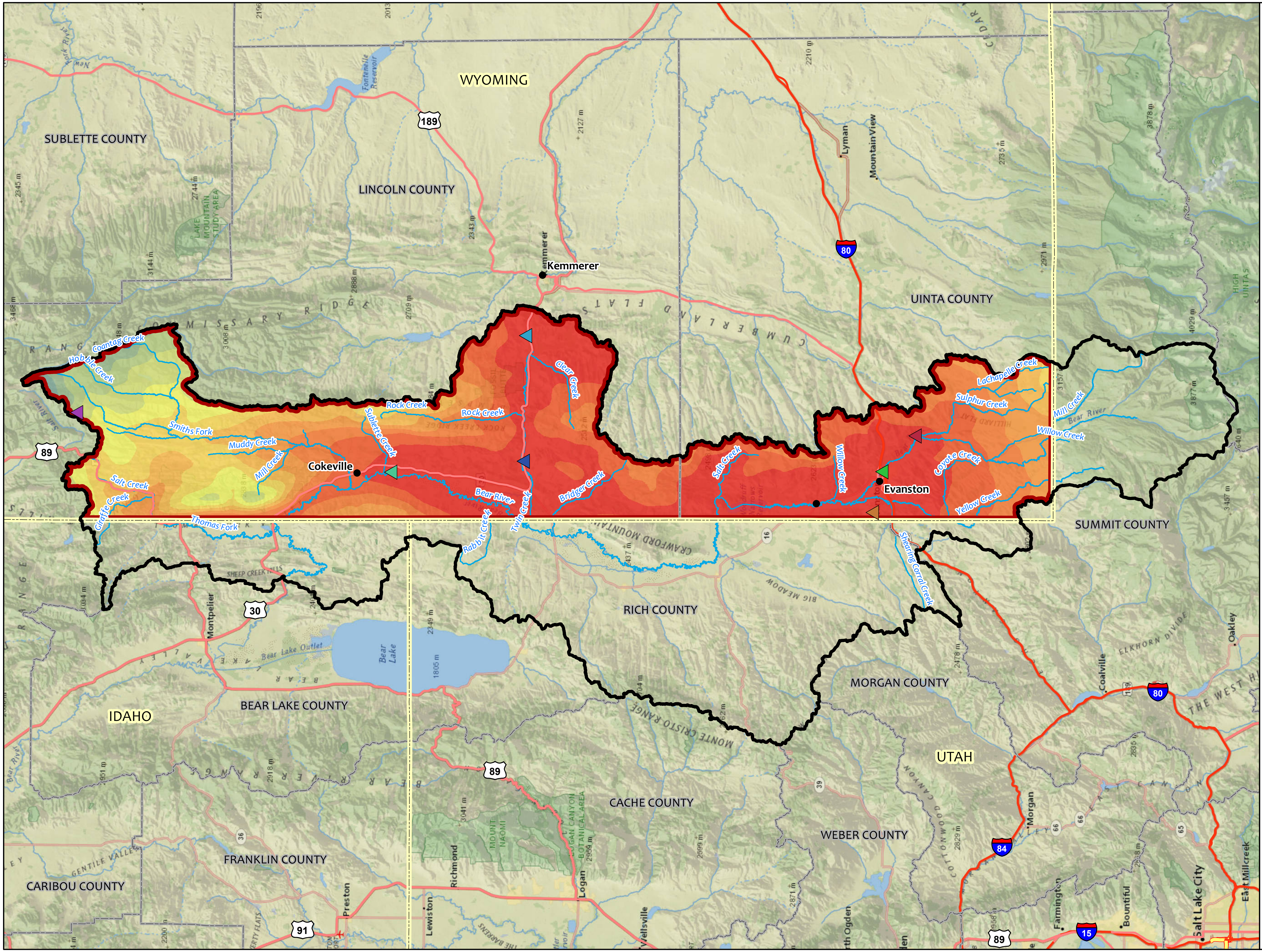
Station:(483100) Evanston; Period of Record: 1890-2014													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	31.2	33.8	40.9	52	62.4	72.2	81.1	79.5	70.7	58.1	42.9	33.1	54.8
Average Low Temperature °F	7.6	9.9	16.7	25.3	32.4	38.7	44.8	43.4	35.1	26.9	17.0	9.2	25.6
Mean Temperature °F	19.4	21.9	28.8	38.7	47.4	62.9	63.0	61.5	52.9	42.5	30.0	21.2	40.2
Mean Precipitation inches	0.85	0.86	1.03	1.19	1.38	1.07	0.84	0.99	1.01	1.13	0.88	0.78	12.01
Station:(429595) Woodruff; Period of Record: 1897-2014													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	28.6	32	41.5	53.7	63.9	72.8	81.8	80.4	72.0	59.9	42.8	31.0	55.0
Average Low Temperature °F	2.0	5.5	15.6	24.6	31.5	38.3	43.2	40.8	32.0	42.3	13.9	5.1	23.0
Mean Temperature °F	15.3	18.8	28.6	39.2	47.7	55.6	62.5	60.6	52.0	51.1	28.4	18.1	39.0
Mean Precipitation inches	0.49	0.55	0.68	0.85	1.11	1.04	0.69	0.84	0.96	1.01	0.62	0.59	9.43
Station:(487955) Sage 4 NNW; Period of Record: 1923-2001													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	27.9	32.3	41.4	54.3	64.8	74.6	83.9	82.0	72.5	60.0	42.0	30.2	55.5
Average Low Temperature °F	-1.3	2.6	13.8	23.5	30.7	36.8	41.9	39.1	30.5	21.2	11.6	1.4	21.0
Mean Temperature °F	13.3	17.5	27.6	38.9	47.8	55.7	62.9	60.6	51.5	40.6	26.8	15.8	38.3
Mean Precipitation inches	0.65	0.57	0.61	0.94	1.18	1.08	0.73	0.83	1.02	0.87	0.66	0.54	9.69

Station:(480915) Border 3N; Period of Record: 1902-1993													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	25	29.7	38.9	52.6	64.3	73.5	83.1	81.8	72.5	59.8	41.6	28.0	54.3
Average Low Temperature °F	-0.8	2.3	11.6	24.0	32.1	39.1	43.0	40.2	31.9	23.7	14.2	2.8	21.9
Mean Temperature °F	12.1	16	25.3	38.3	48.2	56.3	63.1	61.0	52.2	41.8	27.9	15.4	38.1
Mean Precipitation inches	1.26	1.13	1.06	1.16	1.4	1.22	0.81	0.9	1.23	1.22	1.07	1.09	13.53
Station:(427165) Randolph; Period of Record: 1893-2015													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	27.7	30.7	41.3	52.9	62.9	73.2	82.0	80.4	70.2	58.0	41.0	28.2	54.0
Average Low Temperature °F	2.0	3.8	14.5	23.4	30.4	37.4	43.1	40.6	31.6	22.6	13.5	31.1	22.2
Mean Temperature °F		17.3	27.9	38.2	46.7	55.3	62.6	60.5	50.9	40.3	27.3	29.7	38.1
Mean Precipitation inches	0.88	0.84	0.82	1.16	1.43	0.94	0.96	1.18	1.33	1.14	0.86	0.84	12.38
Station:(428900) Uintalands; Period of Record: 1977-1989													
Monthly Averages and Means	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average High Temperature °F	32.7	34.5	38.7	46.7	55.7	67.7	73.9	73.1	63.9	52.7	38.0	33.5	50.9
Average Low Temperature °F	6.6	7.9	13.5	20.7	28.5	36.0	41.8	40.9	33.6	25.0	13.6	7.8	23.0
Mean Temperature °F	19.7	21.2	26.1	33.7	42.1	51.9	57.9	57.0	48.8	38.9	25.8	20.7	37.0
Mean Precipitation inches	1.49	1.72	2.8	2.44	2.39	1.19	1.42	1.79	1.8	1.99	2.24	1.58	22.86

Table 3.4.1-2 Precipitation data collected at Bear River Watershed SNOTEL Sites.

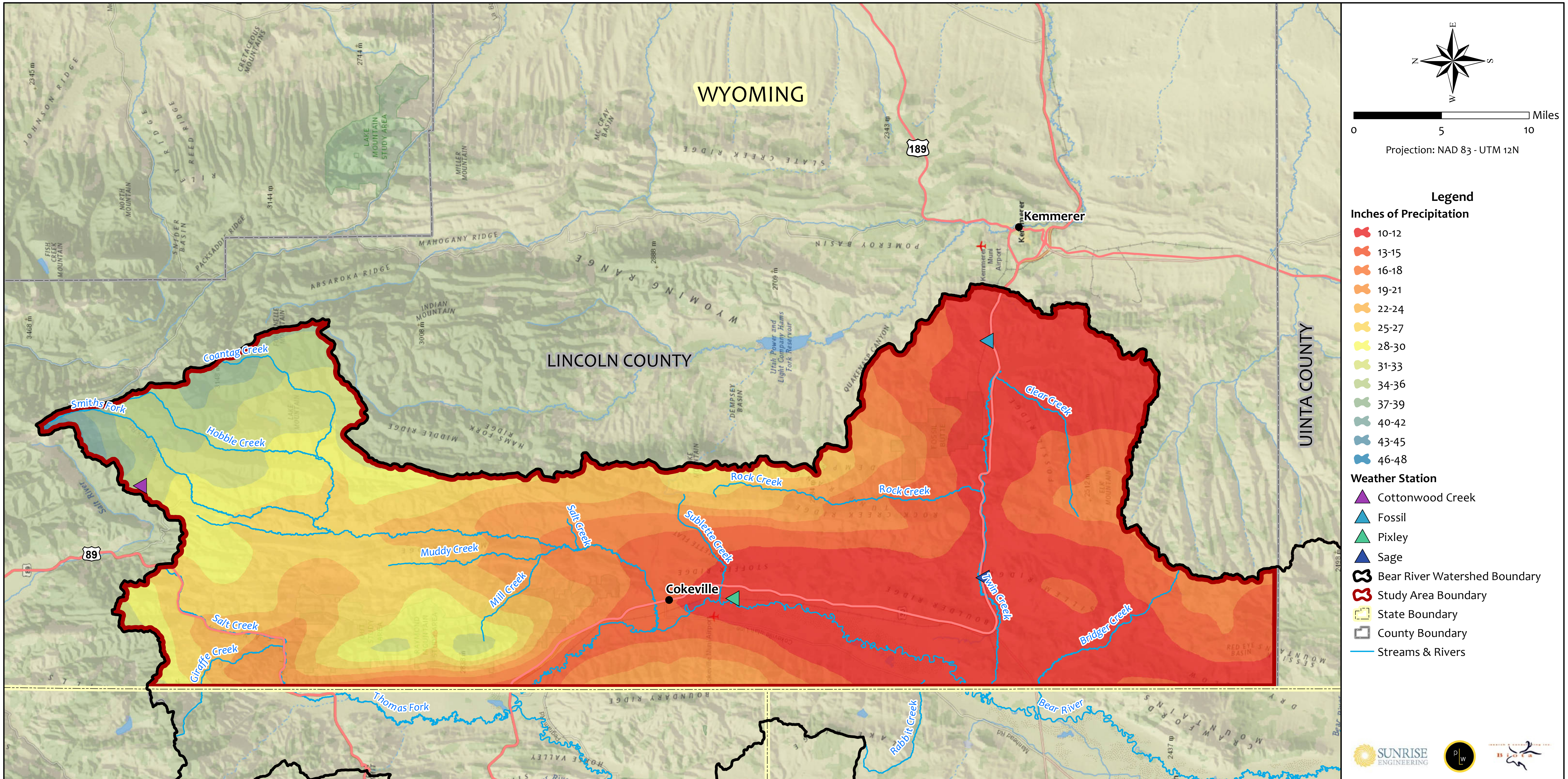
Median Snow Water Equivalent (1981-2010)													
Cottonwood Creek	**Oc**	**No**	**De**	**Jan**	**Feb**	**Ma**	**Apr**	**Ma**	**Jun**	**Jul**	**Aug**	**Sep**	**Total**
Average End of Month Snow Water	0.0	0.9	4.4	8.5	12.9	16.9	21.2	15.3	0.0	0.0	0.0	0.0	
Average Cumulative Precipitation (in)	0.0	2.7	9.6	20.8	36.7	56.3	80.0	135	166.4	200.4	235.7	272.5	
Average Total Monthly Precipitation (in)	0.0	2.7	6.9	11.2	15.9	19.6	23.7	27.5	31.4	34	35.3	36.8	272.5
Lily Lake (579)	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Totals**
Average End of Month Snow Water	0.0	0.7	2.9	5.2	7.4	10.3	12.1	9.9	0.0	0.0	0.0	0.0	
Average Cumulative Precipitation (in)	0.0	2.6	8.1	16.1	26.8	40	56.3	75.8	98.1	122.3	147.9	175.2	
Average Total Monthly Precipitation (in)	0.0	2.6	5.5	8	10.7	13.2	16.3	19.5	22.3	24.2	25.6	27.3	175.2
Hayden Fork (517)	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Totals**
Average End of Month Snow Water	0.0	0.3	5.9	8.6	12.1	15.1	9.3	0.0	0.0	0.0	0.0	0.0	
Average Cumulative Precipitation (in)	0.0	2.7	9	18.6	31.7	48.1	68.2	92	118.8	147.4	177.6	209.5	
Average Total Monthly Precipitation (in)	0.0	2.7	6.3	9.6	13.1	16.4	20.1	23.8	26.8	28.6	30.2	31.9	209.5

Average high and low temperatures for the period of record of the 6 NWS stations are depicted in Figures 3.4.1-1 through 3.4.1-6. Figure 3.4.1-7 shows the annual precipitation and Figure 3.4.1-8 depicts the total monthly precipitation for each weather station for their entire respective period of record.



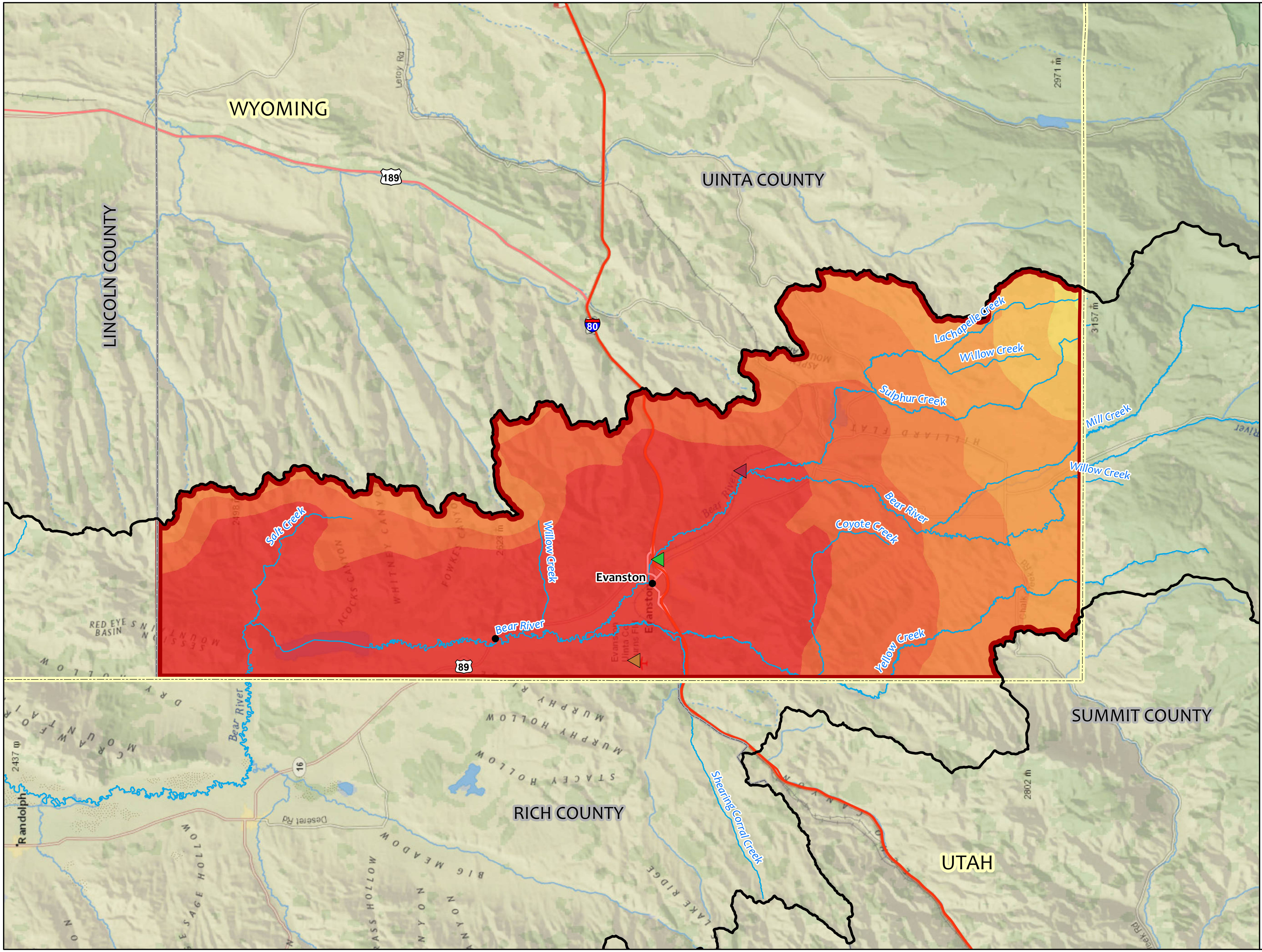
Bear River Watershed

Figure 3.4.1
Average Annual
Precipitation 1981-2010
NWS Weather Stations



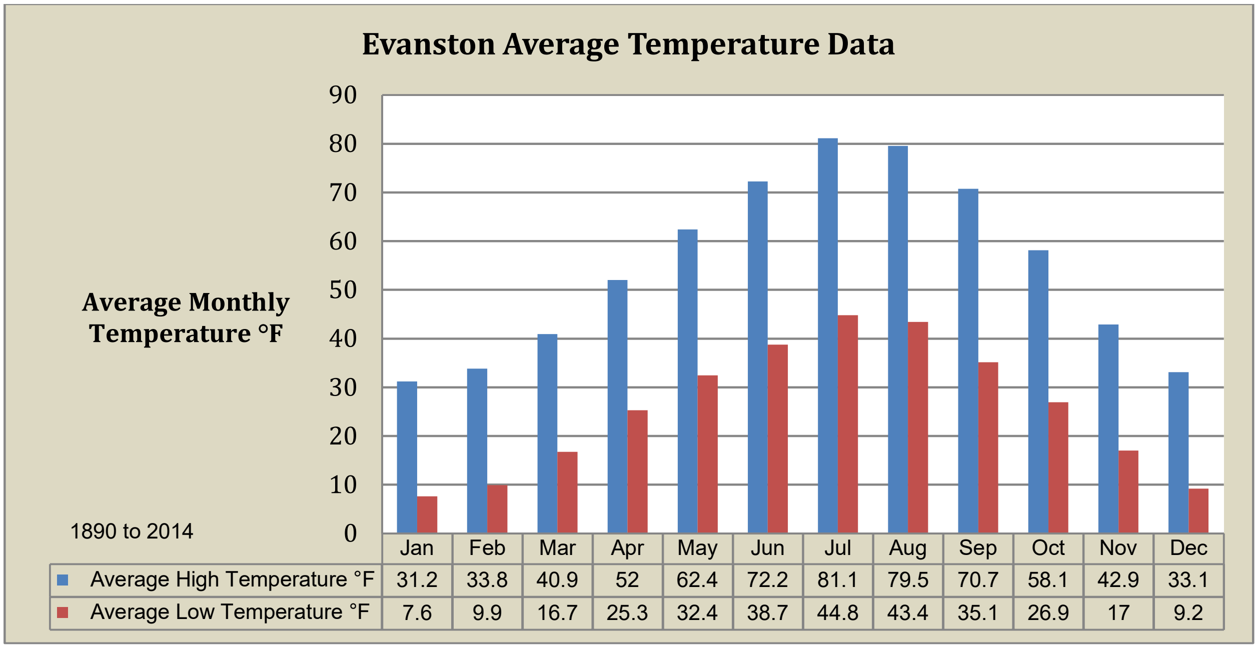
Bear River Watershed
Lincoln County

Figure 3.4.4.1
Average Annual
Precipitation 1981-2010
NWS Weather Stations



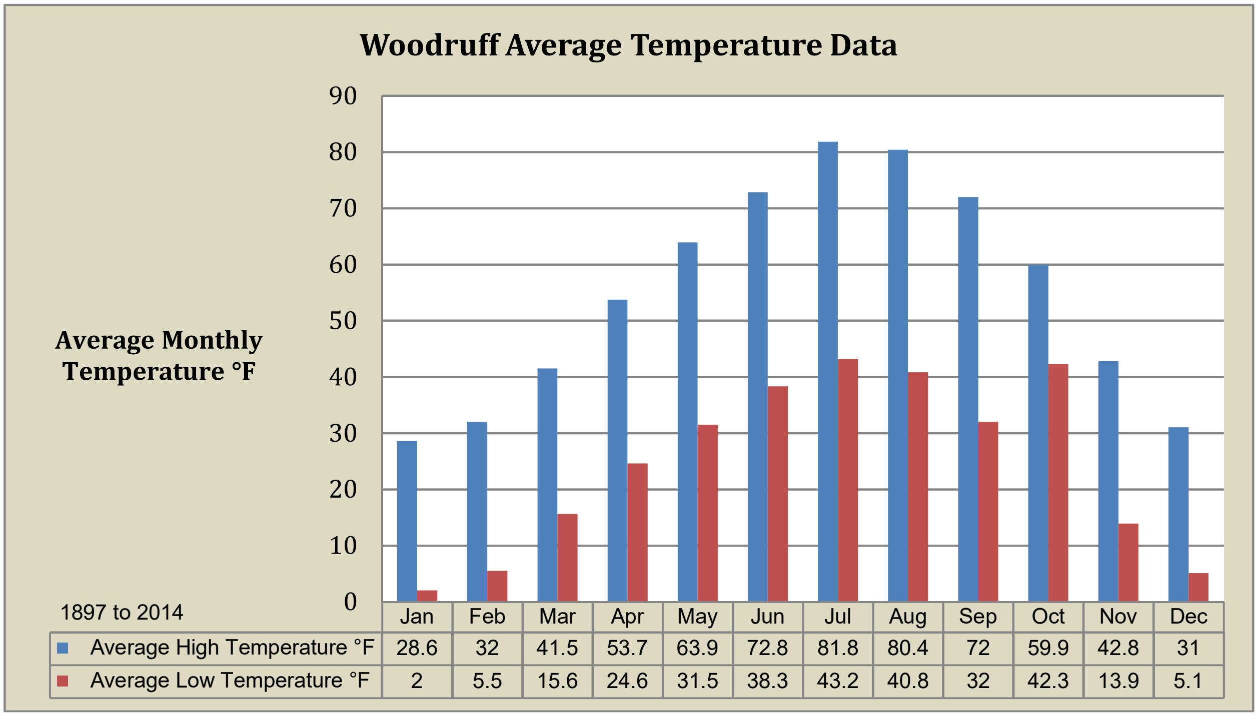
Bear River Watershed
Uinta County

Figure 3.4.1
Average Annual
Precipitation 1981-2010
NWS Weather Stations



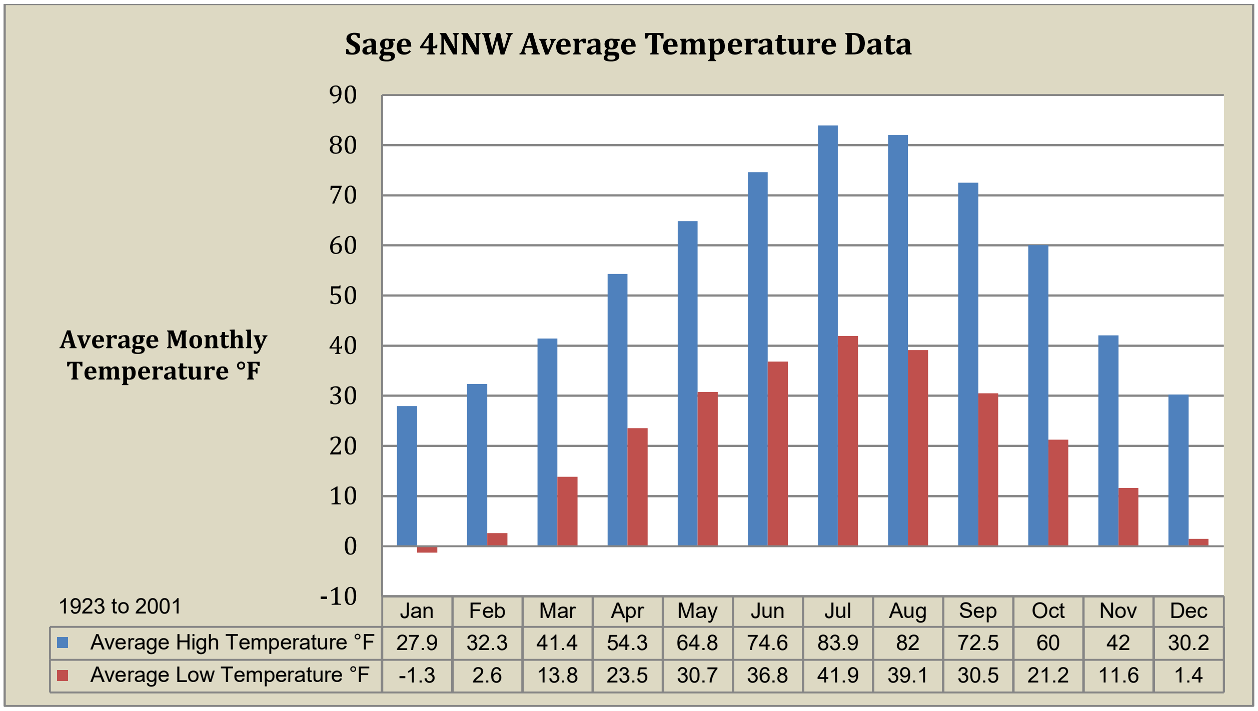
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	31.2	33.8	40.9	52	62.4	72.2	81.1	79.5	70.7	58.1	42.9	33.1
🟥 Average Low Temperature °F	7.6	9.9	16.7	25.3	32.4	38.7	44.8	43.4	35.1	26.9	17	9.2

Figure 3.4.1-1. Average high and low temperatures for the Evanston weather station, Bear River Watershed.



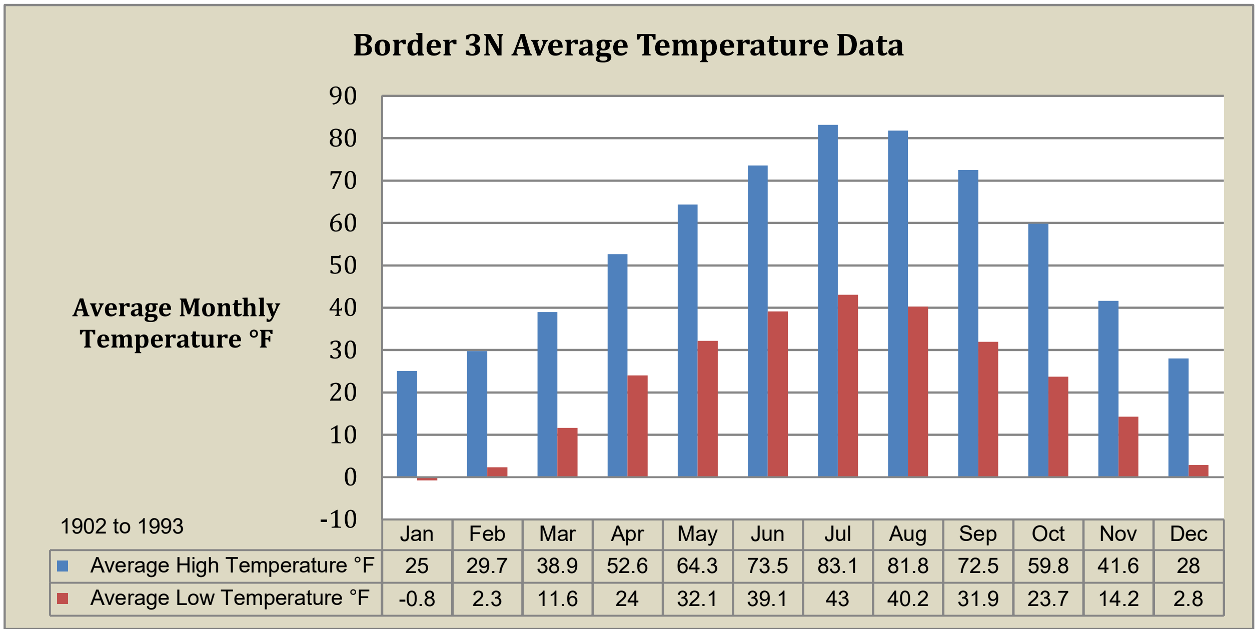
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	28.6	32	41.5	53.7	63.9	72.8	81.8	80.4	72	59.9	42.8	31
🟥 Average Low Temperature °F	2	5.5	15.6	24.6	31.5	38.3	43.2	40.8	32	42.3	13.9	5.1

Figure 3.4.1-2. Average high and low temperatures for the Woodruff weather station, Bear River Watershed.



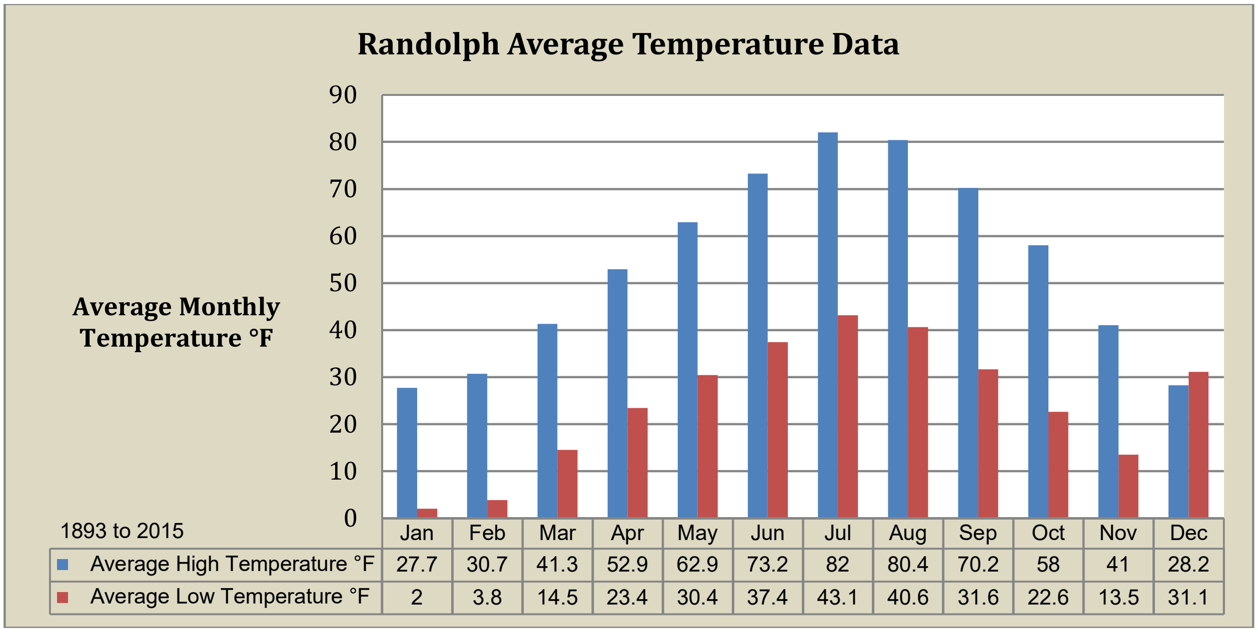
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	27.9	32.3	41.4	54.3	64.8	74.6	83.9	82	72.5	60	42	30.2
🟥 Average Low Temperature °F	-1.3	2.6	13.8	23.5	30.7	36.8	41.9	39.1	30.5	21.2	11.6	1.4

Figure 3.4.1-3. Average high and low temperatures for the Sage 4NNW weather station, Bear River Watershed.



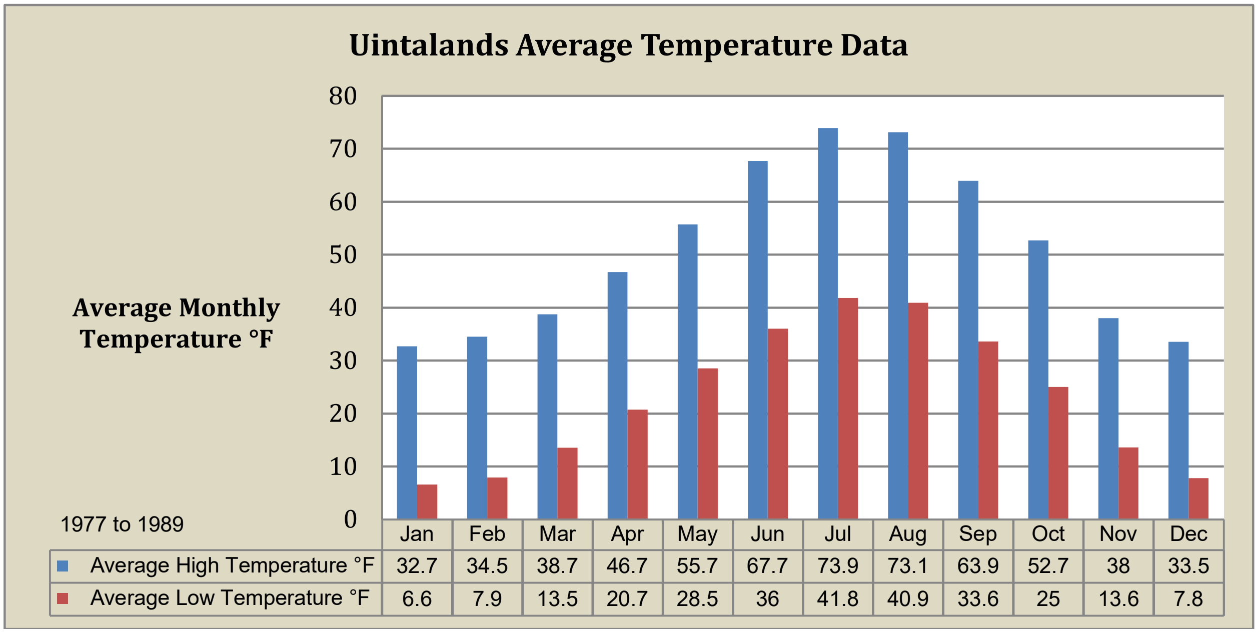
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	25	29.7	38.9	52.6	64.3	73.5	83.1	81.8	72.5	59.8	41.6	28
🟥 Average Low Temperature °F	-0.8	2.3	11.6	24	32.1	39.1	43	40.2	31.9	23.7	14.2	2.8

Figure 3.4.1-4. Average high and low temperatures for the Border 3N weather station, Bear River Watershed.



1893 to 2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	27.7	30.7	41.3	52.9	62.9	73.2	82	80.4	70.2	58	41	28.2
🟥 Average Low Temperature °F	2	3.8	14.5	23.4	30.4	37.4	43.1	40.6	31.6	22.6	13.5	31.1

Figure 3.4.1-5. Average high and low temperatures for the Randolph weather station, Bear River Watershed.



1977 to 1989	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
🟦 Average High Temperature °F	32.7	34.5	38.7	46.7	55.7	67.7	73.9	73.1	63.9	52.7	38	33.5
🟥 Average Low Temperature °F	6.6	7.9	13.5	20.7	28.5	36	41.8	40.9	33.6	25	13.6	7.8

Figure 3.4.1-6. Average high and low temperatures for the Uintalands weather station, Bear River Watershed.

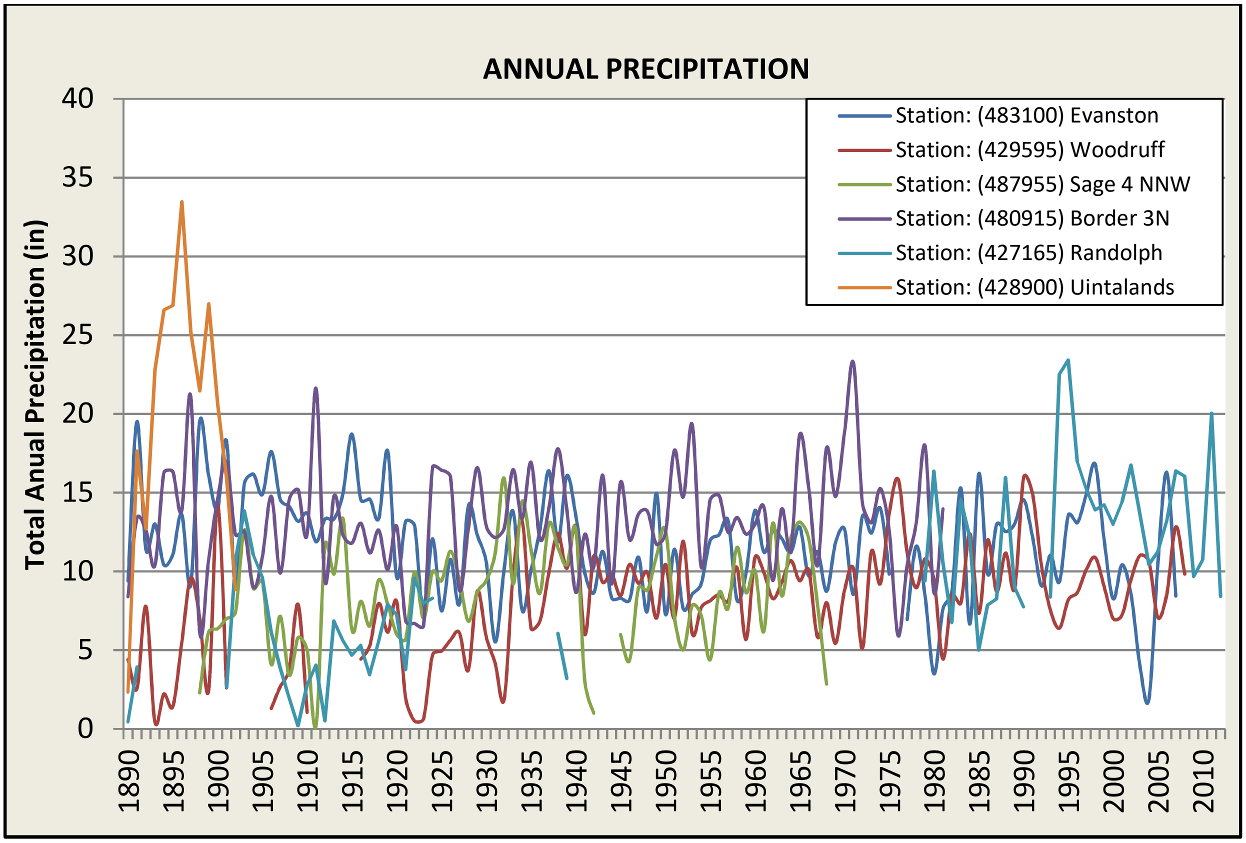
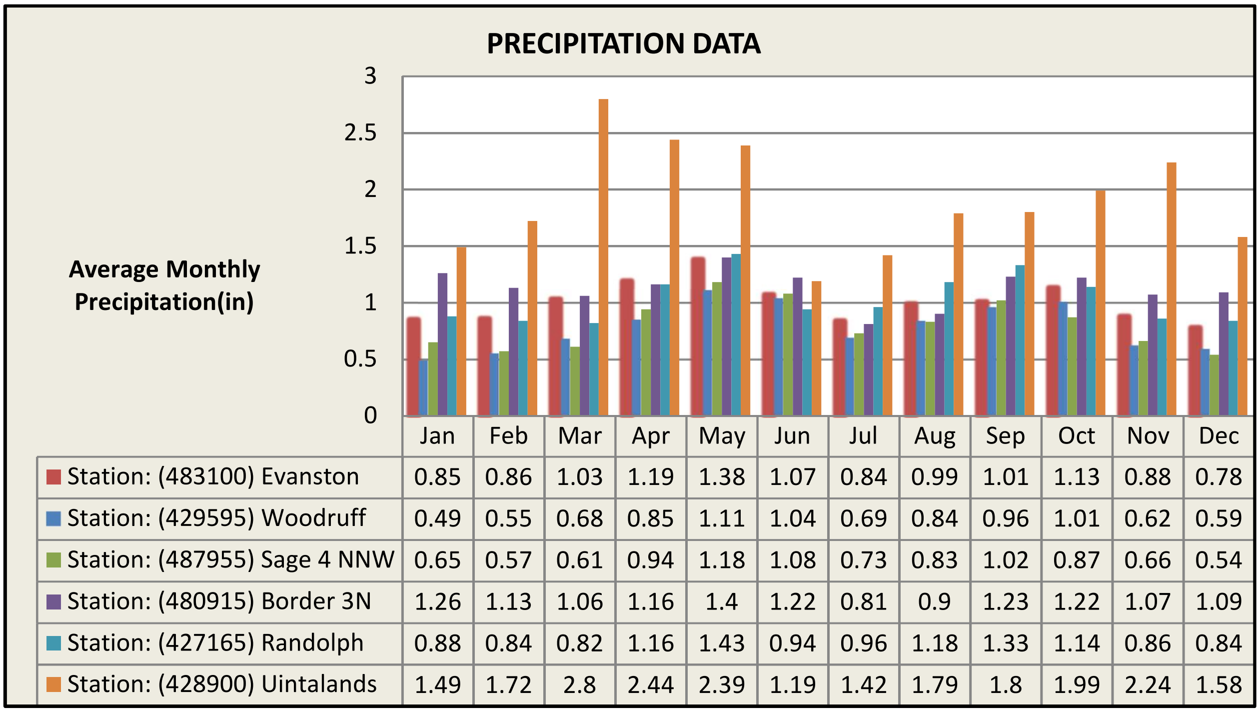


Figure 3.4.1-7. Yearly total annual precipitation for NWS weather stations within the Bear River Watershed.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Station: (483100) Evanston	0.85	0.86	1.03	1.19	1.38	1.07	0.84	0.99	1.01	1.13	0.88	0.78
Station: (429595) Woodruff	0.49	0.55	0.68	0.85	1.11	1.04	0.69	0.84	0.96	1.01	0.62	0.59
Station: (487955) Sage 4 NNW	0.65	0.57	0.61	0.94	1.18	1.08	0.73	0.83	1.02	0.87	0.66	0.54
Station: (480915) Border 3N	1.26	1.13	1.06	1.16	1.4	1.22	0.81	0.9	1.23	1.22	1.07	1.09
Station: (427165) Randolph	0.88	0.84	0.82	1.16	1.43	0.94	0.96	1.18	1.33	1.14	0.86	0.84
Station: (428900) Uintalands	1.49	1.72	2.8	2.44	2.39	1.19	1.42	1.79	1.8	1.99	2.24	1.58

Figure 3.4.1-8. Average monthly precipitation for NWS weather stations within the Bear River Watershed.

Freezes in mid spring and mid fall are common throughout the watershed. The average last occurrence of 32.5 degrees and 28.5 degrees in the spring and the average first occurrence of 32.5 degrees and 28.5 degrees in the fall along with the average length of the 32.5 degrees and 28.5 degrees growing season at each weather station is shown in Table 3.4.1-3.

Table 3.4.1-3. Comparison of early and late freezes and general growing season derived from NWS Weather Stations within the Bear River Watershed.

Weather Station	**Avg. Last Spring Occurrence of 32.5° F**	**Avg. 1st Fall Occurrence of 32.5° F**	**Avg. # Days > 32.5° F**	**Avg. Last Spring Occurrence of 28.5° F**	**Avg. Last Fall Occurrence of 28.5° F**	**Avg. # Days > 28.5° F**
Evanston	Jun-26	Aug-31	62	Jun-7	Sept-12	95
Woodruff	Jun-27	Aug-24	59	Jun-3	Sept-5	93
Sage	Jul-11	Aug-9	34	Jun-20	Aug-31	70
Border	Jul-1	Aug-19	44	Jun-13	Sept-3	84
Randolph	Jun-26	Aug-24	58	Jun-11	Sept-2	86
Uintalands	Jul-6	Sept-1	54	Jun-19	Sept-11	85

Data Provided By the Western Regional Climate Center

3.4.2 REGIONAL GEOLOGY

The Bear River watershed is located within the Middle Rocky Mountain Physiographic Province. The province is characterized by rugged mountains (Hunt, 1967). The portion of the watershed within the state of Wyoming is located within a series of generally north-south oriented mountain ranges referred to as the thrust belt. These mountains generally consist of faulted and tightly folded Paleozoic-age (540 to 252 million years old) and Mesozoic-age (252 to 66 million years old) sedimentary rocks. Along some of these ranges older formations have been thrust eastward onto younger formations. The southern portion of the watershed, mostly located within Utah, is located on the north flank of the Uinta Mountains. The Uinta Mountains are an east-west oriented anticlinal uplift with a Precambrian-age (greater than 540 million years old) core of sedimentary rocks.

3.4.2.1 STRUCTURAL GEOLOGY

Numerous faults and folds within the Bear River watershed are evidence of severe tectonic deformation. The locations of faults and fold axis mapped by the U.S. Geological Survey (USGS) (Bryant, 1992; Dover, 1995; Dover and M'Gonigle, 1993; Love and Christiansen, 1985; M'Gonigle and Dover, 1992; Oriel and Platt, 1980; and Rubey, Oriel, and Tracey, 1980) are shown in Appendix E, Figure 3.4.2.5.

Three distinct structural provinces exist within the watershed: the portion of the watershed north of Sage, Wyoming; the portion of the watershed between Sage and the Uinta Mountains in Utah; and the north slope of the Uinta Mountains. The province north of Sage Wyoming is characterized by generally north-south trending regional thrust faults, anticlines and synclines. Movement on the thrust faults was in an easterly direction. The province between Sage and the Uinta Mountains is characterized by generally north-south trending regional thrust and high angle faults with randomly oriented local high angle faults between the regional faults. High angle faults have generally not been categorized as normal or reverse faults. The north slopes of the Uinta Mountains province is characterized by east west trending thrust and high angle faults.

3.4.2.2 SURFICIAL MATERIALS

Surficial materials identified by the USGS (Reheis, 2005) within the Bear River watershed are shown on Figure 3.4.2.2. The map by Reheis was compared to other published surficial mapping within the watershed (Gibbons, 1986a and Gibbons, 1986b) and we identified some discrepancies. We selected to present only the map by Reheis, because it was the most recently published and it was created by compiling and comparing data from maps by Gibbons and other maps and aerial photography.

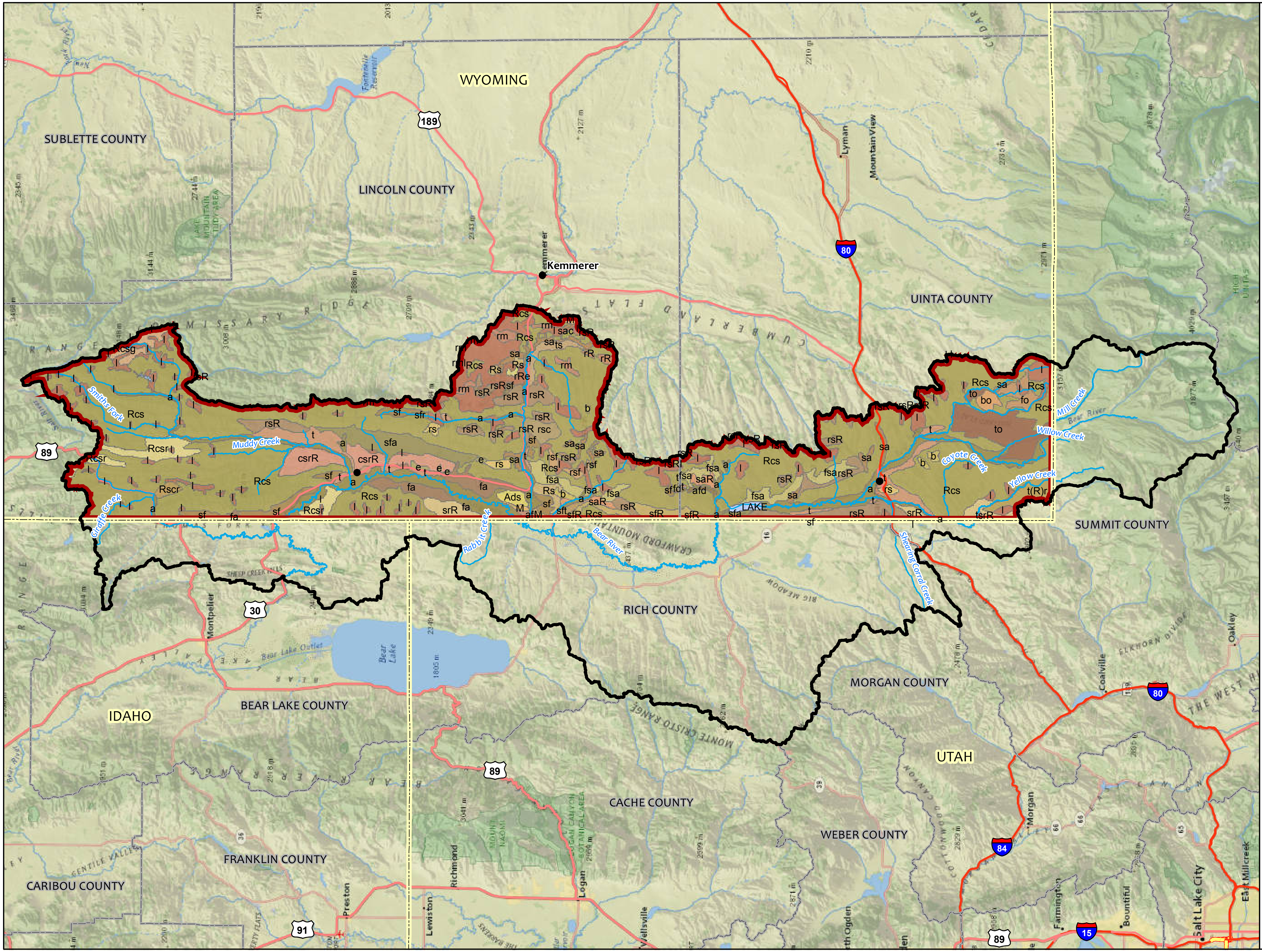
Surficial materials within the watershed are generally confined to valley bottoms and slopes and bedrock is generally at the ground surface in most upland areas. Surficial materials present within the watershed include:

- Artificial fill
- Alluvium, including channel and floodplain deposits
- Terrace deposits
- Alluvial fans
- Eolian deposits
- Landslide deposits
- Talus deposits
- Pediment deposits
- Glacial deposits

Many areas were mapped as consisting of a mixture of two or more surficial materials. General surficial materials are described below.

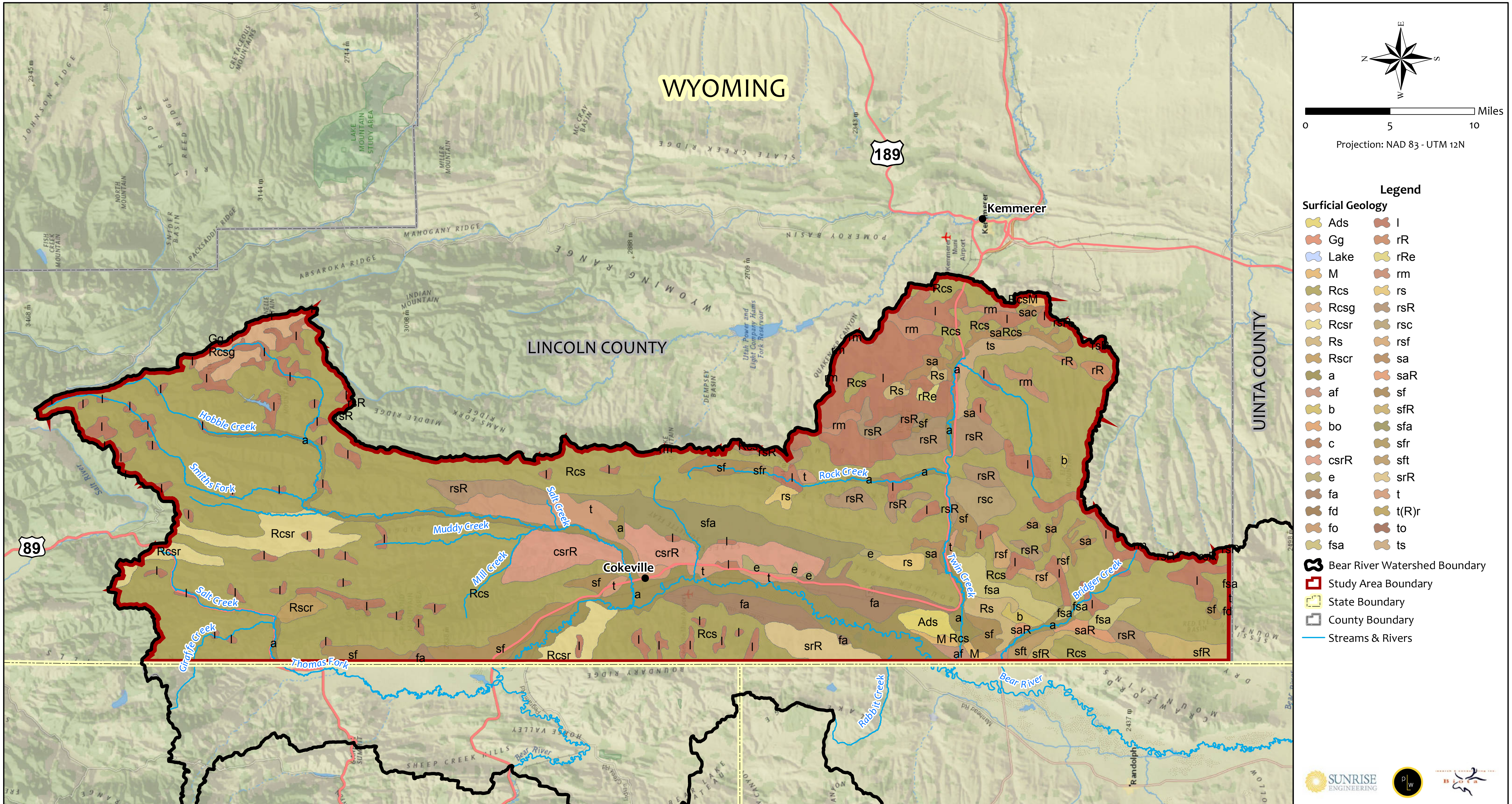
Artificial fill was placed by human activities during historic times and includes highway and railroad embankments, mine waste, and canal lining.

Alluvial materials within the watershed include channel and floodplain deposits, alluvium, terrace deposits, alluvial fan deposits and pediment deposits. These materials were transported and deposited by streams or rivers. Channel deposits, floodplain deposits, and alluvium are the most recent type of alluvial deposits and consists of clay, silt, sand, or gravel within the active channel



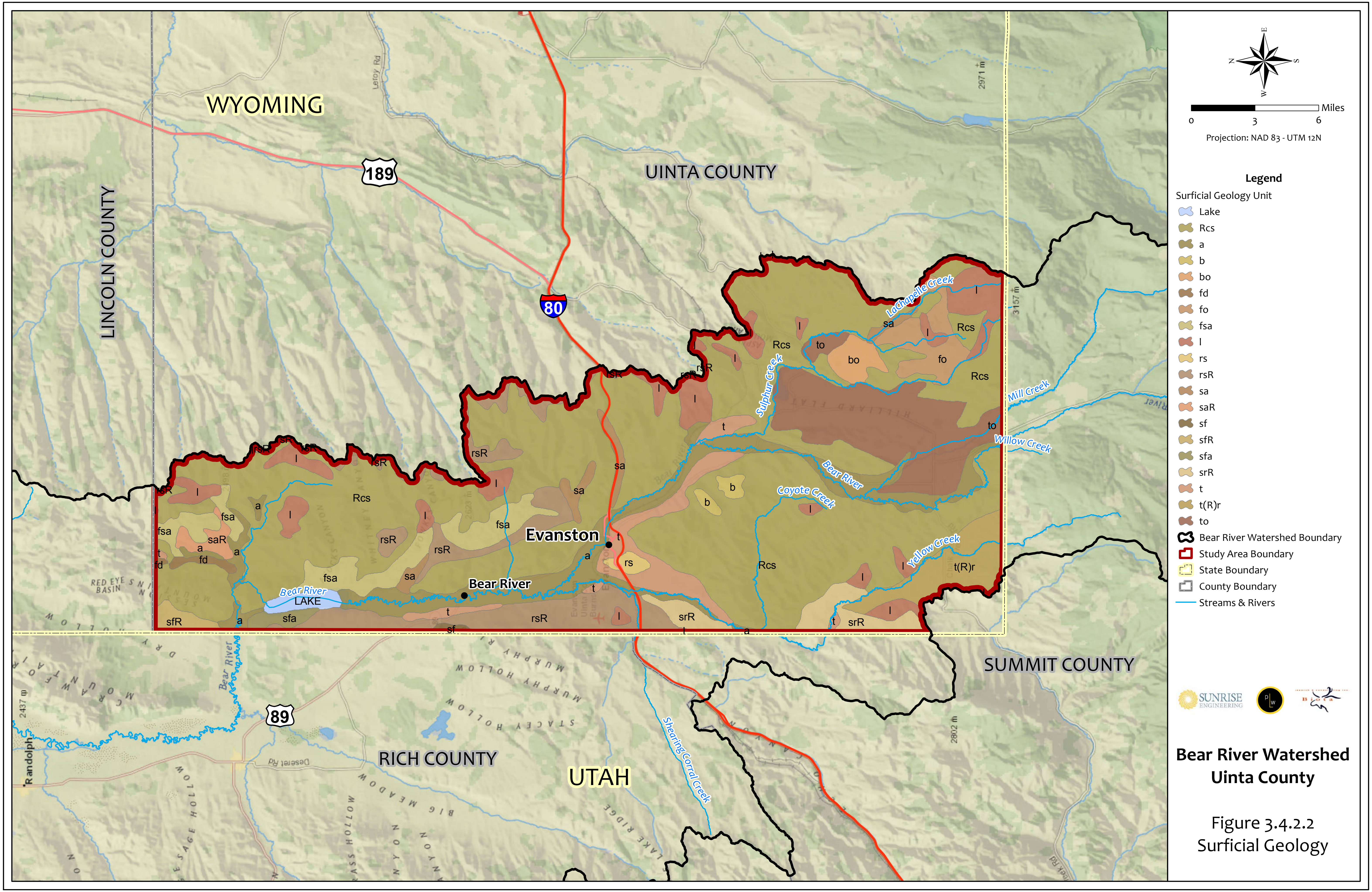
Bear River Watershed

Figure 3.4.2.2
Surficial Geology



Bear River Watershed
Lincoln County

Figure 3.4.2.2
Surficial Geology



Bear River Watershed
Uinta County

Figure 3.4.2.2
Surficial Geology

or meander belt of streams and rivers. Terrace deposits consist of older alluvial deposits that were located adjacent to streams or rivers at elevations higher than the current floodplain. Alluvial fan deposits were gently sloping deposits located at the mouths of narrow canyons. Pediment deposits are gently sloping eroded bedrock surfaces at the base of an escarpment (mountain front) that has a relatively thin deposit of gravel and finer sediment.

Eolian deposits are materials transported by wind and include well sorted sand and silt. Eolian deposits are up to 30 feet thick on the low hills east of the Bear River, south of Cokeville, Wyoming.

Talus deposits and landslide deposits within the watershed were transported primarily by gravity. Talus deposits consist of angular to sub-angular blocks of rock of varying sizes and varying amounts of clay, silt, and sand that accumulate at the base of steep, poorly vegetated slopes. Landslide deposits consist of relatively intact blocks of bedrock or surficial material that have become destabilized and have traveled downslope.

Till and glacial outwash were formed by alpine glaciation. These deposits are located at the southern extent of the watershed on the north slope of the Uinta Mountains. Till is material eroded by the ice from the underlying bedrock and deposited by the glaciers as moraines along the edges and terminus of the ice. Till typically consists of gravel to boulder sized rock fragments within a silt and sand matrix. Glacial outwash is similar to till except it was deposited by meltwater downstream of the glacier.

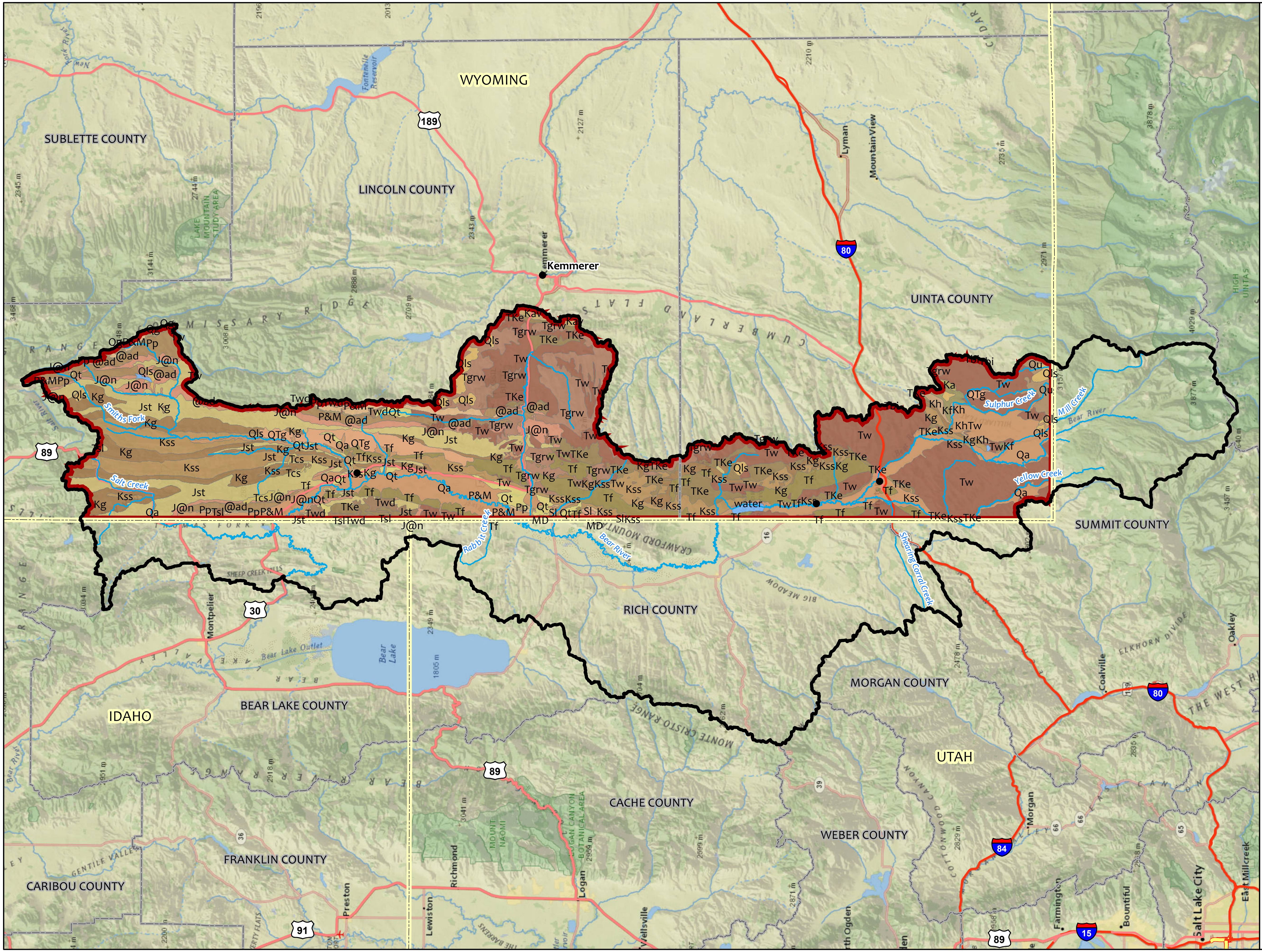
Additional surficial geology maps can be found in Appendix E in Figures 3.4.1.3 and 3.4.1.3a.

3.4.2.3 BEDROCK

Bedrock identified by the USGS (Bryant, 1992; Dover, 1995; Dover and M'Gonigle, 1993; Love and Christiansen, 1985; M'Gonigle and Dover, 1992; Oriel and Platt, 1980; and Rubey, Oriel, and Tracey, 1980) within the Bear River watershed includes rock formations ranging in age from the Middle Proterozoic Era (1,600 to 1,000 million years old) to the Miocene and Pliocene Epochs (23 to 2.6 million years old). The watershed consists of three distinct geologic provinces, as shown on Figure 3.4.2.3. Appendix E (Figures 3.4.2.3 and 3.4.2.3-P1-7) contains a more detailed view of Figure 3.4.2.3.

The province north of Sage, Wyoming consists of primarily Mesozoic age (252 to 66 million years ago) sedimentary rocks (mudstone to conglomerate and limestone). The generally north-south trending regional faults and folds result in moderately to steeply dipping bedrock. Bedrock typically dips downward to the west, but near fold axes and thrust faults, the formations may dip either east or west and may be overturned. As a result of the faults and folds, rock formations appear as narrow bands repeated across the watershed.

The province between Sage and the north slope of the Uinta Mountains, generally consists of steeply dipping, faulted and folded Paleozoic- and Mesozoic-age (540 to 66 million years ago) sedimentary and metasedimentary rocks (mudstone to conglomerate, limestone, dolomite, and quartzite) and relatively shallow dipping Tertiary-age (66 to 2.6 million years ago) sedimentary rocks. The Teritiary-age rocks typically mantel the older rocks. Much of the watershed between Sage and the north slope of the Uinta Mountains is underlain by the Early Tertiary-age (34 to 66 million years old) Wasatch Formation. The Wasatch Formation consists of interbedded mudstone, sandstone, siltstone, claystone, conglomerate and marlstone.



Projection: NAD 83 - UTM 12N

Legend

Bedrock Geology Unit

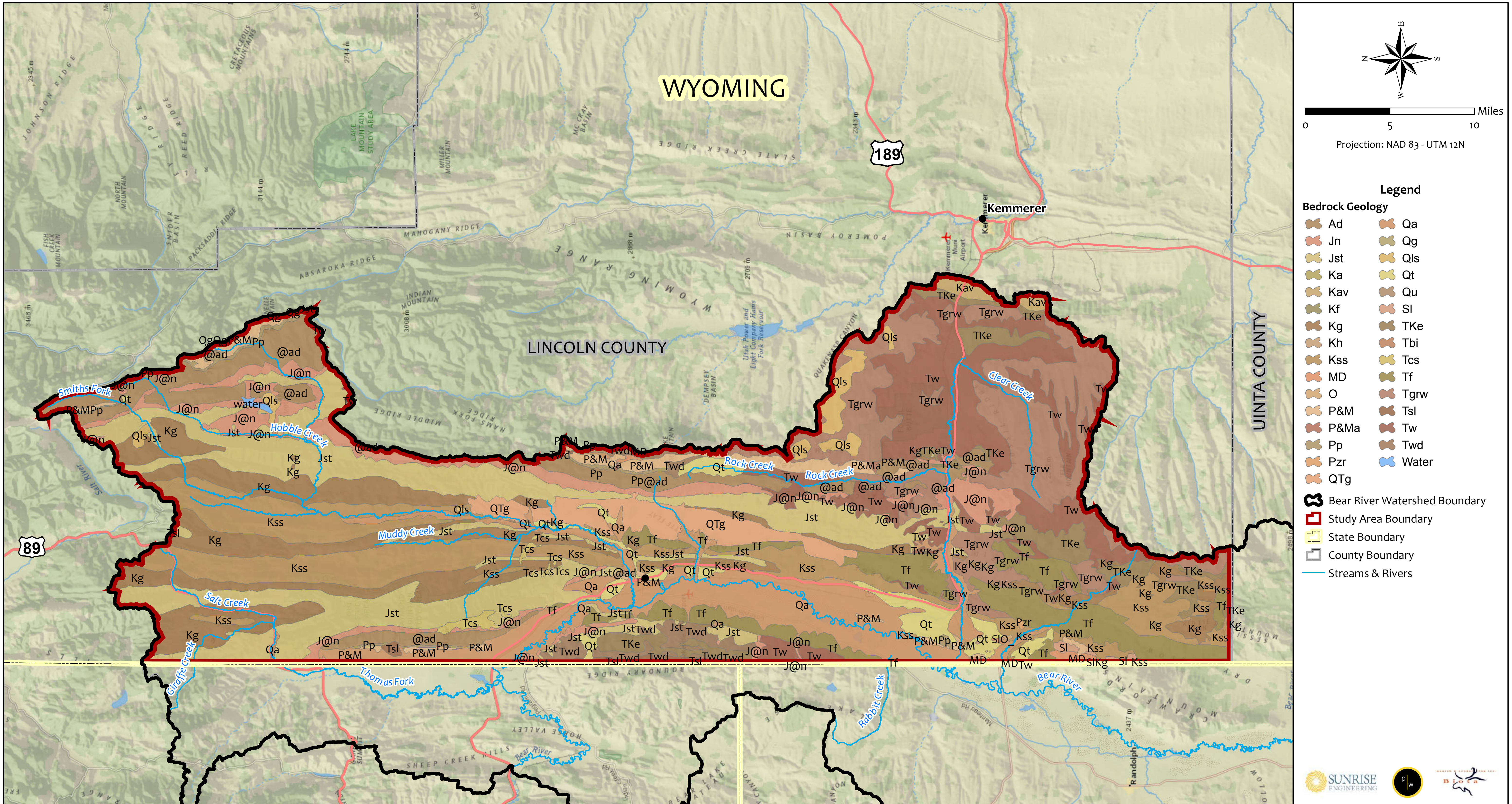
Ad	Qa
Jn	Qg
Jst	Qls
Ka	Qt
Kav	Qu
Kf	Sl
Kg	TKe
Kh	Tbi
Kss	Tcs
MD	Tf
O	Tgrw
P&M	Tsl
P&Ma	Tw
Pp	Twd
Pzr	Water
QTg	

Bear River Watershed Boundary
Study Area Boundary
State Boundary
County Boundary
Streams & Rivers

SUNRISE ENGINEERING

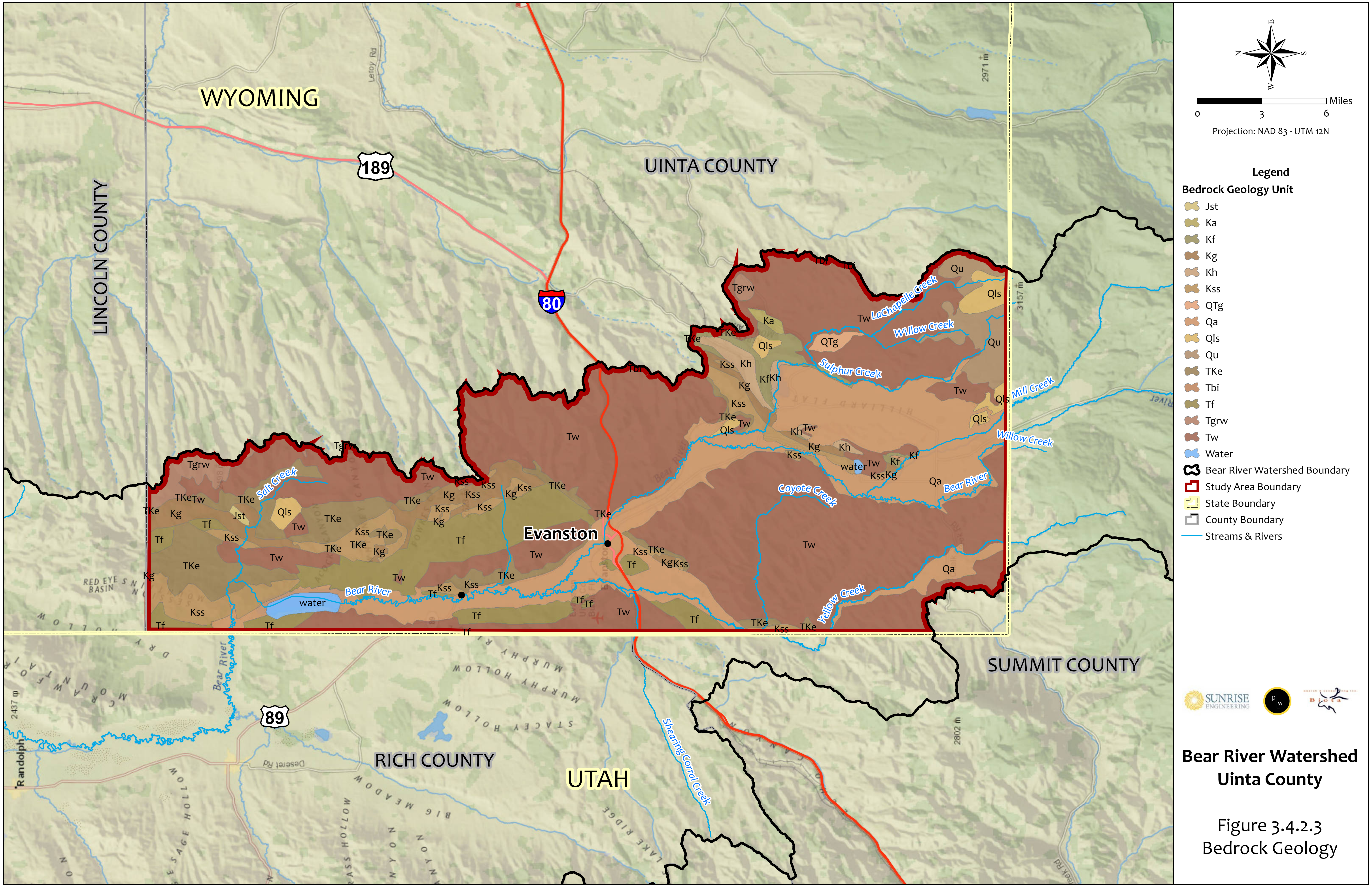
Bear River Watershed

Figure 3.4.2.3
Bedrock Geology



Bear River Watershed
Lincoln County

Figure 3.4.2.3
Bedrock Geology



Bear River Watershed Uinta County

Figure 3.4.2.3
Bedrock Geology

The north slope of the Uinta Mountains are located at the southernmost extent of the watershed and the bedrock consists of Middle Proterozoic- and Paleozoic-age (1,600 to 252 million years ago) sedimentary and metasedimentary rocks (shale, sandstone, limestone, dolomite, and quartzite). Rocks of the Uinta Mountains are heavily faulted and the rock formations on the flanks of the mountains dip downward steeply to the north.

3.4.2.4 GEOLOGIC IMPACTS TO WATERSHED HYDROLOGY

The surficial, bedrock, and structural geology within the Bear River watershed impact the groundwater and surface hydrology. Geologic material properties such as porosity and permeability impact groundwater storage and yield. The infiltration rates and slope angles influence the quantity and direction of surface flow. Geologic materials that are resistant to erosion generally result in topographic high elevations and geologic materials less resistant to erosion generally result in topographic low elevations. Structural features such as faults can be locations of drainages because of the increased disturbance to geologic materials along the faults. Anticlinal folds, shaped like an arch in cross-section, commonly form topographic high elevations while synclinal folds, shaped like a U in cross section, commonly form topographic low elevations. The generally north-south oriented thrust faults, high angle faults, and folds have formed generally north-south oriented mountains and valleys and thus the principal streams within the watershed flow generally north or south.

The Quaternary aged (about 2.6 million years ago), unconsolidated, surficial materials that fill the river and stream valleys (valley fill) form the most important aquifer in the watershed. The valley fill aquifer is greater than 185 feet thick in places, consists of silt to boulder sized particles and the groundwater level is generally close to the ground surface. Wells with pumping rates in excess of 1,100 gallons per minute (gpm) were reported (Robinove and Berry, 1963). Wells penetrating the full depth of the valley fill aquifer in the Bear River Valley may yield up to 2,000 gpm (Robinove and Berry, 1963 and Eddy-Miller, Plafcan, and Clark, 1996).

The pre-Quaternary aged rock units are only minor producers of water (Robinove and Berry, 1963). The Tertiary-aged rock units are gently dipping, but consist predominately of fine grained rock with relatively low permeability. The more permeable rock units, such as sandstone or conglomerate, may produce small to moderate yields sufficient for domestic or stock use (Robinove and Berry, 1963). Eddy-Miller, Plafcan, and Clark (1996) report most wells completed in the Wasatch Formation in the Green River basin produce less than 50 gpm.

Many of the Paleozoic- and Mesozoic-aged formations contain more permeable rocks, including sandstones and limestone, and are water-bearing; however, because of the significant faulting and folding, geologic units are commonly discontinuous, steeply dipping, and have small outcrop areas. Permeable rock units may yield small to moderate quantities of water but the yield is dependent on local conditions (Robinove and Berry, 1963). In many locations, water-bearing formations may be too deep to produce water economically.

The water-yielding characteristics of 53 geologic units in Lincoln County Wyoming were tabulated by Eddy-Miller, Plafcan, and Clark (1996) and are provided in Appendix E. This document (Appendix 3- Lithologic and water yielding characteristics of geologic units in Lincoln County, Wyoming) may not include all water bearing units within the Bear River watershed and may include units identified outside of the watershed.

3.4.2.5 GEOLOGIC HAZARDS

Based on RJH's review of published information, the primary potential geologic hazards and constraints within the watershed for development of water storage or groundwater use include:

- Ground Shaking
- Liquefaction
- Landslides
- Expansive Soil and Rock
- Karst

The locations of faults within the Bear River watershed that have been included in the USGS Quaternary Fault and Fold Database (USGS, 2006) are shown on Figure 3.4.2.5 in Appendix E. Faults included in the database are believed to have been sources of earthquakes with magnitudes greater than 6 during that past 1.6 million years. Additional quaternary faults that could impact the seismic hazard within the watershed have been mapped outside of the watershed boundary. The watershed has recent and reoccurring seismic activity and it is possible that all Quaternary Faults within the watershed are not identified on the published mapping.

The Hazard Curve Application (USGS, 2012) was used to estimate the ground acceleration with a 0.2 second period for a seismic event with a reoccurrence interval of 4974 years (1 percent probability of exceedance in 50 years). Values were estimated for Evanston and Cokeville, Wyoming; and a point along the Smiths Fork approximately 10 miles east of Geneva, Idaho. The estimated design ground acceleration values ranged from 0.33g to 0.86g and are summarized in the following table.

Table 3.4.2.5 Design Horizontal Ground Accelerations

Location	Ground Acceleration with 0.2 Second Period (g)	Reoccurrence Interval (yrs)
Approximately 10 miles east of Geneva, Idaho	0.43	4974
Cokeville, Wyoming	0.86	4974
Evanston, Wyoming	0.33	4974

Deposits of relatively loose and saturated granular soils may be susceptible to liquefaction. Liquefaction is a soil behavior phenomenon in which a soil mass loses a significant portion of its strength because of high excess pore-water pressure generated by earthquake ground shaking. Relatively loose and saturated granular soils could be present within alluvium, alluvial fans, eolian deposits, landslide deposits, and glacial deposits and these materials could have the potential to liquefy.

Multiple landslides were mapped within the Bear River watershed as shown on Figure 3.4.2.5 in Appendix E. The majority of these slides occurred in materials with low shear strengths including shale, claystone, and the soils derived from these rocks. Some slides also occurred in the colluvium and mixed alluvium and colluvium deposits on steeper slopes. The majority of the mapped landslides occurred in the Wasatch Formation, with the largest landslides occurring on the north slope of the Uinta Mountains. Landslides have also been identified in the Ankareh Red Beds, Amsden Formation, Wells Formation, Green River Formation, Evanston Formation, Hilliard Shale, undifferentiated Eocene rocks which could include the Bridger, Green River and Wasatch Formations, and glacial deposits. Seismic ground shaking could also increase the potential for landslides to occur. Several landslides are located adjacent to faults included in the Quaternary Fault and Fold Database (USGS, 2006), as shown on Figure 3.4.2.5 in Appendix E.

Expansive soils and bedrock contain clay minerals that absorb water when wetted, which results in volumetric expansion. These volume changes may cause differential heave and increased soil pressures. Potential differential movement may occur at the contact between expansive and non-expansive soils or bedrock, or at distinct wetting fronts. Shale, claystone, mudstone, and the soils derived from these rock types, can have high swell potentials. Bentonite has an especially high swell potential. Several rock units within the Bear River watershed are prone to swelling. Dickey and M'Gonigle (1992) published a map showing the locations swelling clays within the Kemmerer quadrangle. Based on this map, swelling clays are abundant within the Wasatch Formation and common within the alluvium, terrace deposits, colluvium and landslide deposits derived from the Wasatch Formation. The Wasatch Formation underlies the majority of the watershed between Sage, Wyoming and the north slope of the Uinta Mountains. Other bedrock formations within the watershed that consist of significant percentages of mudstone, claystone and shale and may be prone to swelling include: the Cretaceous-age Sage Junction Formation, Quealy Formation, Cokeville Formation, Thomas Fork Formation, Smiths Formation, and Gannett Group. The Cokeville Formation contains beds of bentonite. The Cretaceous-age units are generally steeply dipping and are present throughout the watershed.

Karst forms by the dissolution of rock as water flows through and enlarges fractures forming underground drainages, caves, and sinkholes. Rocks types most susceptible to karst include limestone, dolomite, gypsum, halite and other salts. Karstic terrain can pose severe seepage problems and is difficult to fully identify with subsurface investigations. In the Bear River watershed, the Cokeville Formation, Draney Limestone and Peterson Limestone members of the Gannet Group, Stump Formation, Preuss Red Beds, Twin Creek Limestone, Thaynes Limestone, Woodside Red Beds, Dinwoody Formation, Phosphoraia Formation, Wells Formation, Park City Formation, Morgan Formation, Round Valley Limestone, Amsden Formation, Doughnut Formation, Humbug Formation, Madison Limestone, Lodgepole Limestone, Three Forks Formation, Jefferson Dolomite, Bighorn Dolomite, and Gallatin Limestone contain limestone and or dolomite. The Stump Formation contains halite in some locations and the Preuss Redbeds contain halite, alum, and gypsum.

3.4.3 Soils

Soil groups identified by the Natural Resources Conservation Service (NRCS) within the Bear River watershed are shown on Figure 3.4.3.1 in Appendix E. Soil group numbers are defined on Figure 3.4.3.1 (second sheet) and a brief description of each soil group is provided in Appendix E. Soil data was compiled from the Web Soil Survey application (NRCS, 2016). Data from the following soil survey areas were collected:

- Uinta County, Wyoming
- Lincoln County, Wyoming, Southern Part
- Bridger National Forest, Wyoming
- Henrys Fork Area, Utah and Wyoming

The Bear River watershed had been divided into over 200 soil groups. Detailed soil survey data was not available for the majority of the watershed located within Lincoln County, Wyoming and the southernmost portion of the watershed in Summit County, Utah. The soil groups shown in Figure 3.4.3.1 in these areas are from the U.S. General Soil Map. The Uinta County, Wyoming survey area and the Henrys Fork Area, Utah-Wyoming survey area contained a few soil group numbers that were the same as in other survey areas but the soil group descriptions were different. To distinguish the soil groups, the number 1 was added to the group numbers in the Uinta County, Wyoming and Henrys Fork Area, Utah-Wyoming survey areas. Changed soil unit numbers are summarized in the following table.

Table 3.4.3 Changes to Duplicate Soil Group Numbers

Soil Survey Area	Original Group Number	Changed Group Number
Uinta County, Wyoming	102	1102
	212	1212
	222	1222
	223	1223
	226	1226
Henrys Fork Area, Utah-Wyoming	103	1103
	121	1121

Soils within the study area are diverse, and soil characteristics can vary over relatively short distances depending on slope, geology, vegetation, and microclimate. The following soil descriptions are adapted from the Kemmerer BLM Proposed RMP and Final EIS (2008).

Overthrust Belt Soils

The majority of the study area is comprised of soil associated with a geologic formation known as the Overthrust Belt. Steep, sloping major ridges with narrow valleys trending north-south are found in association with this formation that extends south of Evanston at the Utah State line to the western divide of the Muddy Creek drainages. This area narrows to the north and tapers in the Cokeville area. Dominant parent materials include residuum formed over sediments; colluvium, including landslide and earth-flow deposits; and alluvium on footslopes and drainages. Geologic overthrusting and the resulting mixed exposures have produced variable soil textures and complex soil/geomorphic relationships. In the narrow valleys and drainages, very deep and well-drained reddish and brown soils are common. The upland ridges are characterized by soils of varying depths, both red and brown in color. Most red soils along the upland ridges, such as along the Bear River Divide, are highly susceptible to water erosion when disturbed. Areas within the Overthrust Belt, especially low areas, are saline (high in soluble salts and sodium), which is a water quality concern in the Colorado River basin.

Floodplain Soils

These soils are located along major drainages but comprise a relatively small percentage of the study area. Due to the influence of adjacent soils and geology, these soils are not uniform in character and can be subdivided into three groups:

- Subgroup A: These soils generally are found in the eastern part of the planning area in intermittent drainages of the Green River basin, such as Slate Creek, Muddy Creek, and the lower part of Blacks Fork River. Textures are dominated by silty clays and other clays, and are often saline.

- Subgroup B: These soils are found along the perennial upper reaches of Blacks Fork River, Willow Creek, Bear River, and Hams Fork River in the Opal area. They tend to have more rock, vary more in texture, and are less saline.

- Subgroup C: These soils are associated with the mountains and foothills of the Overthrust Belt along the perennial drainages of Smiths Fork, Upper Hams Fork, La Barge Creek, upper Fontenelle Creek, Salt River, and Greys River. They have a variable texture and are not highly saline.

The USDA Forest Service and NRCS have mapped soils within 51% of the study area, and these data have been digitized and are included in the project GIS. Approved soil mapping for a large portion (73%) of the Phase 1-Lincoln County study area is not yet available. Approved soil mapping is available for more than 99% of the Phase II-Uinta County study area. The portion of the watershed study area where mapping is available contains more than 146 distinct soil mapping units, and the 3 most expansive mapping units are:

- Almaholt-Roundor-High loams, 3 to 30 percent slopes;

- Dast-Helper-Gladlow complex, 6 to 35 percent slopes; and

- Dast-Artemesia complex, 5 to 25 percent slopes.

Based on the available soil mapping, Inceptisols are the most common soils in the study area. These soils exhibit minimal horizon development and are distributed across a wide range of ecological settings. Soil orders from available mapping for the study area are depicted in Figure 3.4.3.1, in Appendix E.

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3.4.4 WATERSHED HYDROLOGY

3.4.4.1 SURFACE WATER

The Bear River watershed is the largest internally draining basin in the Western hemisphere spanning regions of southwestern Wyoming, southeastern Idaho, and northeastern Utah. This study focuses on the upper Bear River watershed from the confluence of Sheep Creek in southeastern Idaho upstream to the headwaters in the Uinta Mountains in northeastern Utah. The study area is bounded on the west by the Bear River and Wasatch Mountains, on the south by the Uinta Mountains, and to the north and east by the Wyoming Range. Ranging in elevation from 6,000 feet at the confluence with Sheep Creek to 12,712 feet at Yard Peak in the Uinta Mountain headwaters, the watershed has a total relief of approximately 6,712 feet, and a mean basin elevation of 7,315 feet.

The study area contains approximately 193 miles of the mainstem Bear River, and major tributaries in Uinta County including Sulphur Creek, Mill Creek, Aspen Creek, Coyote Creek, Shearing Corral Creek, Bridger Creek, Rabbit Creek, Clear Creek, Twin Creek, Rock Creek, and in Lincoln County including Coantag Creek, Hobble Creek, Smiths Fork, Water Canyon Creek, Thomas Fork, Yellow Creek, Sublette Creek, LaChapelle Creek, Willow Creek, Muddy Creek, Giraffe Creek, and Salt Creek. The dominant basin hydrologic regime is perennial because watercourses convey surface water year-round during most years. Peak flows correspond to spring snow-melt runoff, and the hydrograph in most sub-basins demonstrates a decline throughout the summer and fall, with base flows occurring in the winter season.

Multiple analyses were performed to quantitatively investigate the hydrologic regime within the project area including acquisition of historic stream flow gauge station data, installation and maintenance of temporary stream flow gauges, and application of multiple regional regression equations that quantify hydrologic discharge parameters based upon catchment attributes.

The Watershed Boundary Dataset developed jointly by the US Geological Survey (USGS) and the USDA Natural Resources Conservation Service (NRCS) was obtained from the NRCS Geospatial Data Gateway. Hydrologic Units (HU) are delineated and presented in the dataset at various scales. Each HU has a unique numerical identifier, or a 2-digit code referred to as a Hydrologic Unit Code. The largest scale of delineated watersheds is identified by 2-digit codes referred to as HUC2s. Additional 2-digit codes are added to the numerical identifier to describe nested sub-watersheds. The smallest nationwide dataset of delineated HUs are identified by 6 two-digit codes, and are referred to as 12-digit Hydrologic Unit Codes (or HUC12s).

All HUC12s within the Bear River Watershed Study Area were imported into the project GIS, and are depicted in Figure 3.4.4.1 with National Hydrography Dataset (water lines) derived at the 1:24,000 scale. HUC12s are classified as "complete" if a given HUC12 catchment does not receive natural surface water inputs from adjacent HUC12s, or as a “composite” if it receives natural surface water input from one or more adjacent HUC12(s). The sub-basins associated with a composite HUC12 were delineated by merging all individual HUC12s that comprise the associated catchment. These analyses enabled quantification of various attributes (drainage area, maximum and mean elevation, aspect, slope) of sub-basins corresponding to the downstream extent of each HUC12.

The methods presented in Water-Resources Investigations Report 03-4107 (Miller 2003) were used to develop quantitative estimates of hydrologic regime for each HUC12. The approach uses unique regional regression equations for various defined hydrologic regions. The Bear River Watershed Study Area spans 2 of those regions including the Rocky Mountain region and Overthrust Belt region. Hydrologic regions were input into the project GIS and enabled geographic analyses of sub-basins within the study area for the purpose of applying regionally appropriate regression equations. Regression equations for catchments in the Rocky Mountain region incorporate basin attributes of drainage area, mean elevation, and longitude; Overthrust Belt region equations are based upon drainage area and mean January precipitation. Sub-basins that span more than 1 hydrologic region are addressed in accordance with the procedure outlined in the report (Miller 2003). Results of the hydrologic analyses include peak flow rates (in cubic feet per second) at the downstream boundary of each HUC12 associated with various recurrence intervals (1.5 years to 500 years) (Table 3.4.4.1-1). Analysis results are presented in the project GIS, in which a user can access all recurrence interval peak flow rates at the downstream end of any HUC12 with a single click.

Table 3.4.4.1-1. Multiple recurrence interval peak flow rates in HUC12 sub-basins within the Bear River Watershed Study Area.

		Recurrence Interval (cfs)									
HUC12	**HUC12_Name**	**1.5 yr**	**2-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**	**500-yr**
160101010104	E Fork Bear River	565	689	677	841	950	1,084	1,155	1,231	1,316	1,412
160101010103	Bear River-Willow Cr	1,774	2,220	2,106	2,593	2,916	3,309	3,511	3,733	3,972	4,244
160101010102	Stillwater Fork	561	682	670	830	936	1,065	1,133	1,206	1,288	1,379
160101010101	Bear River-Hayden Fk	328	406	406	521	602	703	761	824	892	972
160101010105	West Fork Bear River	529	668	659	855	995	1,170	1,274	1,384	1,504	1,648
160101010401	Upper Yellow Creek	227	306	312	450	562	712	816	928	1,051	1,213
160101010202	La Chapelle Creek	201	267	273	389	483	607	691	782	881	1,012
160101010106	Mill Creek-Cottonwood Creek	542	692	682	895	1,050	1,245	1,362	1,487	1,623	1,789
160101010203	Upper Sulphur Creek	147	196	202	292	366	464	532	605	686	792
160101010204	Lower Sulphur Creek	387	520	520	734	905	1,129	1,280	1,442	1,618	1,849
160101010404	Lower Wasatch Creek	200	282	289	439	569	749	881	1,025	1,185	1,405
160101010501	Upper Saleratus Creek	95	131	148	232	307	406	479	555	633	734

Table 3.4.4.1-1 (Cont.)

HUC12	**HUC12_Name**	**Recurrence Interval (cfs)**									
		1.5 yr	**2-yr**	**2.33-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**	**200-yr**	**500-yr**
160101010701	Upper Woodruff Cr	155	189	205	271	324	387	430	473	515	567
160101010502	Middle Saleratus Cr	210	285	322	493	642	836	976	1,122	1,270	1,457
160101010702	Sugar Pine Canyon	89	109	118	157	189	226	252	278	304	336
160101010704	Birch Cr -Walton Canyon	150	192	212	298	370	459	521	585	648	727
160101010602	Upper Big Creek	158	202	223	314	389	483	548	615	681	764
160101010304	Alkali Creek-Salt Cr	58	86	100	173	244	342	419	502	588	703
160101010801	Bridger Cr -Bear River	71	105	122	210	294	410	500	597	698	831
160101010901	Upper Twin Cr -Bear River	90	134	156	272	384	541	663	795	932	1,115
160101010902	Clear Creek-Twin Cr	33	48	56	95	133	185	225	268	314	374
160101010904	North Fork Twin Cr	55	78	90	148	201	274	330	388	449	529
160101010605	Little Creek	112	147	164	239	303	384	442	502	562	637
160101010606	Otter Creek	110	147	165	248	320	412	480	549	619	708
160101010906	Lower Twin Creek-Bear River	288	416	480	799	1,095	1,498	1,799	2,120	2,449	2,875
160101010903	Middle Twin Creek	256	366	422	694	945	1,284	1,537	1,805	2,080	2,435
160101010804	Sixmile Creek	75	105	119	191	256	342	407	475	545	636
160101010905	Rock Creek-Twin Cr	117	157	176	267	345	447	520	596	673	772
160101020103	Sublette Creek	67	92	104	162	214	283	334	387	441	512
160101020106	Sweetwater Cr-Bear River	125	167	188	283	365	472	549	629	709	812
160101020206	Lower Smiths Fork	882	1,102	1,203	1,641	1,994	2,417	2,699	2,988	3,268	3,603
160101020204	Middle Smiths Fork	743	916	995	1,332	1,601	1,920	2,131	2,346	2,555	2,804
160101020205	Mill Creek-Smiths Fk	104	135	149	213	267	334	382	431	480	541
160101020107	Sheep Creek-Bear R.	57	79	89	139	183	241	284	329	375	435
160101020305	Preuss Creek	87	113	125	181	228	287	329	372	416	471
160101020307	Thomas Fork Raymond Creek	600	776	858	1,225	1,530	1,908	2,168	2,435	2,699	3,020
160101020201	Upper Smiths Fork-Bear River	400	488	527	696	829	986	1,091	1,198	1,301	1,426
160101020202	Hobble Creek	220	267	288	378	450	534	591	648	704	772

Table 3.4.4.1-1 (Cont.)

HUC12	HUC12_Name	Recurrence Interval (cfs)									
		1.5 yr	2-yr	2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
160101020203	Coantag Creek	258	314	339	448	534	636	704	774	841	924
160101020302	Salt Cr -Thomas Fork	150	190	208	288	354	435	491	548	605	675
160101020304	Giraffe Creek	92	117	128	179	221	272	308	345	381	427
160101020303	Thomas Fork-Dry Cr	426	542	596	835	1,032	1,272	1,437	1,606	1,772	1,975
160101020306	Thomas Fork-Bischoff Canyon	537	692	765	1,090	1,359	1,693	1,923	2,158	2,391	2,675
160101020301	Thomas Fork-Huff Cr	165	210	232	326	405	502	569	638	707	793
160101010703	Lower Woodruff Cr	396	501	550	765	940	1,154	1,301	1,451	1,597	1,777
160101010305	Cottonwood Cr-Bear River	56	83	97	170	240	339	417	500	587	704
160101010405	Upper Wasatch Creek	55	80	92	155	213	292	353	418	486	575
160101010603	Lower Big Creek	199	262	291	426	540	685	787	892	998	1,130
160101010504	Neponset Reservoir	62	95	113	204	295	426	530	643	762	923
160101010205	Stowe Creek	95	131	124	214	279	368	434	505	582	686
160101010402	Lower Yellow Creek	415	584	524	914	1,183	1,549	1,813	2,097	2,399	2,799
160101010403	Coyote Cr -Clifton Hollow	79	110	109	181	238	319	379	445	518	618
160101010201	Bear River-Duncomb Hollow	2,091	2,736	2,532	3,361	3,920	4,621	5,038	5,491	5,966	6,551
160101010301	Crompton Reservoir	2,099	2,752	2,521	3,400	3,980	4,715	5,158	5,640	6,145	6,769
160101010302	Bear River-Fowkes Canyon Creek	2,686	3,535	3,155	4,376	5,151	6,142	6,754	7,420	8,114	8,974
160101010303	Bear River-Whitney Canyon Crk	2,740	3,619	3,198	4,556	5,419	6,538	7,253	8,031	8,839	9,846
160101010503	Lower Saleratus Creek	2,868	3,813	3,346	4,933	5,935	7,235	8,080	8,993	9,935	11,107
160101010604	Bear River-Brazier Canyon	3,435	4,569	4,003	6,177	7,522	9,243	10,372	11,576	12,795	14,285
160101010803	Bear River-Rabbit Cr	3,711	4,977	4,470	6,980	8,633	10,769	12,202	13,730	15,276	17,170
160101010805	Bear R.- Antelope Cr	3,734	5,013	4,513	7,053	8,737	10,916	12,379	13,940	15,520	17,456
160101020101	Bear River-Horse Cr	3,773	5,081	4,594	7,201	8,947	11,206	12,727	14,350	15,992	18,007
160101020102	Bear River-Spring Cr	4,475	5,989	5,488	8,606	10,668	13,290	15,034	16,879	18,725	20,955

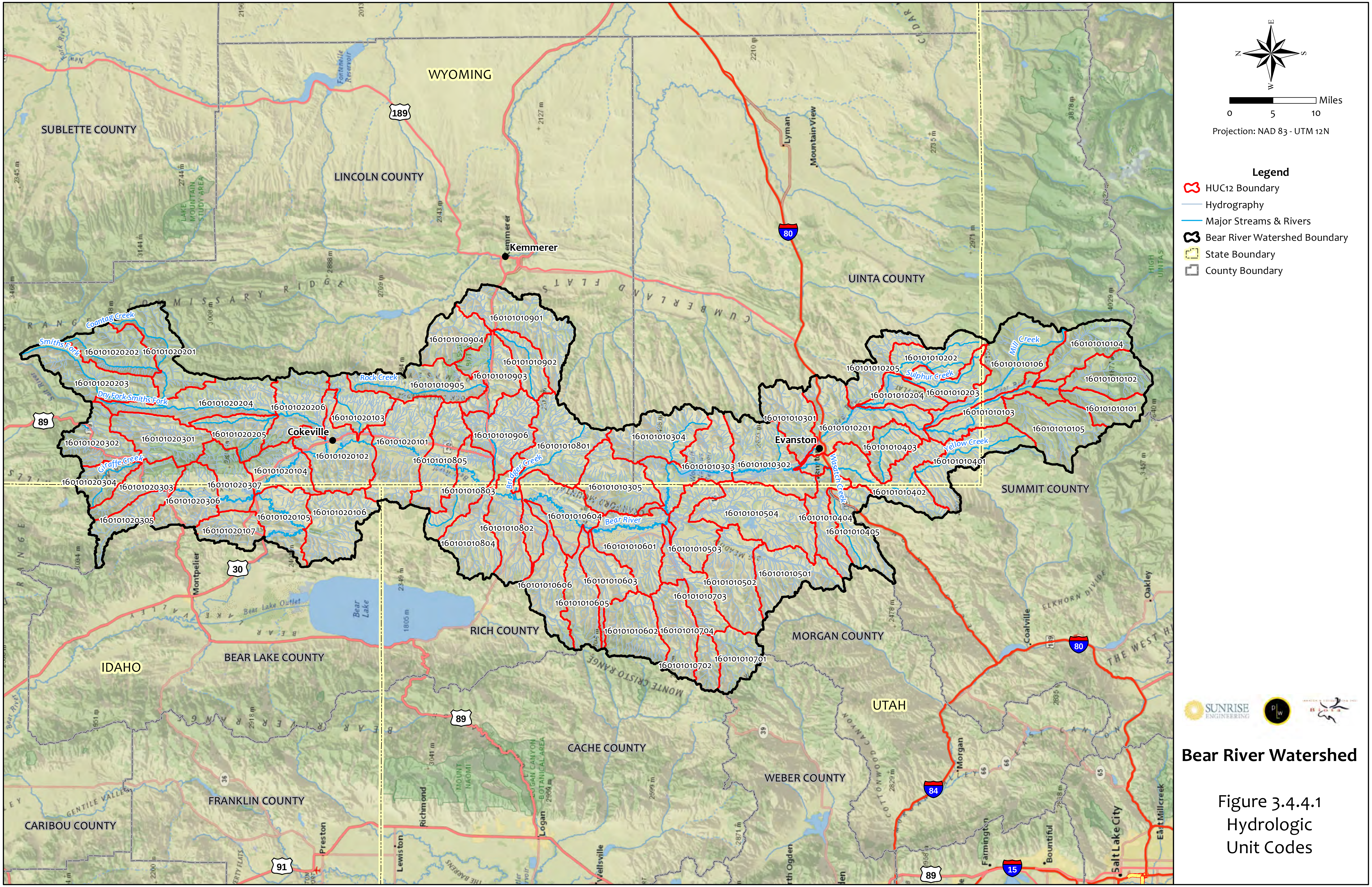
Table 3.4.4.1-1 (Cont.)

HUC12	HUC12_Name	Recurrence Interval (cfs)									
		1.5 yr	2-yr	2.33-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
160101020105	Bear River-Taylor Cr	5,016	6,699	6,235	9,747	12,101	15,076	17,051	19,135	21,209	23,699
160101020104	Bear R.-N Willow Cr	4,507	6,033	5,537	8,684	10,771	13,423	15,189	17,057	18,925	21,182
160101010601	Bear R.-Sage Hollow	3,177	4,223	3,680	5,602	6,785	8,303	9,294	10,356	11,437	12,766
160101010802	Bear River-Sage Cr	3,496	4,661	4,109	6,362	7,781	9,602	10,804	12,087	13,386	14,975

Mean annual discharge and total annual yield in all HUC12 sub-basins were calculated using an equation from Miselis (1999) that estimates mean annual discharge for streams in mountainous regions of Wyoming based on drainage area (Table 3.4.4.1-2). Miselis used existing stream gauge data within the Bear River Watershed to develop and test the hydrologic models. Although the Bear River Watershed spans 3 different states (WY, UT, and ID), the equations presented in the report for mountainous streams of Wyoming can provide appropriate estimates of streamflow due to the proximity of the watershed to study sites used in the development and testing of the Miselis equations. The equation which uses drainage area to predict mean annual discharge has an $R^2 = 0.789$ and a standard error of 0.3136.

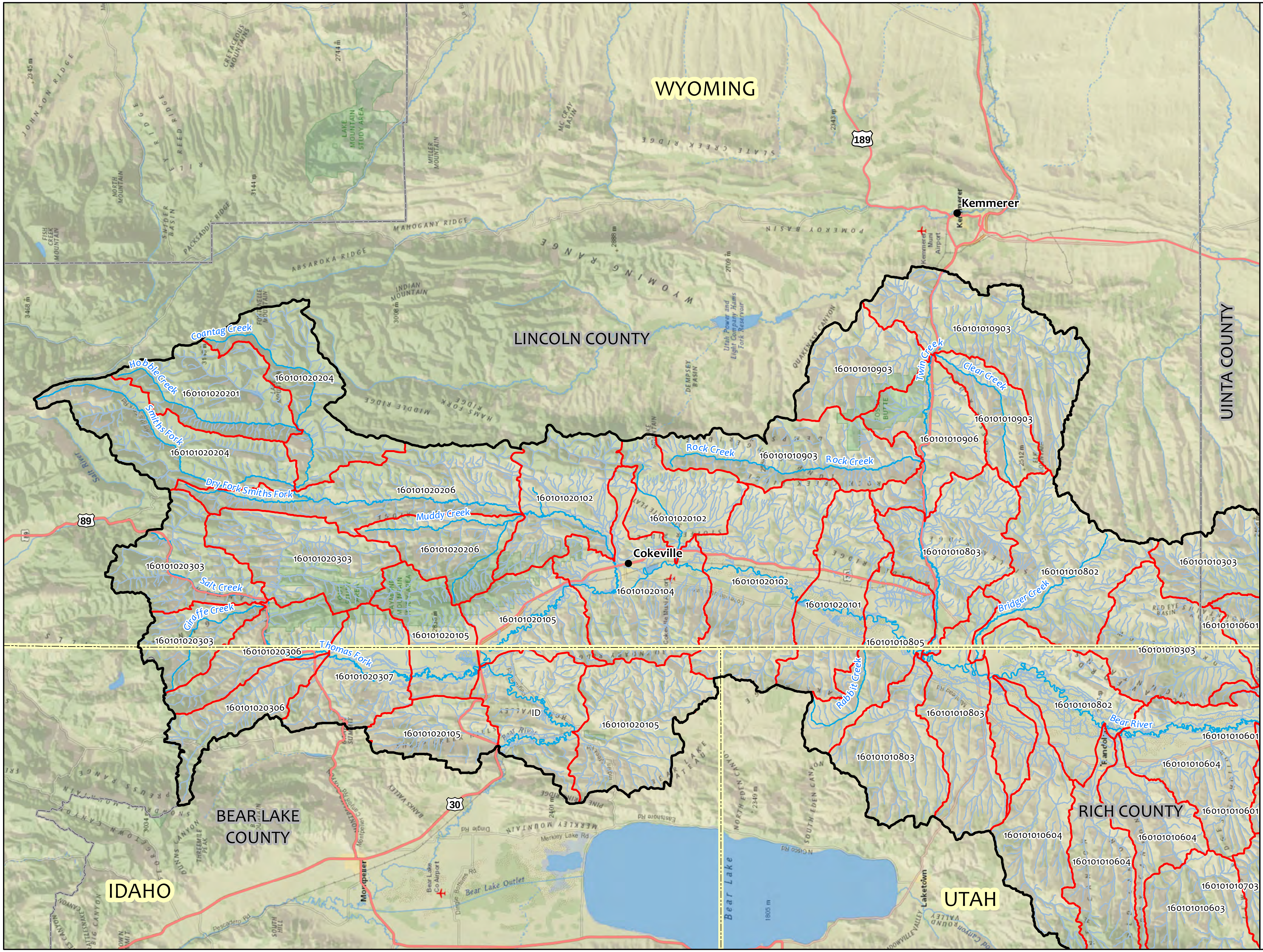
Table 3.4.4.1-2. Mean annual discharge and total annual yield in HUC12 sub-basins within the Bear River Watershed Study Area.

Area (sq mi)	HUC 12 #	HUC 12 Name	Mean Annual Discharge (drainage area method, cfs)	Total Yield (acre-ft)
40.37	160101010104	East Fork Bear River	33.00	23,893
198.87	160101010103	Bear River-Willow Creek	137.28	99,390
38.69	160101010102	Stillwater Fork	31.77	22,999
25.63	160101010101	Bear River-Hayden Fork	21.98	15,914
56.97	160101010105	West Fork Bear River	44.90	32,508
49.23	160101010401	Upper Yellow Creek	39.41	28,529
35.68	160101010202	La Chapelle Creek	29.55	21,396
30.59	160101010205	Stowe Creek	25.75	18,644
206.69	160101010402	Lower Yellow Creek	142.10	102,878
25.34	160101010403	Coyote Creek-Clifton Hollow	21.76	5,754



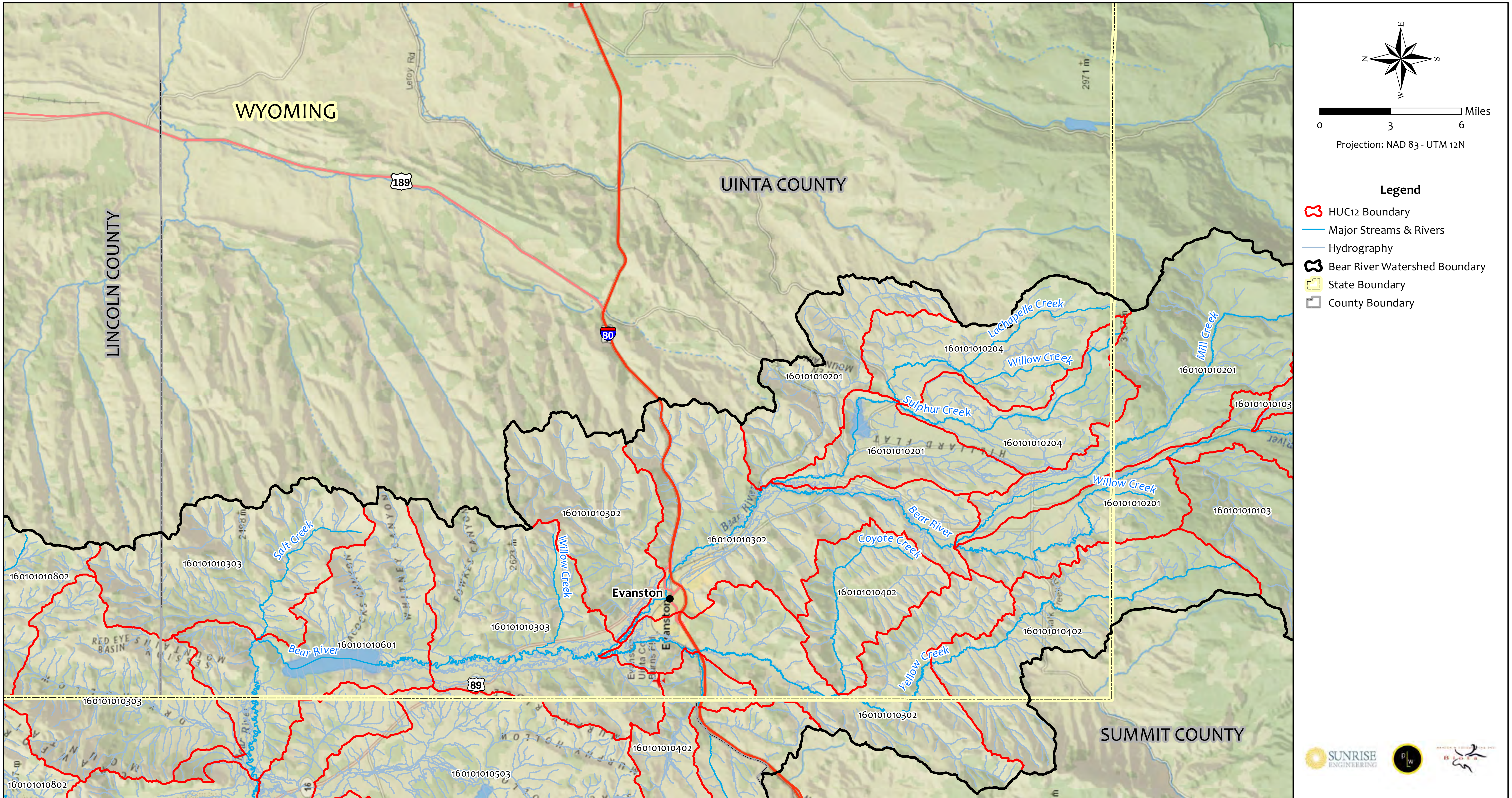
Bear River Watershed

Figure 3.4.4.1
Hydrologic
Unit Codes



Bear River Watershed
Lincoln County

Figure 3.4.4.1
Hydrologic
Unit Codes



Bear River Watershed Uinta County

Figure 3.4.4.1
Hydrologic
Unit Codes

Table 3.4.4.1-2 (Cont.)

Area (sq mi)	HUC 12 #	HUC 12 Name	Mean Annual Discharge (drainage area method, cfs)	Total Yield (acre-ft)
38.33	160101010405	Upper Wasatch Creek	31.50	22,808
70.58	160101010404	Lower Wasatch Creek	54.38	39,370
444.26	160101010201	Bear River-Duncomb Hollow	281.64	203,898
481.60	160101010301	Crompton Reservoir	302.71	219,154
748.49	160101010302	Bear River-Fowkes Canyon Creek	448.97	325,046
47.70	160101010501	Upper Saleratus Creek	38.31	27,737
29.09	160101010701	Upper Woodruff Creek	24.62	17,826
105.39	160101010502	Middle Saleratus Creek	77.82	56,338
15.64	160101010702	Sugar Pine Canyon	14.14	10,236
41.90	160101010704	Birch Creek-Walton Canyon	34.12	24,699
44.53	160101010602	Upper Big Creek	36.02	26,080
907.96	160101010303	Bear River-Whitney Canyon Creek	533.60	386,311
50.76	160101010304	Alkali Creek-Salt Creek	40.50	29,319
1074.44	160101010503	Lower Saleratus Creek	620.26	449,057
61.36	160101010801	Bridger Creek-Bear River	47.98	34,739
88.54	160101010901	Upper Twin Creek-Bear River	66.59	48,212
23.49	160101010902	Clear Creek-Twin Creek	20.33	14,720
34.10	160101010904	North Fork Twin Creek	28.37	20,543
37.31	160101010605	Little Creek	30.76	22,267
43.71	160101010606	Otter Creek	35.43	25,651
1512.88	160101010604	Bear River-Brazier Canyon	842.26	609,775
260.24	160101010906	Lower Twin Creek-Bear River	174.60	126,406
210.93	160101010903	Middle Twin Creek	144.70	104,763

Table 3.4.4.1-2 (Cont.)

Area (sq mi)	HUC 12 #	HUC 12 Name	Mean Annual Discharge (drainage area method, cfs)	Total Yield (acre-ft)
41.19	160101010804	Sixmile Creek	33.60	24,325
1960.20	160101010803	Bear River-Rabbit Creek	1061.73	768,672
2006.11	160101010805	Bear River-Antelope Creek	1083.94	784,747
2077.30	160101020101	Bear River-Horse Creek	1118.26	809,596
48.70	160101010905	Rock Creek-Twin Creek	39.02	28,252
30.92	160101020103	Sublette Creek	26.00	18,824
2441.00	160101020102	Bear River-Spring Creek	1291.77	935,212
51.53	160101020106	Sweetwater Creek-Bear River	41.05	29,716
272.95	160101020206	Lower Smiths Fork	182.20	131,911
2824.36	160101020105	Bear River-Taylor Creek	1471.71	1,065,484
2474.93	160101020104	Bear River-North Willow Creek	1307.81	946,825
198.19	160101020204	Middle Smiths Fork	136.87	99,088
30.01	160101020205	Mill Creek-Smiths Fork	25.31	18,327
25.40	160101020107	Sheep Creek-Bear River	21.81	15,791
25.66	160101020305	Preuss Creek	22.01	15,934
232.78	160101020307	Thomas-Fork Raymond Creek	158.03	114,413
86.99	160101020201	Upper Smiths Fork-Bear River	65.55	47,457
41.64	160101020202	Hobble Creek	33.93	24,561
51.85	160101020203	Coantag Creek	41.27	29,881
37.73	160101020302	Salt Creek-Thomas Fork	31.07	22,491
21.99	160101020304	Giraffe Creek	19.17	13,879
137.19	160101020303	Thomas Fork-Dry Creek	98.51	71,318
200.86	160101020306	Thomas Fork-Bischoff Canyon	138.51	100,277

Table 3.4.4.1-2 (Cont.)

Area (sq mi)	HUC 12 #	HUC 12 Name	Mean Annual Discharge (drainage area method, cfs)	Total Yield (acre-ft)
46.46	160101020301	Thomas Fork-Huff Creek	37.42	27,091
119.97	160101010703	Lower Woodruff Creek	87.38	63,260
66.69	160101010106	Mill Creek-Cottonwood Creek	51.69	37,421
25.84	160101010203	Upper Sulphur Creek	22.15	16,035
83.70	160101010204	Lower Sulphur Creek	63.33	45,851
73.86	160101010504	Neponset Reservoir	56.63	40,998
1301.41	160101010601	Bear River-Sage Hollow	736.18	532,980
51.33	160101010305	Cottonwood Creek-Bear River	40.90	29,612
1619.69	160101010802	Bear River-Sage Creek	895.22	648,121

3.4.4.2 STREAM GAUGING STATIONS

Historic and currently active stream gauging stations operated within the study area by the USGS or WYSEO are presented in Figure 3.4.4.2.1 with numerical identifier, and gauge station details presented in Table 3.4.4.2.1. The USGS currently maintains 8 stream flow gauge stations in the Bear River Watershed Study Area. In addition, there are 26 historic USGS gauges in the basin. The WY State Engineer's Office currently maintains 130 stream flow gauge stations in watercourses, ditches, and delivery systems in the basin. The following links connect to the real time State and the USGS stream gauge data respectively; http://seoflow.wyo.gov/WDPortal http://waterwatch.usgs.gov/?m=real&r=wy

Table 3.4.4.2.1. Stream flow gauging stations located within the Bear River Study Area.

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
A	USGS	10041000	Thomas Fork near WY-ID state line	113	10/1/49	9/30/92	43	Lincoln, WY
B	USGS	10040500	Salt Creek near Geneva ID	37.6	10/28/39	9/30/51	12	Lincoln, WY
C	USGS	10028500	Bear River below Pixley Dam, near Cokeville WY	2032	11/1/41	active	13	Lincoln, WY

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
D	USGS	10040000	Thomas Fork near Geneva ID	45.3	10/23/39	9/30/51	12	Lincoln, WY
E	USGS	10038000	Bear River below Smiths Fork, Near Cokeville WY	2447	5/1/54	active	50	Lincoln, WY
F	USGS	10027000	Twin Creek at Sage WY	246	4/1/43	9/30/81	25	Lincoln, WY
G	USGS	10035000	Smiths Fork at Cokeville WY	275	6/1/42	9/30/52	10	Lincoln, WY
H	USGS	10032800	Mill Creek near Cokeville WY (WQ Samples)	8.07	9/14/67	5/16/68	1	Lincoln, WY
I	USGS	10032700	Muddy Creek above Mill Creek near Cokeville WY (WQ Samples)	20.7	9/14/67	5/16/68	1	Lincoln, WY
J	USGS	10032000	Smiths Fork near Border WY	165	6/1/42	active	62	Lincoln, WY
K	USGS	10019500	Chapman Canal at state line near Evanston, WY	0.01	10/1/60	9/30/86	26	Uinta, WY
L	USGS	10020200	Woodruff Narrows Reservoir near Woodruff UT	784	10/1/82	9/30/96	6	Uinta, WY
M	USGS	10020100	Bear River above Reservoir, near Woodruff UT	754.9	10/1/61	active	43	Uinta, WY
N	USGS	10020300	Bear River Below Reservoir, near Woodruff UT	784	10/1/61	active	43	Uinta, WY
O	USGS	10019000	Bear River near Evanston WY (WQ Samples)	715	9/12/67	4/6/82	4	Uinta, WY
P	USGS	10020500	Bear River near Woodruff UT	870	4/10/42	9/30/61	19	Uinta, WY
Q	USGS	10016900	Bear River at Evanston WY	443	5/14/84	active	12	Uinta, WY
R	USGS	10014000	Bear River above Sulphur Creek near Evanston WY	282	10/1/46	9/30/56	10	Uinta, WY
S	USGS	10012500	Mill Creek near Evanston WY	60.6	10/1/46	9/30/57	3	Uinta, WY
T	USGS	10016000	Sulphur Creek near Evanston WY	80.5	10/1/46	9/30/57	11	Uinta, WY
U	USGS	10015900	Sulphur Creek below reservoir near Evanston WY	69.2	4/1/58	10/6/92	34	Uinta, WY
V	USGS	10015700	Sulphur Cr above reservoir below La Chapelle Cr near Evanston WY	64.2	10/1/57	9/30/97	40	Uinta, WY
W	USGS	10011200	West Fork Bear River at Whitney Dam, near Oakley UT	6.79	10/1/63	9/30/86	23	Summit, UT
X	USGS	10011400	West Fork Bear River below Deer Creek near Evanston, WY	52.2	10/1/73	9/30/86	13	Summit, UT

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
Y	USGS	10011500	Bear River near UT-WY state line	59.1	7/1/42	active	62	Summit, UT
Z	USGS	10012000	Mill Creek at UT-WY state line	59	10/1/49	9/30/62	13	Summit, UT
AA	USGS	10010500	Hilliard East Fork Canal near state line near Evanston WY	n/a	5/1/48	9/30/68	20	Summit, UT
AB	USGS	10010400	East Fork Bear River near Evanston WY	34.6	10/1/73	9/30/86	13	Summit, UT
AC	USGS	10017000	Yellow Creek near Evanston WY	79.2	2/1/43	10/25/78	32	Summit, UT
AD	USGS	10020900	Woodruff Creek Below Reservoir near Woodruff UT	50	10/1/70	9/30/86	16	Rich, UT
AE	USGS	10021000	Woodruff Creek near Woodruff UT	56.8	10/1/37	9/30/75	32	Rich, UT
AF	USGS	10023000	Big Creek near Randolph UT	52.4	3/19/39	active	44	Rich, UT
AG	USGS	10026500	Bear River near Randolph UT	1616	12/1/43	10/13/92	49	Rich, UT
AH	USGS	10042500	Thomas Fork near Raymond ID	202	5/21/42	9/30/52	10	Bear Lake, ID
AI	USGS	10039500	Bear River at Border WY	2480	10/1/37	active	66	Bear Lake, ID
AJ	SEO	0402SF01	Etchevery	n/a	5/1/14	9/30/14	0	Lincoln, WY
AK	SEO	0402SF02	Quinn-Bourne	n/a	5/1/08	9/30/15	7	Lincoln, WY
AL	SEO	0402SF03	Francis-Larson	n/a	5/1/08	9/30/15	7	Lincoln, WY
AM	SEO	10032000	Smiths Fork near Border, WY	n/a	3/6/14	9/30/15	2	Lincoln, WY
AN	SEO	0402SF04	Button Flat	n/a	5/1/08	10/1/15	7	Lincoln, WY
AO	SEO	0402SF05	C.B.D. No. 7	n/a	5/1/12	10/1/15	3	Lincoln, WY
AP	SEO	0402SF06	Progress	n/a	5/1/08	10/1/15	7	Lincoln, WY
AQ	SEO	0402SF07	Larson Pump	n/a	5/1/08	10/1/15	7	Lincoln, WY
AR	SEO	0402SF08	Nate North Pump	n/a	5/1/08	9/30/14	6	Lincoln, WY
AS	SEO	0402SF10	Nate South Pump	n/a	5/1/08	9/30/14	6	Lincoln, WY
AT	SEO	0402SF09	Emelle	n/a	5/1/08	9/30/15	7	Lincoln, WY
AU	SEO	0402SF11	Cooper	n/a	5/1/08	9/30/15	7	Lincoln, WY
AV	SEO	0402SF12	Seven C Ranch N Pivot & Pipeline	n/a	5/1/08	10/1/15	7	Lincoln, WY
AW	SEO	0402SF14	Wheelock	n/a	5/1/08	10/1/15	7	Lincoln, WY

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
AX	SEO	0402SF13	Seven C Ranch S Pivot & Pipeline	n/a	5/1/08	10/1/15	7	Lincoln, WY
AY	SEO	0402GC01	Grade (Grade Canyon Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
AZ	SEO	0402BR74	Wyman No. 1 (East)	n/a	5/1/08	9/30/11	3	Lincoln, WY
BA	SEO	0402SF15	Covey (Headgate)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BB	SEO	0402BC02	D.C.P. (Bruner Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BC	SEO	0402BC01	Covey (Bruner Cr)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BD	SEO	0402BC03	Curtis Pump (Bruner Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BE	SEO	0402BC04	Haggerty No. 3 (Bruner Cr)	n/a	9/30/14	10/30/14	0	Lincoln, WY
BF	SEO	0402PC02	V.H. (Pine Cr)	n/a	5/1/08	11/13/15	8	Lincoln, WY
BG	SEO	0402PC01	Goodell (Pine Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BH	SEO	0402SC02	Diamond No. 2 (Spring Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BI	SEO	0402SC03	Kenyon (Spring Cr)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BJ	SEO	0402SC01	Covey (Spring Cr)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BK	SEO	0402SF16	Whites Water	n/a	5/1/08	9/30/15	7	Lincoln, WY
BL	SEO	0402SFS1	Petersen Pump (S Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BM	SEO	0402SFM2	Minnie Roberts (M Branch)	n/a	5/1/08	11/13/15	8	Lincoln, WY
BN	SEO	0402SFM1	Stoner & Nichols (M Branch)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BO	SEO	0402BR79	J.R. Richards	n/a	5/1/08	9/30/15	7	Lincoln, WY
BP	SEO	0402BR78	Cook Bros	n/a	5/1/08	9/30/15	7	Lincoln, WY
BQ	SEO	0402BR77	Rocky Point (D2)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BR	SEO	0402BR76	Oscar E. Snyder	n/a	5/2/20	10/1/15	95	Lincoln, WY
BS	SEO	0402BR75	Wyman No. 2 (West)	n/a	5/1/08	9/30/15	7	Lincoln, WY
BT	SEO	0402BR73	Alonzo F. Sights (Main Stem)	n/a	5/1/79	9/30/15	36	Lincoln, WY
BU	SEO	0402BR72	Bridge Pump	n/a	5/1/08	10/1/15	7	Lincoln, WY
BV	SEO	0402BR71	Thornock Pump & Pivot	n/a	5/1/08	10/1/15	7	Lincoln, WY
BW	SEO	0402SFM11	Igo No. 2 (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
BX	SEO	0402SFM12	Smith's Fork Ditch (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BY	SEO	0402SFM10	Star Two Pump (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
BZ	SEO	0402SFM9	Igo No. 3 (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CA	SEO	0402SFM8	Cokeville Water (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CB	SEO	0402SFM7	Star (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CC	SEO	0402SFM6	Tanner (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CD	SEO	0402SFM5	N Cokeville/Morgan (M Branch)	n/a	5/1/08	9/30/15	7	Lincoln, WY
CE	SEO	0402SFM4	Gastenaga South (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CF	SEO	0402SFM3	Gastenaga North (M Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CG	SEO	0402SFN2	Reed (N Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CH	SEO	0402SFN1	South Branch Irrigating (N Branch)	n/a	5/1/08	9/30/15	7	Lincoln, WY
CI	SEO	0402SFS4	Petersen Yard P.L.	n/a	5/1/13	10/1/15	2	Lincoln, WY
CJ	SEO	0402SFS3	Forgeon Irrigating (S Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CK	SEO	0402SFS2	Bourne (S Branch)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CL	SEO	0402SL03	Teichert Bro's Spreader Dike	n/a	5/1/14	10/1/15	1	Lincoln, WY
CM	SEO	0402SL02	Teichert Bro's Ditch	n/a	5/1/14	10/1/15	1	Lincoln, WY
CN	SEO	0402SL01	Abraham Stoner (Sublette Cr)	n/a	5/1/08	9/30/15	7	Lincoln, WY
CO	SEO	0402WEA1	Cokeville Weather	n/a	10/1/11	9/30/15	4	Lincoln, WY
CP	SEO	0402BR70	Pixley Irrigating (West)	n/a	5/1/20	9/30/15	95	Lincoln, WY
CQ	SEO	0402BR69	Pixley Irrigating (East)	n/a	5/1/08	10/1/15	7	Lincoln, WY
CR	SEO	0402BR64	McFarland	n/a	5/1/08	9/30/15	7	Lincoln, WY
CS	SEO	0402BR63	C-12 Pump	n/a	5/1/08	9/30/15	7	Lincoln, WY
CT	SEO	0402BR66	B.Q. West	n/a	5/1/08	9/30/15	7	Lincoln, WY
CU	SEO	0402BR68	Weston Ranch Pump 2	n/a	1/1/04	9/30/15	112	Lincoln, WY
CV	SEO	0402BR59	Johnson Pipeline 3 (Pivots 4-8)	n/a	5/1/15	9/30/15	0	Lincoln, WY
CW	SEO	0402BR62	Johnson Pipeline 2 (Pivot 3)	n/a	5/1/12	11/9/15	4	Lincoln, WY

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
CX	SEO	0402BR61	Johnson Pipeline 2	n/a	5/1/12	9/30/15	3	Lincoln, WY
CY	SEO	0404BR55	Francis Lee(*)	n/a	5/1/08	9/30/15	7	Uinta, WY
CZ	SEO	0404BR54	Bear River Canal (*)	n/a	5/1/08	9/30/15	7	Uinta, WY
DA	SEO	0404BR56	Woodruff Narrows Reservoir	n/a	3/20/12	9/30/15	4	Uinta, WY
DB	SEO	0404BR45	Chapman (Stateline)	n/a	5/1/08	9/30/15	7	Uinta, WY
DC	SEO	0404BR50	Johnson No. 1 Pump	n/a	5/1/08	9/30/15	7	Uinta, WY
DD	SEO	0404BR51	Tunnel	n/a	5/1/08	9/30/15	7	Uinta, WY
DE	SEO	0404BR49	Olson No. 1 Pump	n/a	5/1/08	9/30/15	7	Uinta, WY
DF	SEO	0404BR48	Browns & Bruce	n/a	5/1/08	11/23/15	8	Uinta, WY
DG	SEO	0404BR47	Morris Bros Irrigating (Lower)	n/a	5/1/08	9/30/15	7	Uinta, WY
DH	SEO	0404BR44	Chapman (Headgate)	n/a	5/1/08	9/30/15	7	Uinta, WY
DI	SEO	0404BR43	Turner	n/a	5/1/08	9/30/15	7	Uinta, WY
DJ	SEO	0404BR42	Nixon West Side	n/a	5/1/08	9/30/15	7	Uinta, WY
DK	SEO	0404BR41	Bowns	n/a	5/1/08	9/30/15	7	Uinta, WY
DL	SEO	0404BR40	Sims, Blight & Turner	n/a	5/1/08	9/30/15	7	Uinta, WY
DM	SEO	0404BR39	Almy	n/a	5/1/08	9/30/15	7	Uinta, WY
DN	SEO	0404BR33	S.P.	n/a	5/1/08	9/30/15	7	Uinta, WY
DO	SEO	0404BR35	Michael Sims	n/a	5/1/08	9/30/15	7	Uinta, WY
DP	SEO	0404BR38	Fearne Irrigating & Saxton-Thomas	n/a	5/1/08	9/30/13	5	Uinta, WY
DQ	SEO	0404BR37	Morganson	n/a	5/1/08	9/30/13	5	Uinta, WY
DR	SEO	0404BR32	John Sims	n/a	5/1/08	9/30/15	7	Uinta, WY
DS	SEO	0404BR36	Junction	n/a	5/1/08	9/30/15	7	Uinta, WY
DT	SEO	0404BR34	A.W. Sims	n/a	5/1/08	9/30/13	5	Uinta, WY
DU	SEO	0404BR61	Bruce-Barton	n/a	5/1/08	9/30/13	5	Uinta, WY
DV	SEO	0404BR62	Sim's Creek Slough Diversion	n/a	5/1/14	9/30/15	1	Uinta, WY
DW	SEO	0404BR31	Fritzy	n/a	5/1/08	9/30/13	5	Uinta, WY

Table 3.4.4.2.1 (Cont.)

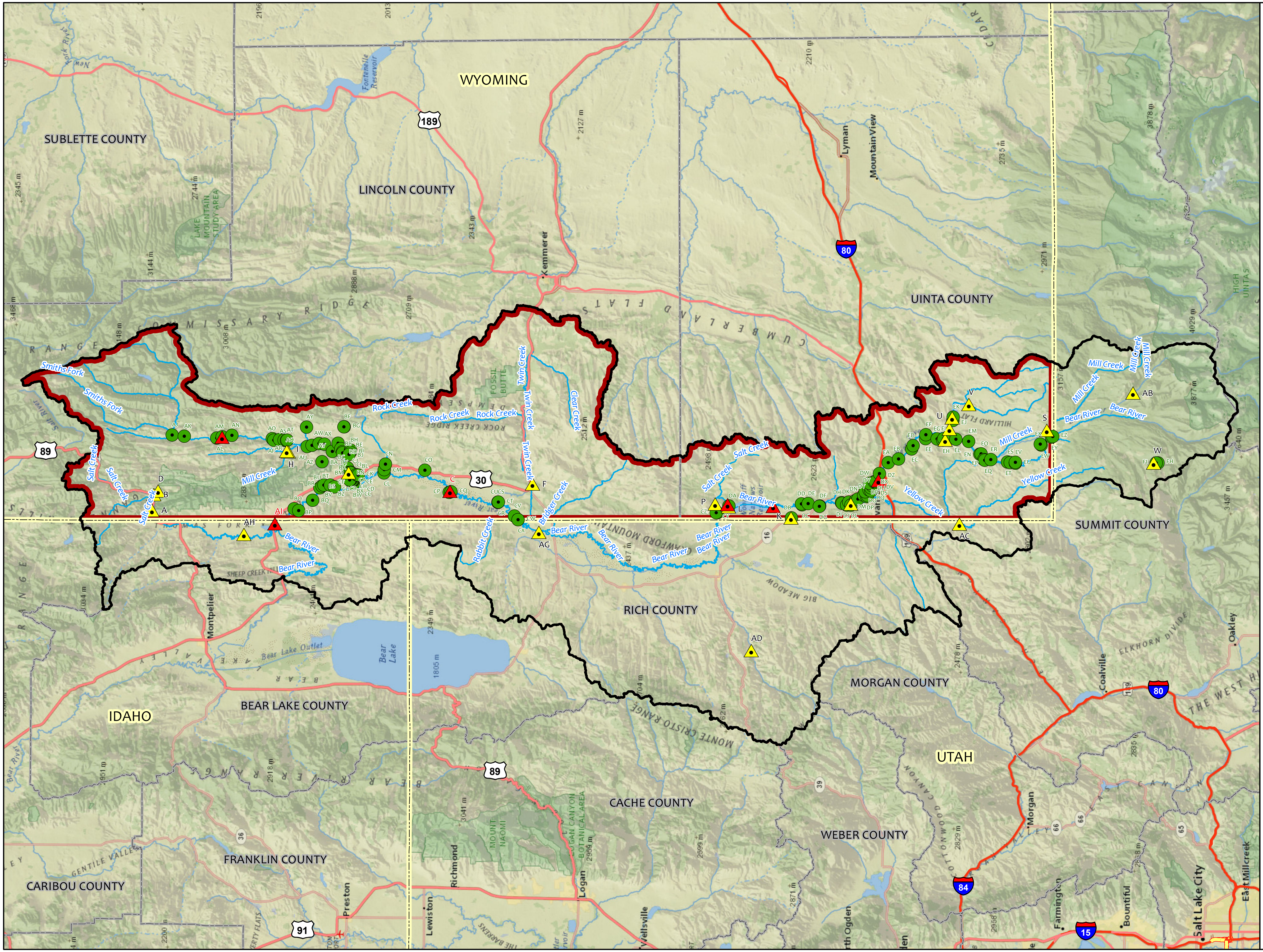
ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
DX	SEO	0404BR30	Johnston & Narramore	n/a	5/1/08	9/30/15	7	Uinta, WY
DY	SEO	0404BR29	Fife Irrigating	n/a	5/1/08	9/30/15	7	Uinta, WY
DZ	SEO	0404BR59	B.E.A.R. Project Pipeline	n/a	5/1/08	9/30/15	7	Uinta, WY
EA	SEO	0404BR27	Faulkner	n/a	5/1/08	9/30/15	7	Uinta, WY
EB	SEO	0404BR26	Wilson Irrigating	n/a	5/1/08	9/30/15	7	Uinta, WY
EC	SEO	0404BR22	Evanston Water	n/a	5/1/08	9/30/15	7	Uinta, WY
ED	SEO	0404BR24	State Hospital Ditch	n/a	5/1/08	9/30/15	7	Uinta, WY
EE	SEO	0404BR23	Knight No. 1&2	n/a	5/1/08	9/30/15	7	Uinta, WY
EF	SEO	0404BR60	Ev Water Supply	n/a	5/1/08	9/30/15	7	Uinta, WY
EG	SEO	0404BR21	Cornelison	n/a	5/1/08	9/30/15	7	Uinta, WY
EH	SEO	0404BR19	Booth	n/a	5/1/08	9/30/15	7	Uinta, WY
EI	SEO	0404BR20	Anel Irrigating	n/a	5/1/08	9/30/15	7	Uinta, WY
EJ	SEO	0404SC80	Sulphur Creek Res. Storage Release	n/a	5/1/12	9/30/15	3	Uinta, WY
EK	SEO	0404SC09	Sulphur Creek Reservoir	n/a	9/30/11	9/30/15	4	Uinta, WY
EL	SEO	0404BR17	Myers Irrigating	n/a	5/1/08	9/30/15	7	Uinta, WY
EM	SEO	0404BR16	Myers No. 1	n/a	5/1/08	9/30/15	7	Uinta, WY
EN	SEO	0404BR18	Evanston Pipeline	n/a	5/1/08	9/30/15	7	Uinta, WY
EO	SEO	0404BR15	Knoder	n/a	5/1/08	9/30/15	7	Uinta, WY
EP	SEO	0404BR06	Danielson	n/a	5/1/08	9/30/15	7	Uinta, WY
EQ	SEO	0404BR14	Coffman	n/a	5/1/08	9/30/15	7	Uinta, WY
ER	SEO	0404BR13	Hare	n/a	5/1/08	9/30/15	7	Uinta, WY
ES	SEO	0404BR12	Myers No. 2	n/a	5/1/08	9/30/15	7	Uinta, WY
ET	SEO	0404BR11	Lewis & Blanchard	n/a	5/1/08	9/30/15	7	Uinta, WY
EU	SEO	0404BR10	Homer	n/a	5/1/08	9/30/15	7	Uinta, WY
EV	SEO	0404BR09	Lewis (D4)	n/a	5/1/08	9/30/15	7	Uinta, WY
EW	SEO	0404BR08	McGraw	n/a	5/1/08	9/30/15	7	Uinta, WY

Table 3.4.4.2.1 (Cont.)

ID	Agency	Site ID	Site Name	Drainage Area (sq mi)	Operation Begin	Operation End	Period of Record (yrs)	County
EX	SEO	0404BR07	Crown & Pine Grove	n/a	5/1/08	9/30/15	7	Uinta, WY
EY	SEO	0404BR04	Tropic	n/a	5/1/08	9/30/15	7	Uinta, WY
EZ	SEO	0404BR03	Bear (Bear R)	n/a	5/1/08	9/30/15	7	Uinta, WY
FA	SEO	0404BR02	Hilliard West Side	n/a	5/1/08	9/30/15	7	Summit, UT
FB	SEO	0404BR01	Lannon & Lone Mtn	n/a	5/1/08	9/30/15	7	Summit, UT
FC	SEO	0404BR05	Kreider Domestic Pump	n/a	5/1/08	9/30/15	7	Summit, UT
FD	SEO	0404WFB3	Hatch (W Fk)	n/a	5/1/08	9/30/15	7	Summit, UT
FE	SEO	0404WF82	Grassy Lake Storage Release	n/a	5/1/12	9/30/15	3	Summit, UT
FF	SEO	0404EFB2	Hilliard East Fork (E Fk)	n/a	5/1/08	9/30/15	7	Summit, UT
FG	SEO	0404EFB1	Havorka (E Fk)	n/a	5/1/08	9/30/15	7	Summit, UT
FH	SEO	0404WF81	Whitney Res. Storage Release	n/a	1/1/04	9/30/15	112	Summit, UT
FI	SEO	0404WFB1	Whitney Reservoir	n/a	1/1/04	9/30/15	112	Summit, UT

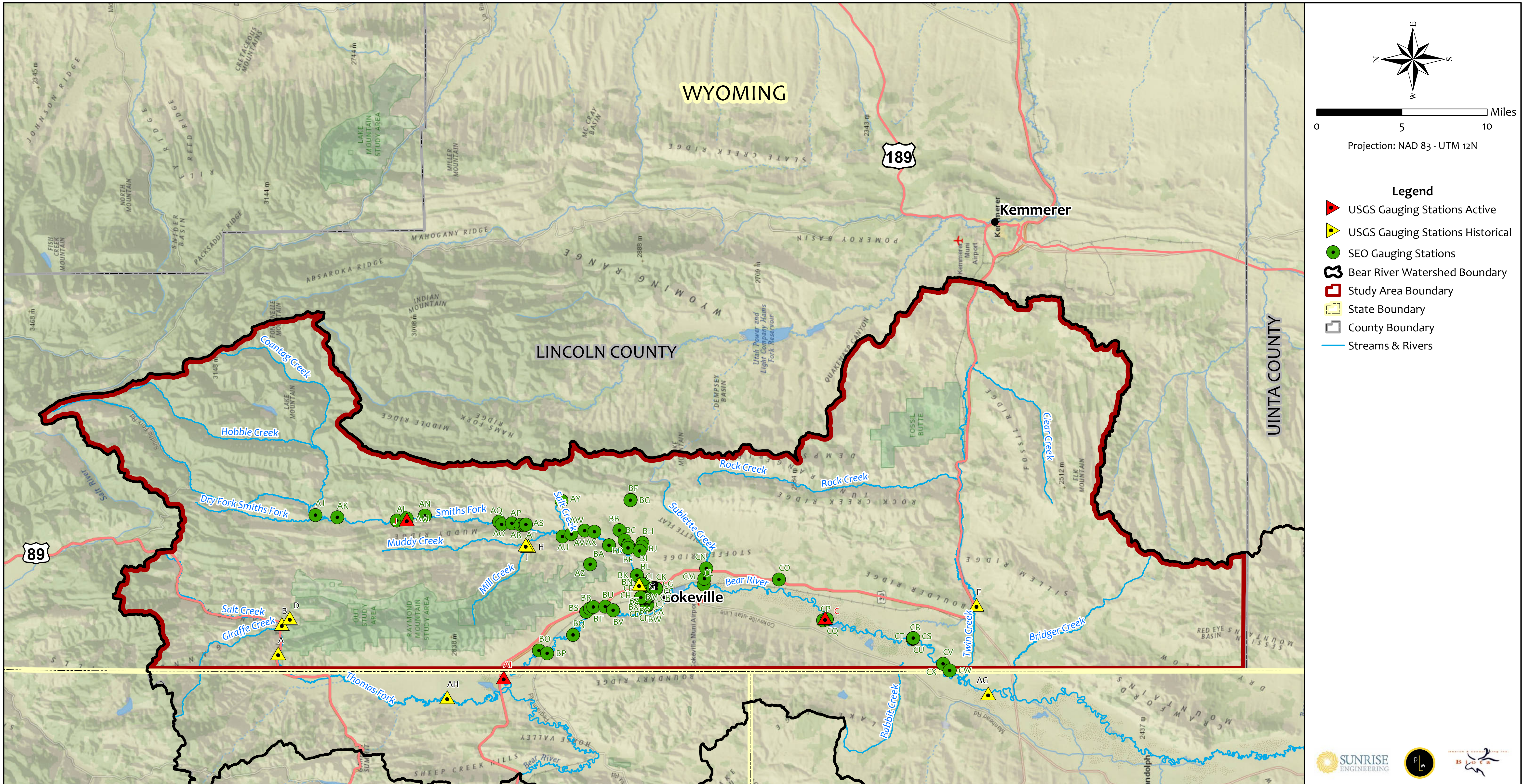
Mean daily discharges were obtained from 5 long-established USGS stream gauging stations in the basin including:

Bear River below reservoir near Woodruff, UT (Site 10020300) with a record of 53 years
Bear River above reservoir near Woodruff, UT (Site 10020100) with a record of 53 years
Bear River at Evanston (Site 10016900) in Uinta County, WY with a record of 30 years
Bear River below Smiths Fork near Cokeville (Site 10038000) in Lincoln County, WY with a record of 60 years
Bear River at Border (Site 10039500) in Lincoln County, WY with a record of 77 years



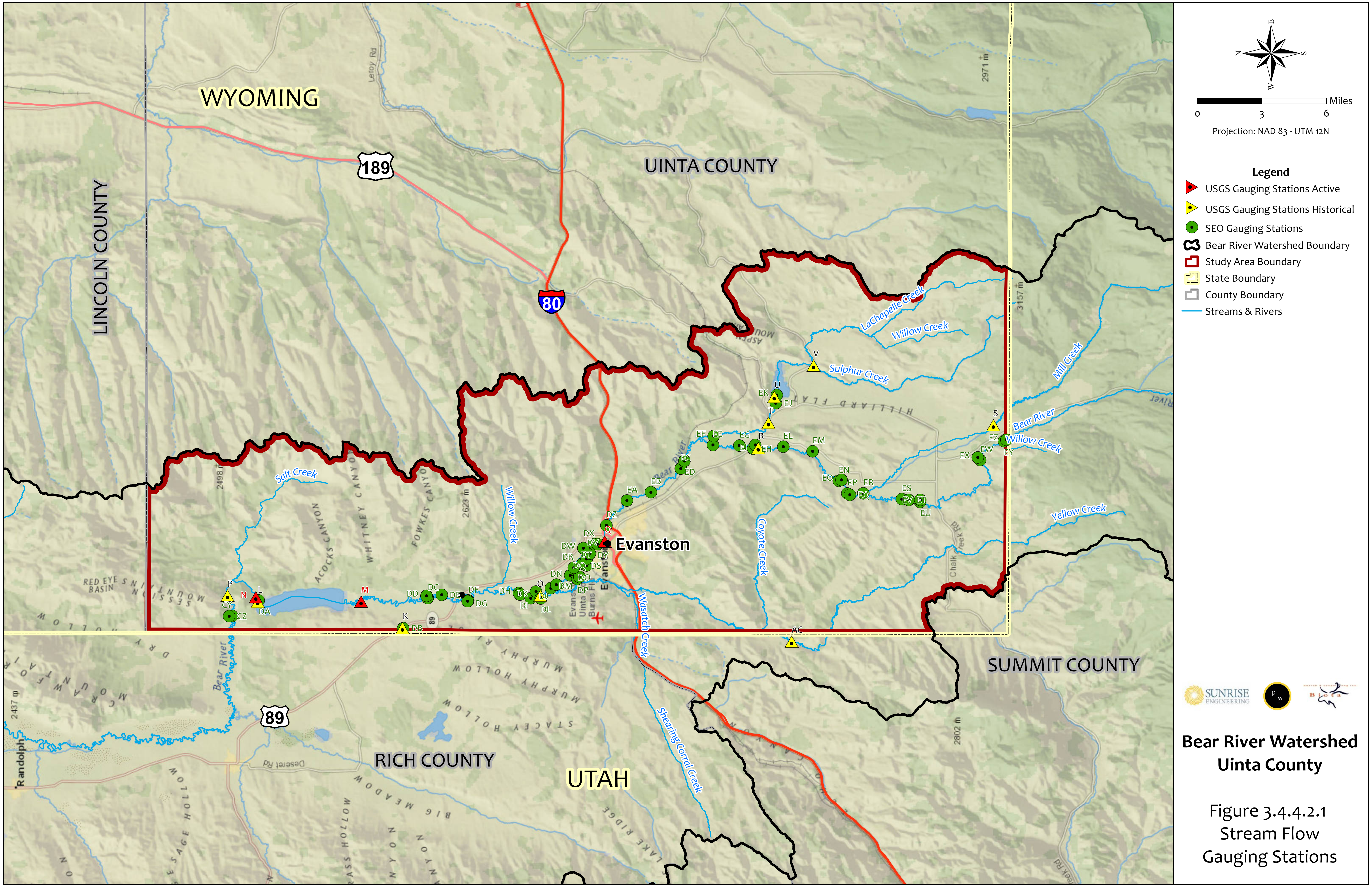
Bear River Watershed

Figure 3.4.4.2.1
Stream Flow
Gauging Stations



Bear River Watershed
Lincoln County

Figure 3.4.4.2.1
Stream Flow
Gauging Stations



Bear River Watershed
Uinta County

Figure 3.4.4.2.1
Stream Flow
Gauging Stations

Figures 3.4.4.2.2 and 3.4.4.2.3 depict mean daily discharge data with 80% and 20% values recorded at these locations. The hydrographs depict the typical timing and magnitude of flows within the Bear River study area and its tributary system. Elevated flows typically occur for about a 3-month period between May to July during spring snowmelt; declining flows are typical during the late summer; and base flows occur for a 4 to 5-month period during the winter months. Note the late summer dip in flows above the Woodruff Narrows Reservoir.

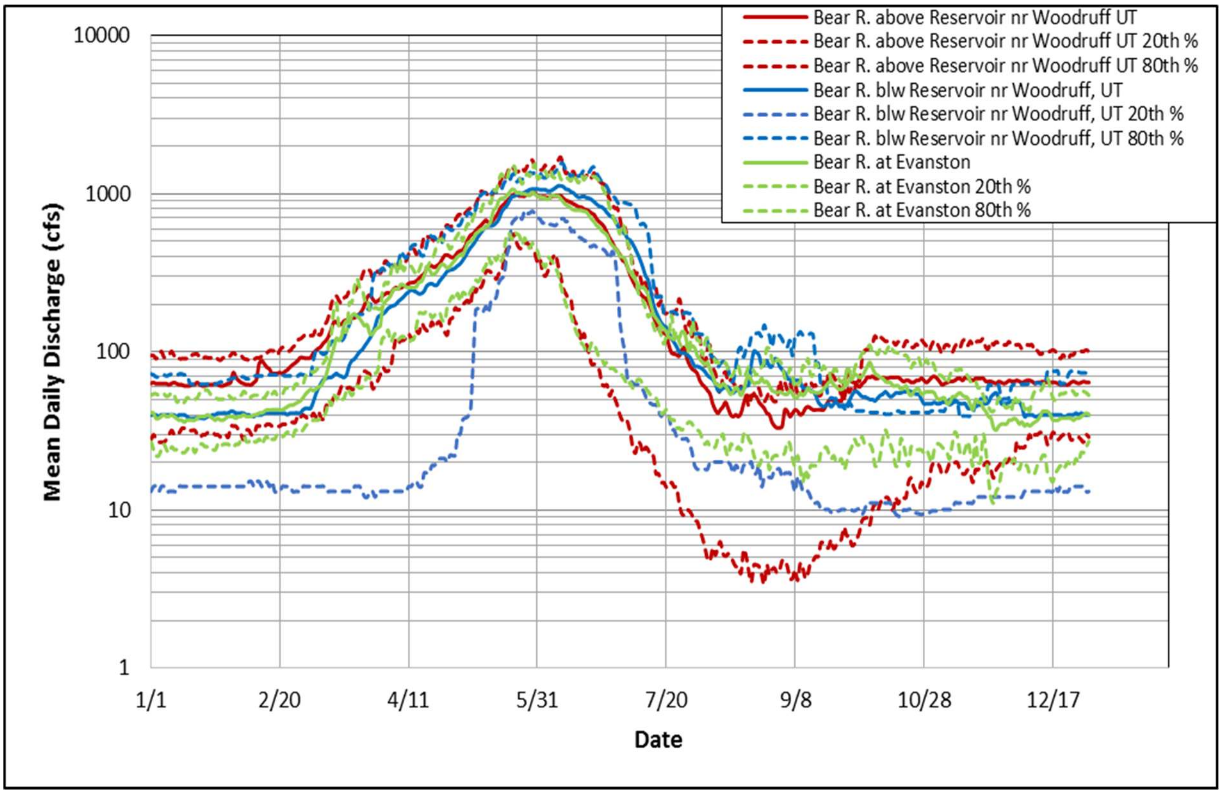


Figure 3.4.4.2.2. Mean daily discharge with 80% and 20% values from 3 USGS gauging stations with long period of record on the main stem in the Bear River Study Area near Woodruff Narrows Reservoir.

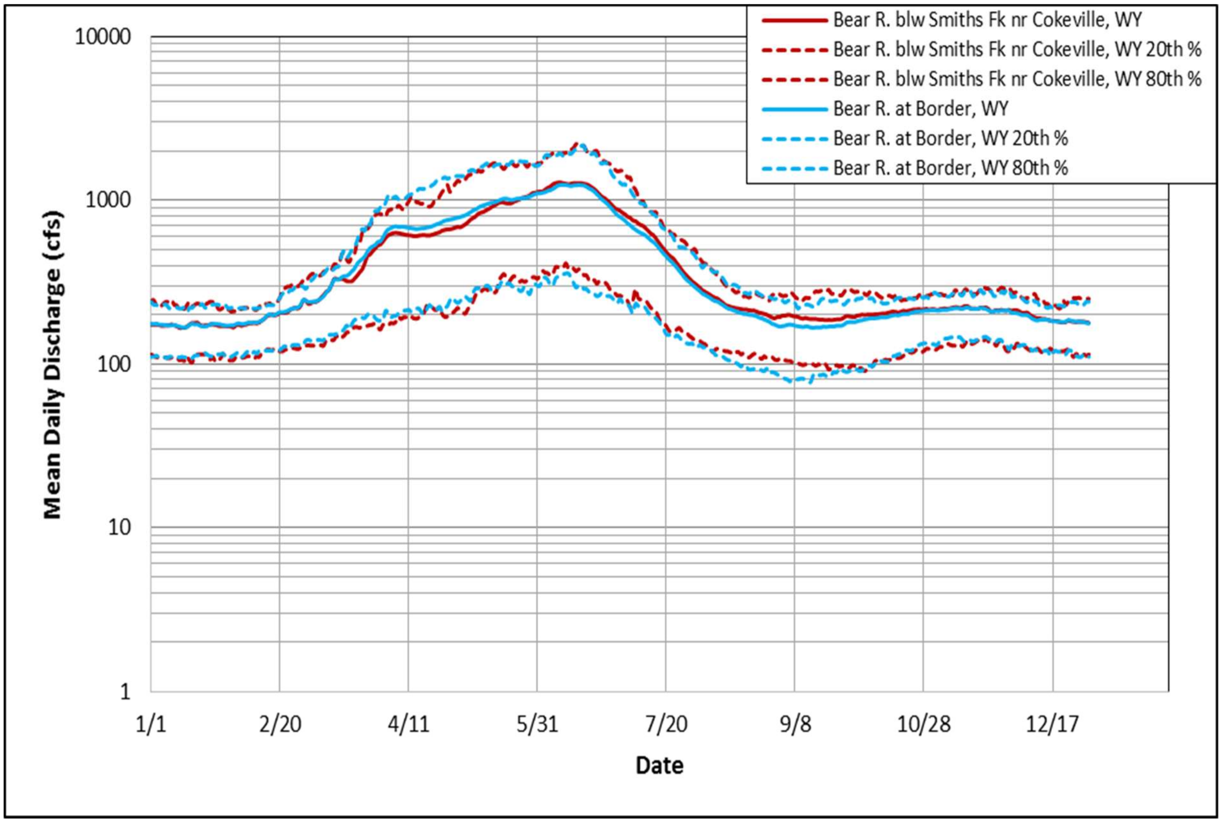


Figure 3.4.4.2.3. Mean daily discharge with 80% and 20% values from 2 USGS gauging stations with long period of record on the main stem in the Bear River Study Area near Cokeville, WY.

Figures 3.4.4.2.4 and 3.4.4.2.5 depict mean daily discharge flow duration curves developed from recorded flow data at the five gauging stations. Flow duration curves from these gauges have similar slopes, reflective of the flashy snow-melt driven hydrologic regime in the basin. At all 3 locations from the upper Bear River Study Area, the 50% exceedance discharge is between 1% and 2.5% of the recorded peak mean daily discharge, and the 100% exceedance discharge is less than 1% of the recorded peak (Figure 3.4.4.2.4). The gauges in Bear River study area near Cokeville, WY have 50% exceedance discharge values at about 4% of the recorded peak (Figure 3.4.4.2.5).

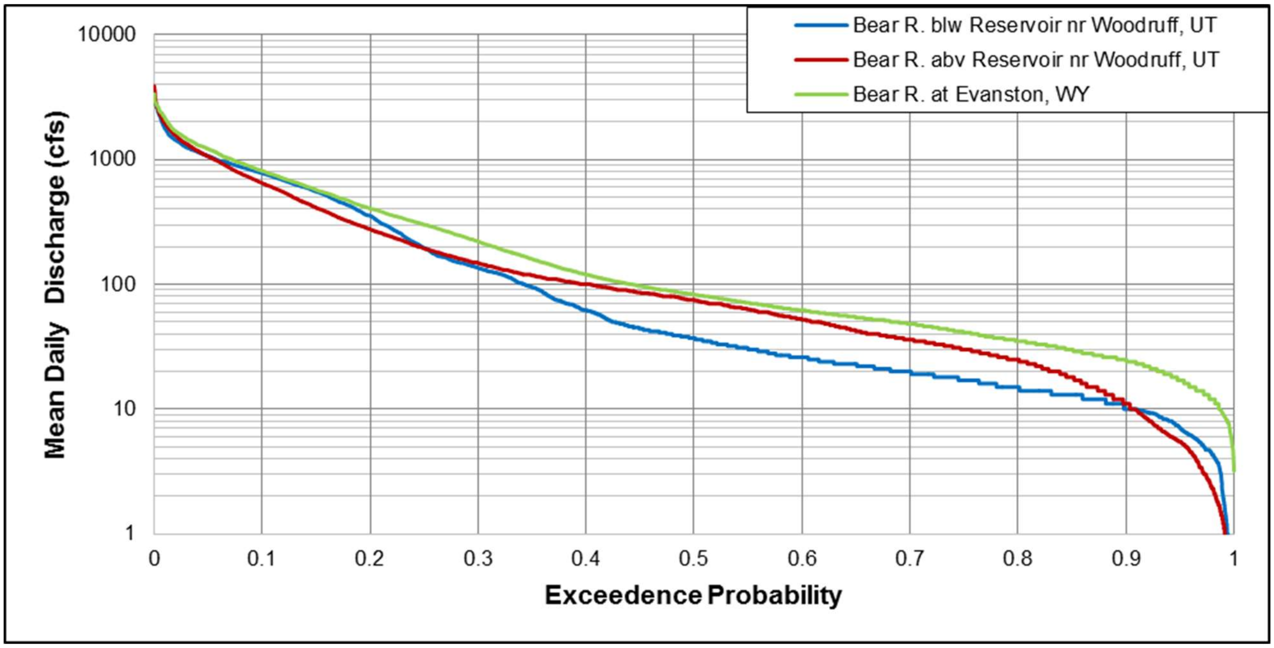


Figure 3.4.4.2.4. Mean daily discharge flow duration curves developed from 3 gauging stations in the Bear River study area near Woodruff Narrows Reservoir.

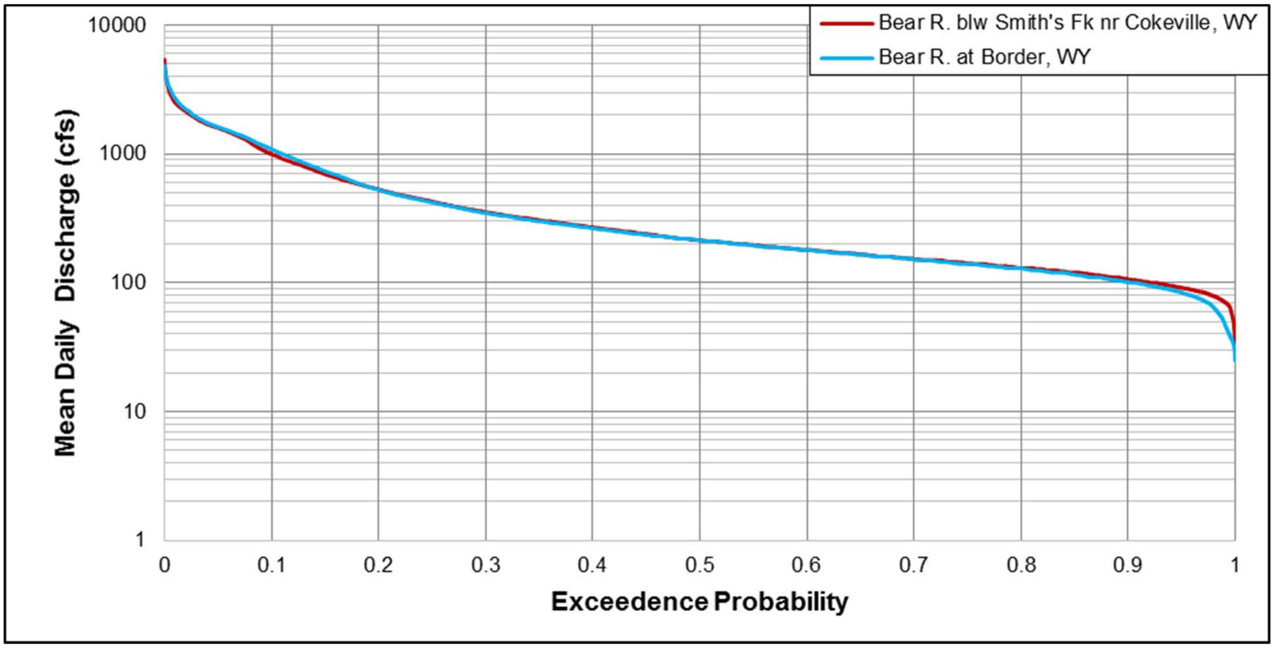


Figure 3.4.4.2.5. Mean daily discharge flow duration curves developed from 2 gauging stations in the Bear River Study Area near Cokeville, WY.

3.4.4.3 Temporary Stream Gauging Stations

Temporary streamflow gauging stations were established to quantify surface water resources at areas of interest within the watershed study area. Temporary gauging stations were established in Rock Creek, Mill Creek, and Salt Creek in Lincoln County, and Yellow Creek in Uinta County.

Temporary stream flow gauging stations were equipped with permanent elevation benchmarks located within the floodplain, a staff plate, and a pressure transducer datalogger (manufactured by Schlumberger) set to record stage at 15-minute intervals throughout the deployment period. Gauge sites were placed in single thread channel reaches with stable channel morphology appropriate to maintain a relationship between stage and discharge at all anticipated discharge rates.

The Salt Creek, Yellow Creek, and Rock Creek gauges were established in November of 2015 as soon as landowner permissions were obtained. The Mill Creek gauge was established in April of 2016, after the project sponsor was successful in reaching landowners and securing authorization for site access.

Discharge measurements were collected at all gauging stations using a Marsh-McBirney digital conductance flow meter and a top-set wading rod following established protocols (i.e., USGS Techniques of Water-Resources Investigations Book 3 Applications of Hydraulics; USGS Water Supply Paper 2175 by Rantz, 1982). Multiple discharge measurements were collected at each gauging station location across the range of flow rates experienced during the study period. Site-specific stage-discharge correlations were developed from measured discharge and stage data. In addition, channel surveys were conducted at all gauging stations in order to quantify site-specific channel slope; sinuosity; staff plate elevation; local floodplain elevation; and channel geometry. Survey data were subsequently used in conjunction with measured hydraulic roughness (Manning's n-value) and open channel flow equations to calculate discharge at moderate to high stages. Calculated hydraulic conditions were used to further assess stage-discharge correlations, and to bolster the middle and upper portions of the stage-discharge rating curves. Figure 3.4.4.3 shows the relative location of the temporary gauge locations.

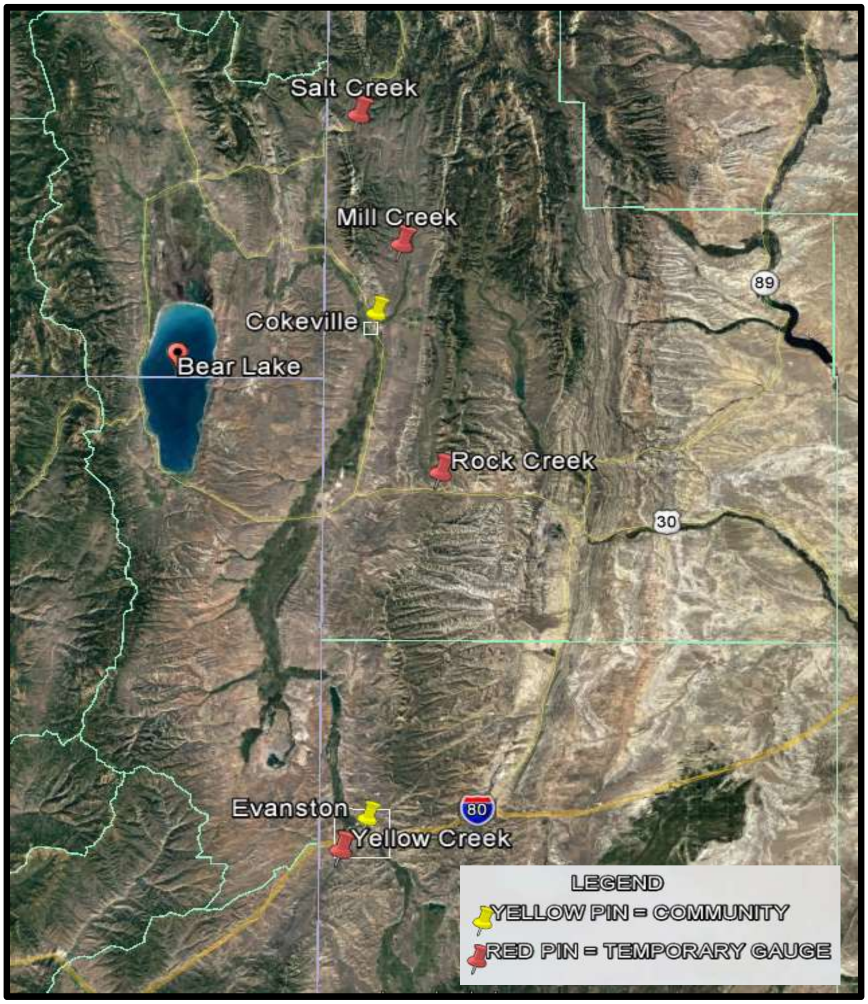


Figure 3.4.4.3 General Temporary Gauge Locations

Salt Creek

The Salt Creek gauging station (Lincoln County) was located downstream of its confluence with Coal Creek (42.39992 N, -110.99365 W), at the approximate location of a historical USGS gauging station (USGS 10040500 Salt Creek Near Geneva, Idaho). Neither hardware or benchmarks from the historical gauging station operations could be located in the field, so the temporary gauging station was established in a single channel reach with stable morphology. The staff plate was established in November of 2015 and an instantaneous discharge of 8.9 cfs was measured. The gauging station was not activated at that time due to freezing conditions that could damage computerized hardware and because prevalent shore and anchor ice were altering local hydraulic conditions (i.e. the relationship between stage and discharge). The gauging station was re-activated on April 6, 2016 and was operated continuously until the fall of 2016. Figure 3.4.4.3.1 depicts the instantaneous discharge (15-minute interval), the mean daily discharge, and the cumulative conveyance based upon 2016 data recorded at the site. The instantaneous peak discharge is 222 cfs and the peak mean daily discharge is 170 cfs. During the 2016 study period from April 6 to October 13, the location conveyed approximately 18,215 ac-ft of water.

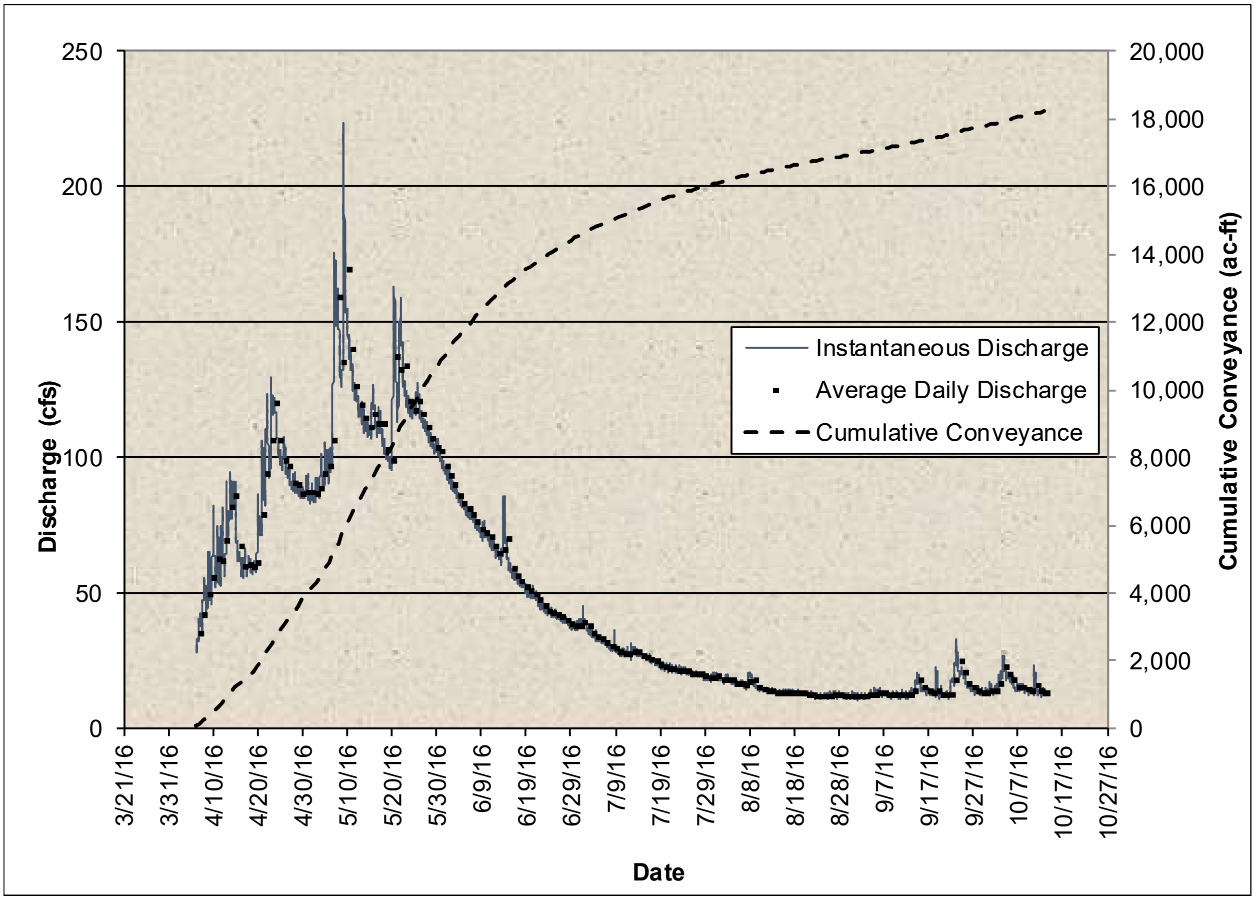


Figure 3.4.4.3.1. Instantaneous discharge and mean daily discharge at Salt Creek gauging station, Lincoln County, Wyoming.

Rock Creek

A gauging station was established in Rock Creek (Lincoln County) downstream of the intersection with U.S. Route 30 (41.82339 N, -110.82924 W). The temporary gauging station was installed in a single channel reach with stable morphology on November 9, 2015. The gauging station was not activated at that time due to freezing conditions that could damage computerized hardware and because prevalent shore and anchor ice were altering local hydraulic conditions (i.e. the relationship between stage and discharge). The site was equipped with pressure transducer and data logger on April 6, 2016 and was operated continuously until the fall of 2016. Figure 3.4.4.3.2 depicts the instantaneous discharge (15-minute interval), the mean daily discharge, and the cumulative conveyance based upon 2016 data recorded at the site. The instantaneous peak discharge is 88 cfs and the peak mean daily discharge is 45 cfs. During the 2016 study period from April 6 to October 13, the location conveyed approximately 5,065 ac-ft of water.

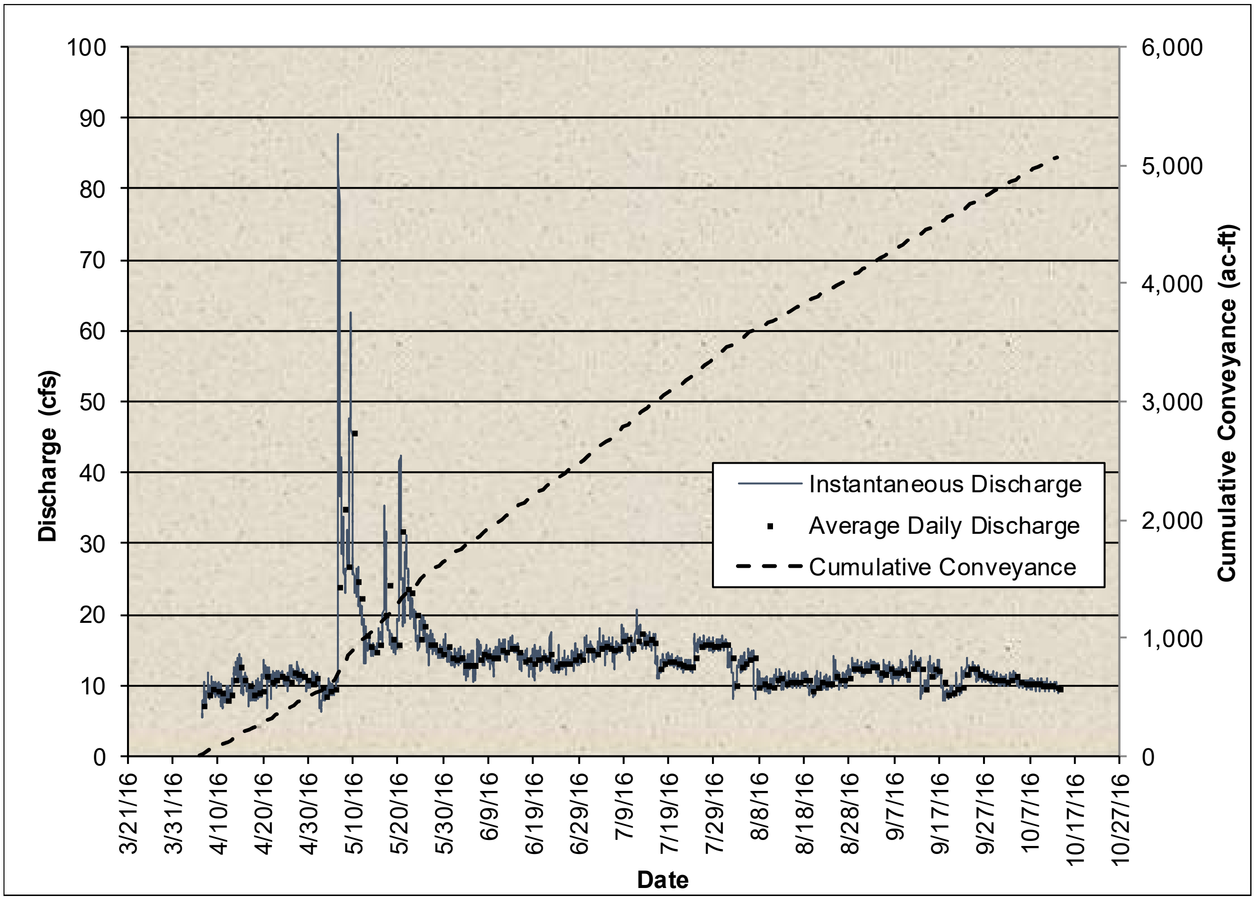


Figure 3.4.4.3.2. Instantaneous discharge and mean daily discharge at Rock Creek gauging station, Lincoln County, Wyoming.

Yellow Creek

A gauging station was established in Yellow Creek (Uinta County) approximately 100 feet downstream of the intersection with Yellow Creek Road (41.21392 N, -111.01448 W). The temporary gauging station was installed in a single channel reach with stable morphology on November 9, 2015. The gauging station was not activated at that time due to freezing conditions that could damage computerized hardware and because prevalent shore and anchor ice were altering local hydraulic conditions (i.e. the relationship between stage and discharge). The site was equipped with pressure transducer and data logger on April 6, 2016 and was operated continuously until the fall of 2016. Figure 3.4.4.3.3 depicts the instantaneous discharge (15-minute interval), the mean daily discharge, and the cumulative conveyance based upon 2016 data recorded at the site. The instantaneous peak discharge is 31 cfs and the peak mean daily discharge is 28 cfs. During the 2016 study period from April 6 to October 13, the location conveyed approximately 1,650 ac-ft of water.

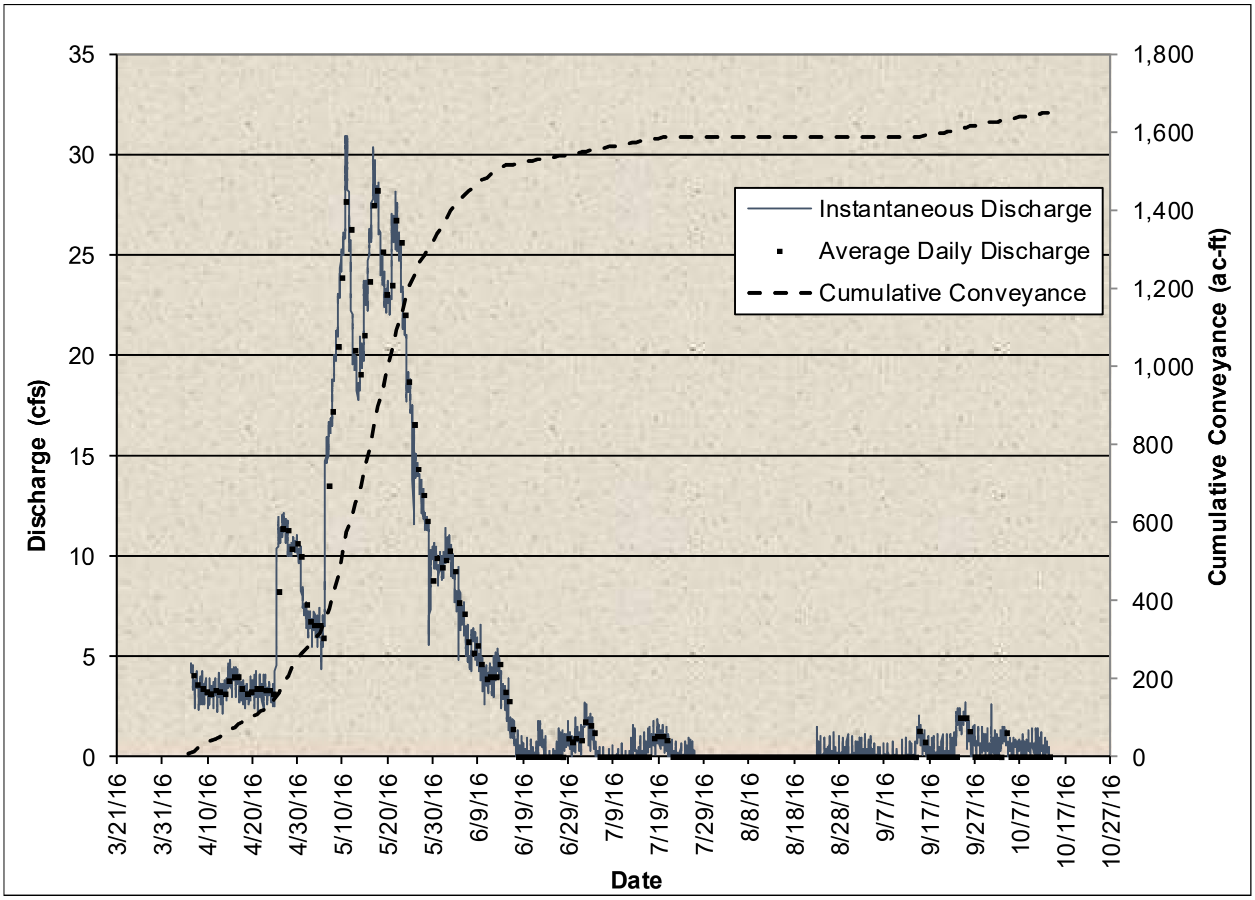


Figure 3.4.4.3.3. Instantaneous discharge and mean daily discharge at Yellow Creek gauging station, Uinta County, Wyoming.

Mill Creek

A gauging station was established in Mill Creek (Lincoln County) approximately 0.5 miles upstream of the confluence with Muddy Creek. (42.191164 N, -110.907022 W). The temporary gauging station was installed in a single channel reach with stable morphology and equipped with pressure transducer and data logger on April 21, 2016. The site was operated continuously until the fall of 2016. Figure 3.4.4.3.4 depicts the instantaneous discharge (15-minute interval), the mean daily discharge, and the cumulative conveyance based upon 2016 data recorded at the site. The instantaneous peak discharge is 11 cfs and the peak mean daily discharge is 10 cfs. During the 2016 study period from April 21 to October 13, the location conveyed approximately 1,613 ac-ft of water.

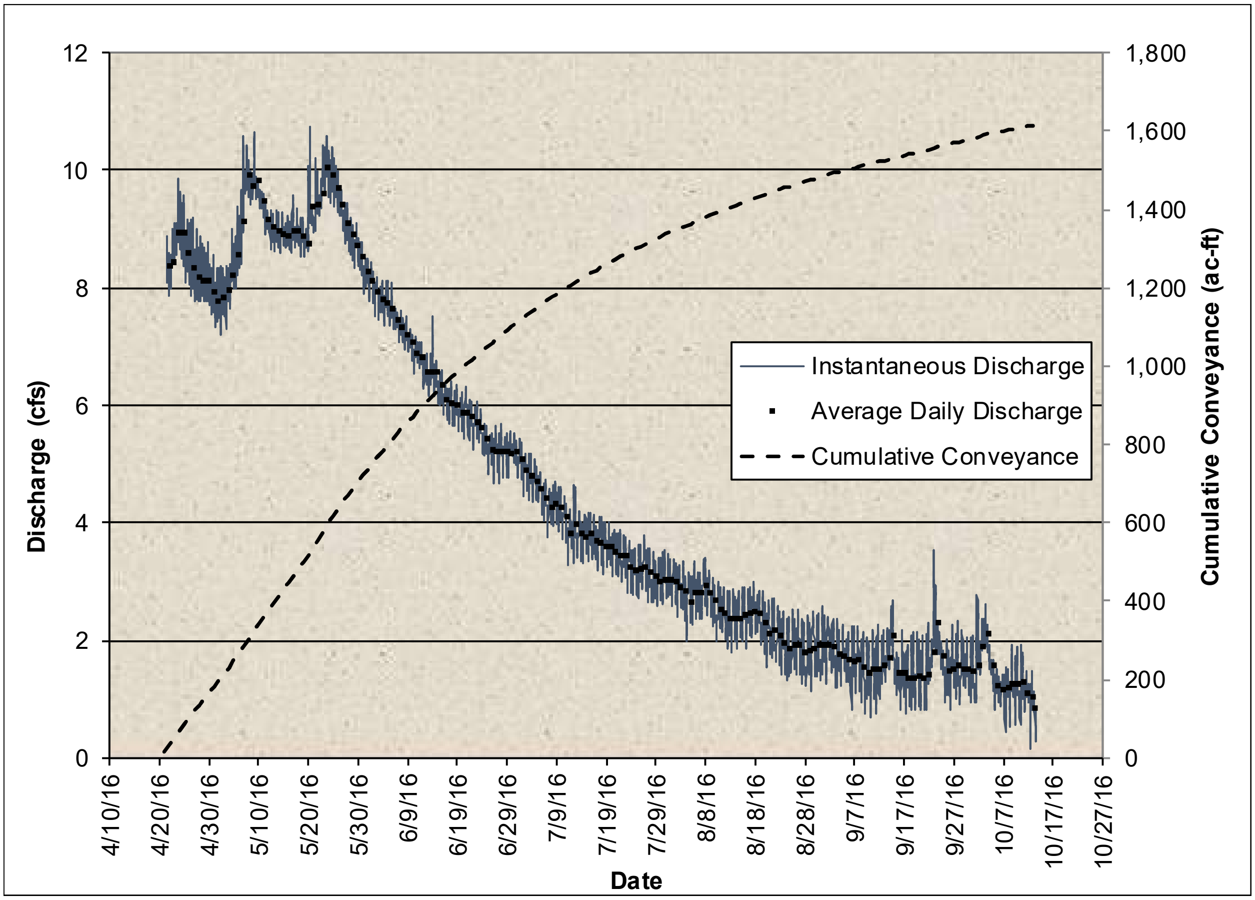


Figure 3.4.4.3.4. Instantaneous discharge and mean daily discharge at Mill Creek gauging station, Lincoln County, Wyoming.

Conclusion

Analysis of recorded flow data from the US Geological Survey Bear River at Border, Wyoming, gauging station (#10039500) indicates that 2016 was a relatively average year. Mean daily discharge data from the entire period of record (1938-present) were obtained from the site. Data were used to rank water years by percentile based upon the mean daily discharge for the study period (April 6 to October 13). The median year from the period of record has a mean daily discharge of 521 cfs. The mean daily discharge during the 2016 study period is 481 cfs, which corresponds to approximately the 40th percentile year from the period of record. Figure 3.4.4.3.5 depicts the cumulative conveyance at the USGS Bear River near Border gauging station during 1975 which represents a wet year (D80), during 1991 which represents a dry year (D20), during 1978 which represents the median year (D50), and during the 2016 study period. The cumulative water conveyance in 2016 is 181,550 ac-ft, which is approximately 77% of that conveyed during the median water year. Analysis indicates that mean daily discharge and cumulative water conveyance recorded at the temporary stream gauging locations during the 2013 study period reflect conditions during an average year (40th percentile), and likely represent approximately 77% of a normal, or median, water year.

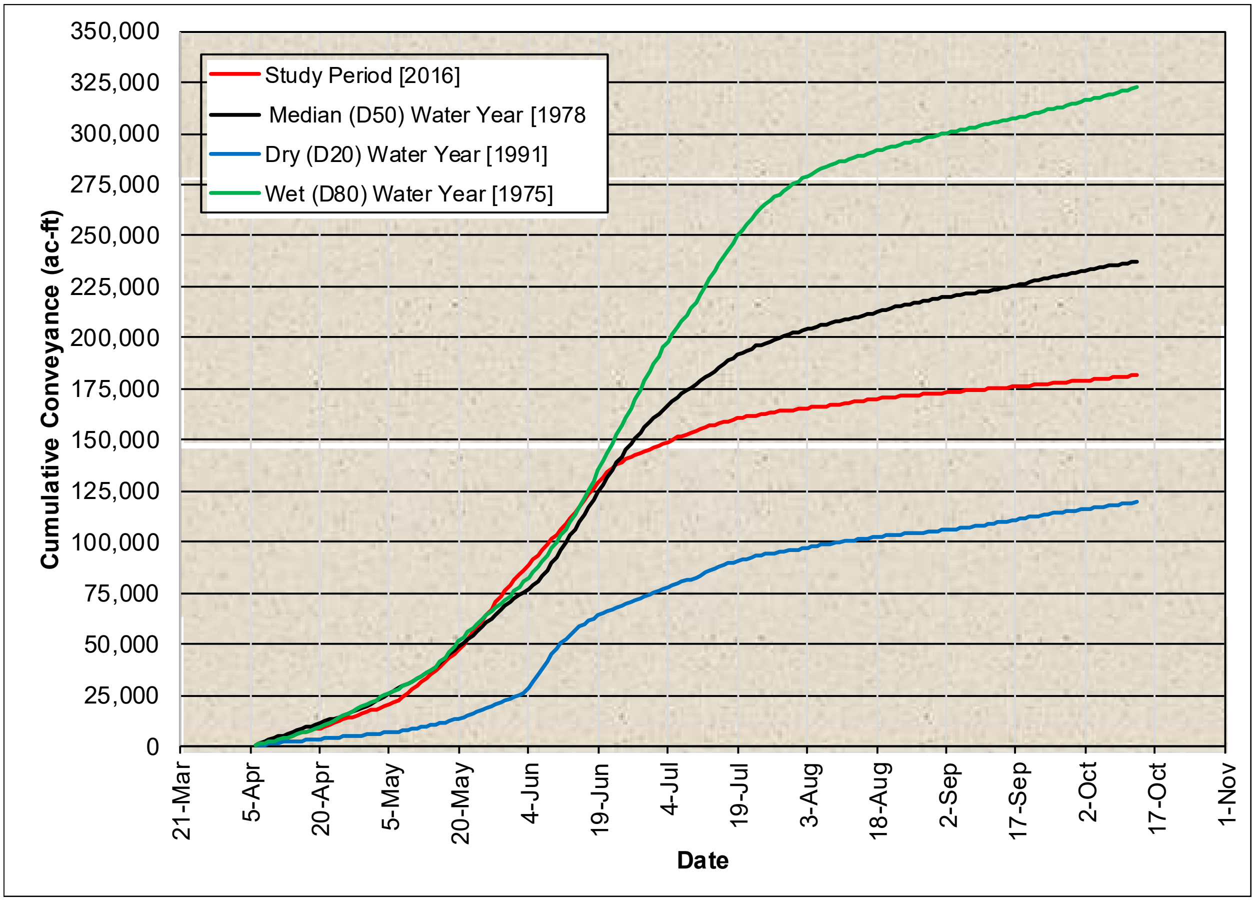


Figure 3.4.4.3.5. Cumulative conveyance at the USGS Bear River at Border, WY gauging station (10039500), Bear River Watershed, Wyoming.

3.4.4.4 Bear River Planning Model

A river planning model was prepared for the Bear River drainage in the 2001 Bear River Basin Plan. Portions of this model were updated in the 2011 Bear River Basin Plan Update. The model is actually three models consisting of dry, normal and wet hydrological conditions. The models estimate the amount of water put to beneficial use under the given condition. The model divides the basin into twelve reaches and estimates water available at the bottom of each reach. As stated in the 2011 Basin Plan Update; “This method of determining availability does not take into account any legal entitlements to downstream users; rather it is assumed that the legal water used is reflected in the hydrologic and diversion records”.

To update the model, stream gauge data was added up through the year 2014. Section 6.2 of this report contains additional discussion of the model and modeling results.

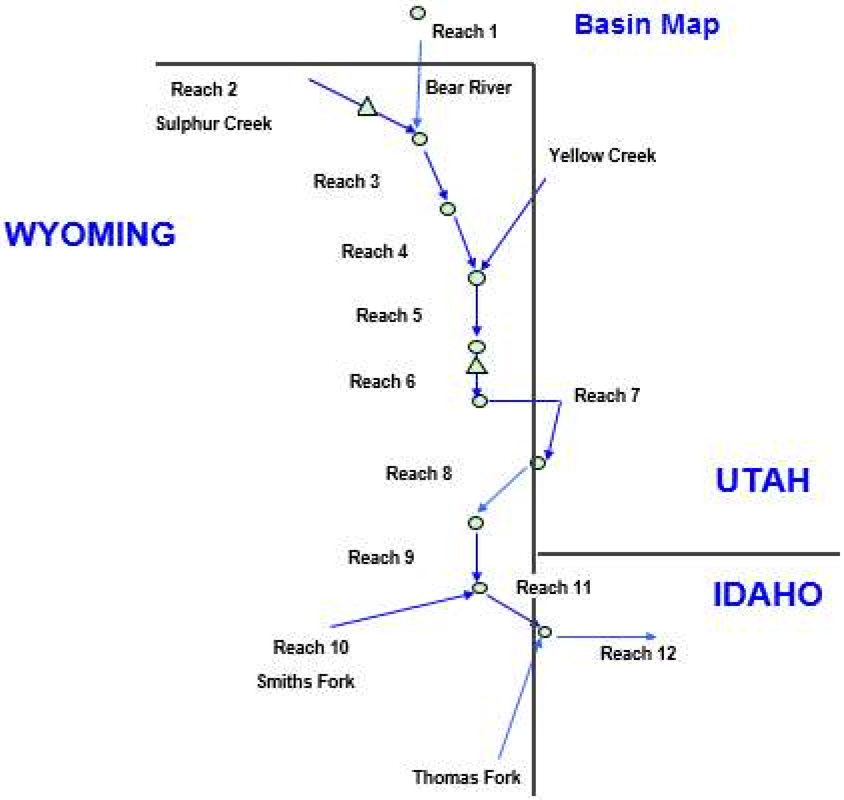


Figure 3.4.4.4.1 Bear River Basin Map from Planning Model (North is downward)

Refer to Section VI. Water Supply and Storage Opportunities for more information regarding water supply and storage.

3.4.4.5 EXISTING STORAGE FACILITIES

Within the Bear River Watershed study area the benefits of storage have long been recognized. Several smaller storage facilities exist in the basin having local significance and benefit. Existing storage sites within the Bear River Watershed study area are listed in Table 3.4.4.5 by order of size. In addition to the larger reservoirs on this table, numerous constructed stock ponds are distributed throughout the watershed. The functionality of the ponds varies with many of the ponds suffering from sediment build up and erosion of the dam itself.

Table 3.4.4.5 Existing Reservoirs in Bear River Watershed

Reservoir Site Name	Permit Number	Priority	Source	Volume (AF)
Woodruff Narrows	6556 U& WR, 8060R,8061R	1959, 1975, 1979	Bear River	57,300
Sulpher Creek Reservoir	5695R,6481R, 6562R, 9222R	1950, 1958, 1982	Sulpher Creek	19,775
Whitney Reservoir	Utah Permit		Bear River	4,200
Myers Reservoir	5064R	3-28-1939	Mill Creek	556.5
3rd Enl. Crompton Res.	6117R	2-5-1954	Pleasant Valley	406.25
Heber Reservoir	896R	8-21-1906	Willow Creek	388.5
Enl. Crompton Reservoir	5270R	4-25-1940	Pleasant Valley	208.68
Painter Reservoir	5515R	12-7-1943	Pleasant Valley	167.61
Massae Reservoir	6884R, 6885R	1960, 1967	Mill Creek	158.19
Blake Reservoir	5698R	12-15-1949	Willow Creek	152.70
Richey Reservoir	3309R	7-11-1916	Twin Creek	135.95
East (A.V. Quinn)	1159R	9-20-1907	Sulphur Creek	125
Thoman Reservoir	5513R	9-16-1943	Gooseberry Draw	98.08
Quealy Sheep - Q.P.	2753R	10-12-1914	Birch Cr. Springs	97.1
Crompton Reservoir	4057R	1-20-1928	Pleasant Valley	90.83
Martin Reservoir (Bazoo Hollow)	6434R	5-29-1958		87.90
C.H. Smith Reservoir	3370R	10-26-1916	South Fork Twin Creek	84.55
Enl. Crompton Reservoir	4616R	11-13-1934	Pleasant Valley	79.46
Rock Reservoir	2748R	10-3-1914	Hartley Creek	72.5
Holland Reservoir	2379R	10-21-1911	Leeds Creek	65.32
Pacific Fruit Express	2048R	1-19-1911	Bear River	64.62
Bartek	3221R	11-12-1915	Rock Creek	36.12
Noblitt No. 1	1669R	9-21-1907	Erwin Creek	31.2
Angelo	5703R	9-4-1957	Buyer Creek	29.64
Noblitt No. 3	1671R	9-25-1907	Potatoe Creek	24.5
Wyman Reservoir	6484R	11-14-1958	Bear River	21.88
Noblitt - Poison Cr. Res.	1590R	8-2-1909	Poison Creek	21.5
Reed Lower	6096R	12-17-1953	Garrett Sprgs, Birch Creek	21.3
E.W. Smith Reservoir	3398R	10-20-1914	Spring Creek	20.7
Gus Reservoir	1588R	8-4-1909	Dipper Creek	20
Noblitt No. 2	1670R	9-25-1907	Potatoe Creek	18
Hawkins Cr. Res.	1841R	6-29-1910	Hawkins Creek	14.1
Ellen Reservoir	2673R	6-1-1914	Antelope Creek	12.8
Anna Reservoir	1589R	8-4-1909	Lindon Creek	12
Noblitt No. 4	I672R	9-21-1907	Erwin Creek	10.5
Maninfior	5559R	10-31-1945	Spring Creek	9.76
Reed Upper	6095R	12-17-1953	Garrett Sprgs, Birch Creek	8.55
Rasmussen Reservoir	3405R	1-4-1917	Springs (Yellow Creek	8.25
Larson	5499R	5-28-1943	Pine Creek	3.81
Stoffers Reservoir	2214R	8-16-1910	Wyman Creek	3.74
Frederick No. 1	2213R	6-3-1910	Underwood Creek	1.32
Martin	5544R	11-8-1944	North Sublette Creek	1.25

3.4.4.6 GROUNDWATER

The Bear River Watershed study area is underlain by various geologic units that function as groundwater filters and storage reservoirs. The valley bottoms have little topographic relief and are generally underlain by unconsolidated Cenozoic deposits and bedrock formations, while the steeper terrain of the headwater tributaries and watershed boundaries are commonly situated atop older Paleozoic and Mesozoic bedrock formations. The basin is bounded to the south by the Uinta Mountains, to the west by the Bear River Mountains and Wasatch Mountains, and to the north by the Wyoming Range.

Alluvial aquifers, generally considered unconfined aquifers, are typically close to the land surface and consist of layers of permeable material. Proximate to the land surface, alluvial aquifers are relatively vulnerable to anthropogenic impacts. These aquifers consist primarily of river, floodplain, and terrace deposits that border major river systems and are comprised primarily of sand, silt, and gravel on top of a bedrock foundation. Alluvial aquifers range in thickness from 10 to 100 feet or more, and contain water that is typically suitable for most purposes.

Structural basin aquifers are typically surrounded by mountain ranges with steep slopes of porous and/or fractured rock types. Permeable formations of fractured igneous and metamorphic rock or porous sedimentary rock such as sandstone, siltstone, and limestone are common geologic units of structural aquifers. In these conditions, hydrologic units often function as regional aquifers. Structural aquifers are typically less vulnerable to human influence due to a less permeable layer. Groundwater in these basins can be confined or unconfined, and confined aquifers can discharge water through springs.

A digital dataset generated by the Wyoming State Geological Survey (WSGS) containing digitized USGS spring location data within the Bear River basin was obtained. The dataset depicts 717 mapped springs within the Bear River Watershed study area (Figure 3.3.4.2d).

The Wyoming State Engineer's Office (WSEO) database of permitted wells within the Bear Green River basin was obtained. The database includes well parameters of permit number, priority date, facility name, applicant name, permitted uses, location, appropriation, total depth, static water level, and depth of pump. Most wells in the basin are constructed into the Cenozoic hydrogeologic units (lower Tertiary, upper Tertiary, and Quaternary hydrogeologic units). The WSEO identifies a permitted use for each well location. Major categories of permitted uses include domestic, industrial, irrigation, municipal, stock, miscellaneous, monitoring/test, and unknown. A total of 1,429 wells are permitted within the Bear River basin (Figure 3.3.4.2c), and the primary (first listed) permitted uses are broken down by category in Table 3.4.4.6.1 and Figure 3.4.4.6.1. A total of 58% of all permitted wells in the basin are classified as domestic use, and the second most abundant classification (at 16%) is for stock water.

Table 3.4.4.6.1. Well types within the Bear River Watershed Study Area.

Well Type	**Quantity**
Domestic (DOM)	834
Industrial (IND)	18
Irrigation (IRR)	67
Municipal (MUN)	8
Stock (STK)	232
Miscellaneous (MIS)	115
Monitor/Observation/Test (MON/TST)	152
Unknown	3
Total	**1,429**

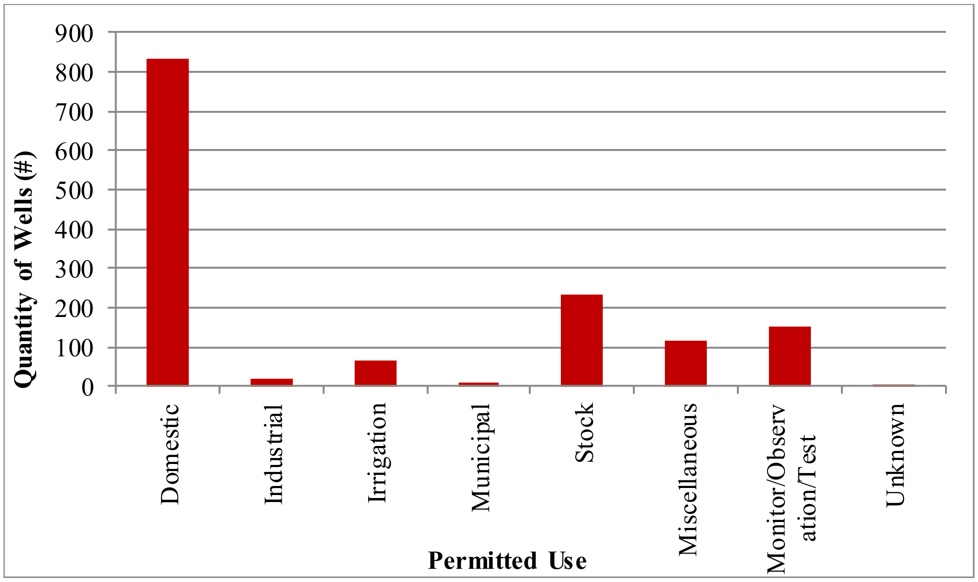


Figure 3.4.4.6.1. Histogram of well types within the Bear River Watershed Study Area.

The depths of permitted wells in the Bear River Basin are presented in Table 3.4.4.6.2 and Figure 3.4.4.6.2. The majority of wells in the basin (30%) are between 0 and 50 feet deep, and the deepest wells in the basin are more than 4,000 ft deep.

Table 3.4.4.6.2. Well depths within the Bear River Watershed Study Area.

Well Depth (ft)	Quantity
0 to 50	461
51 to 100	308
101 to 200	245
201 to 400	126
401 to 600	15
601 to 800	22
801 to 1000	7
1000 to 2000	10
2001 to 3000	0
3001 to 4000	0
>4000	6
No data	229
Total	**1,429**

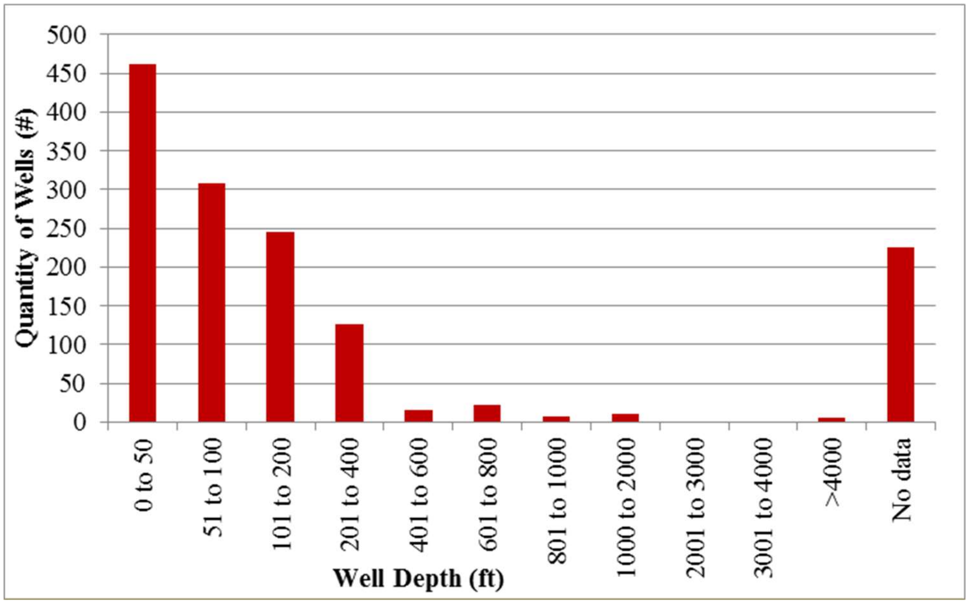


Figure 3.4.4.6.2. Histogram of well depths within the Bear River Watershed Study Area.

The static water levels of permitted wells in the Bear River Basin are presented in Table 3.4.4.6.3 and Figure 3.4.4.6.3. The majority of wells in the basin (57%) have static water level between 0 and 50 feet deep, and the deepest static water levels are from more than 2,000 ft deep.

Table 3.4.4.6.3. Static water level depth in permitted wells within the Bear River Watershed Study Area.

Static Water Level (ft)	**Quantity**
0 to 50	822
51 to 100	135
101 to 200	43
201 to 400	27
401 to 600	5
601 to 800	2
801 to 1000	0
1001 to 2000	2
>2000	2
-1 to -10	144
No data	247
Total	**1,429**

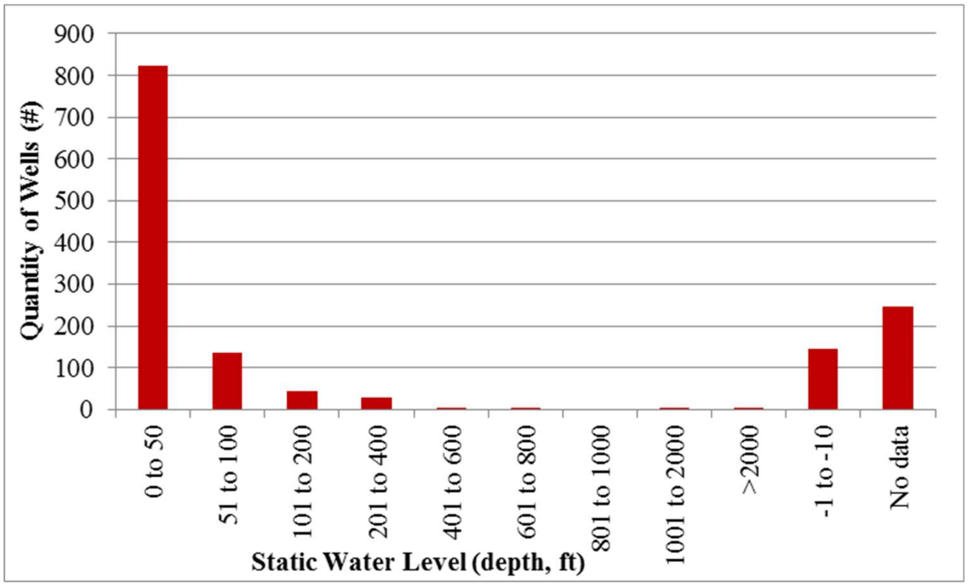


Figure 3.4.4.6.3. Histogram of static water level depths within the Bear River Watershed Study Area.

The reported yield of permitted wells in the Bear River Basin is presented in Table 3.4.4.6.4 and Figure 3.4.4.6.4. The majority of wells in the basin (53%) have reported yield between 11 & 25 gpm, but there are 2 high capacity wells that produce more than 2,000 gpm.

Table 3.4.4.6.4. Reported yield of wells within the Bear River Watershed Study Area.

Well Yield (gpm)	**Quantity**
0 to 5	118
6 to 10	247
11 to 25	756
26 to 50	21
51 to 100	18
101 to 200	18
201 to 500	20
501 to 1000	23
1001 to 2000	21
>2000	2
No data (0 or -1)	185
Total	**1,429**

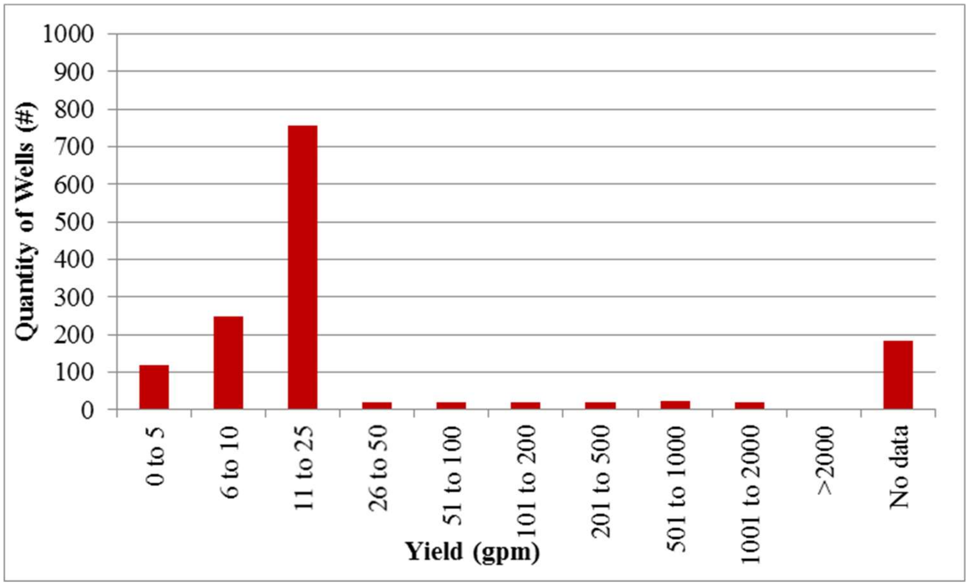


Figure 3.4.4.6.4. Histogram of reported yield of wells within the Upper Green River Watershed Study Area.

3.4.4.7 FLOOD CONTROL

Control of the Bear River hydrologic system rests with the state water resource organizations of Utah, Idaho, and Wyoming. Coordination among the 3 states is accomplished by their participation on the Bear River Commission, which administers the three-state Bear River Compact. A U.S.

District Court ruling, known as the Dietrich Decree dated July 13, 1920, granted diversion rights of 5,500 cubic feet per second of Bear River water to storage in Bear Lake. Additionally, the Bear River Compact of 1955 and the revised Compact of 1978 permitted storage development above Bear Lake of 106,500 acre feet annually, and provided for a specified reserve of stored water that could only be released for irrigation as its primary use. If the elevation of Bear Lake falls below 5,914.7 feet, no storage water can be released unless required for downstream irrigation use.

The WWDO "Bear River State Water Plan" (2011) describes previous investigations of reservoir storage opportunities within the Smiths Fork and Sublette Creek drainages in Lincoln County. Multiple sites were evaluated for purposes of irrigation, flood control, and recreation with the potential for municipal and industrial uses and possible hydropower generation. These studies concluded that construction of a reservoir on the Smiths Fork did not have a positive cost benefit ratio and, therefore, investigations were halted. The report does conclude that there are not currently sufficient needs or economic drivers for new reservoir construction in the Basin's Upper or Central Divisions. However, the Plan states that construction of a small reservoir on Sublette Creek for supplemental irrigation water and recreation may prove to be feasible, although further study is needed.

A rain on snow event in June 2010 produced significant Bear River flooding within the Bear River State Park area south of Evanston in Uinta County. The USGS "Bear River at Evanston" gauge (10016900) recorded peak discharge value of 3,890 cfs on June 8, 2010 (Figure 3.4.4.7.1 and 3.4.4.7.2). In addition to flooding, several areas within the park were badly scoured. To address flood-related concerns near Evanston and Bear River State Park, a consultant (Cook Sanders Associates) was contracted to design bank stabilization structures to mitigate future flooding. A 2D hydraulic model was developed by Aquaveo LLC for the Bear River reach south of Evanston to better understand the flow conditions of 100-year flood waters, and to verify the benefits of mitigation structures. A series of Bendway Weirs were modeled and were shown to be effective at diverting the direction of the thalweg during low flow conditions toward the center of the channel, thereby shifting erosive forces away from unstable banks. There are now 5 locations within the Bear River State Park where Bendway Weirs were installed, as well as 3 locations where banks have been hardened with riprap.

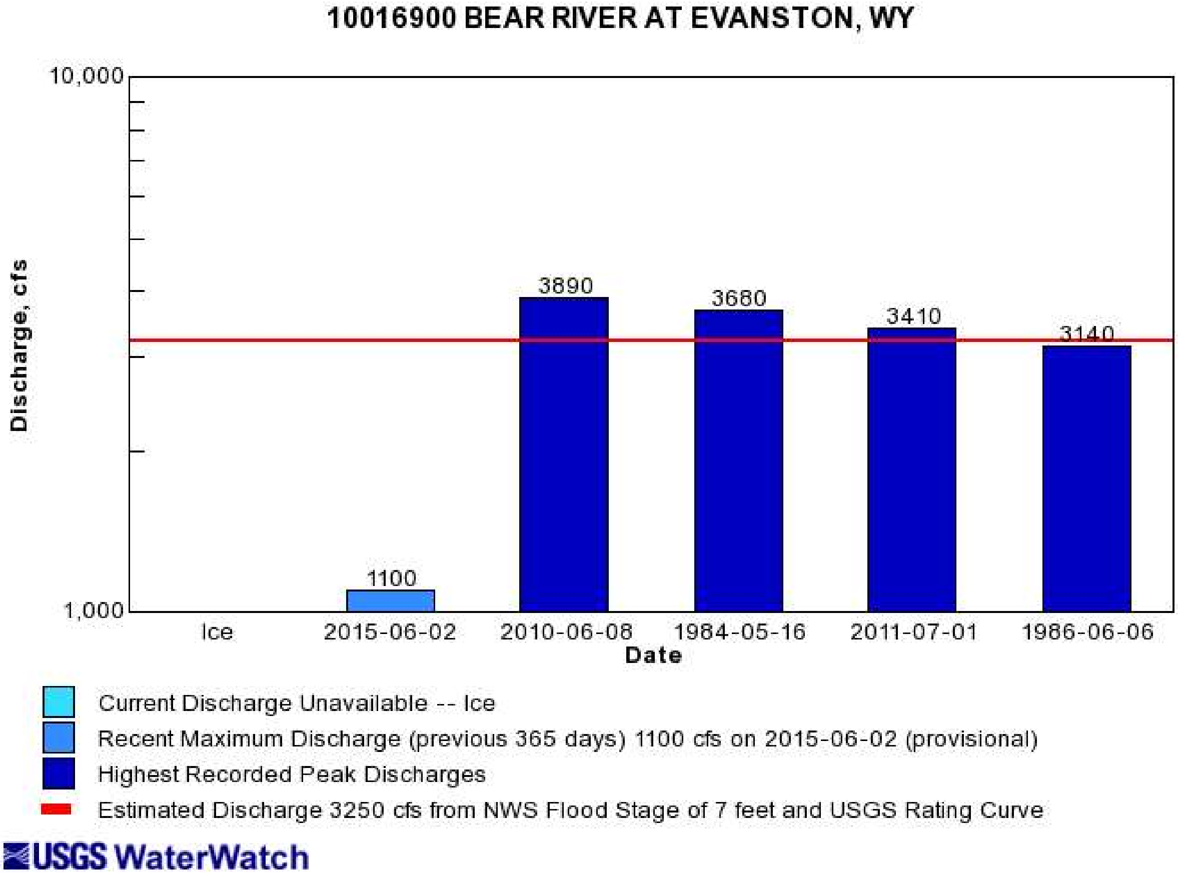


Figure 3.4.4.7.1 Historical peak discharges at the Bear River at Evanston, WY USGS #10016900 gauge.

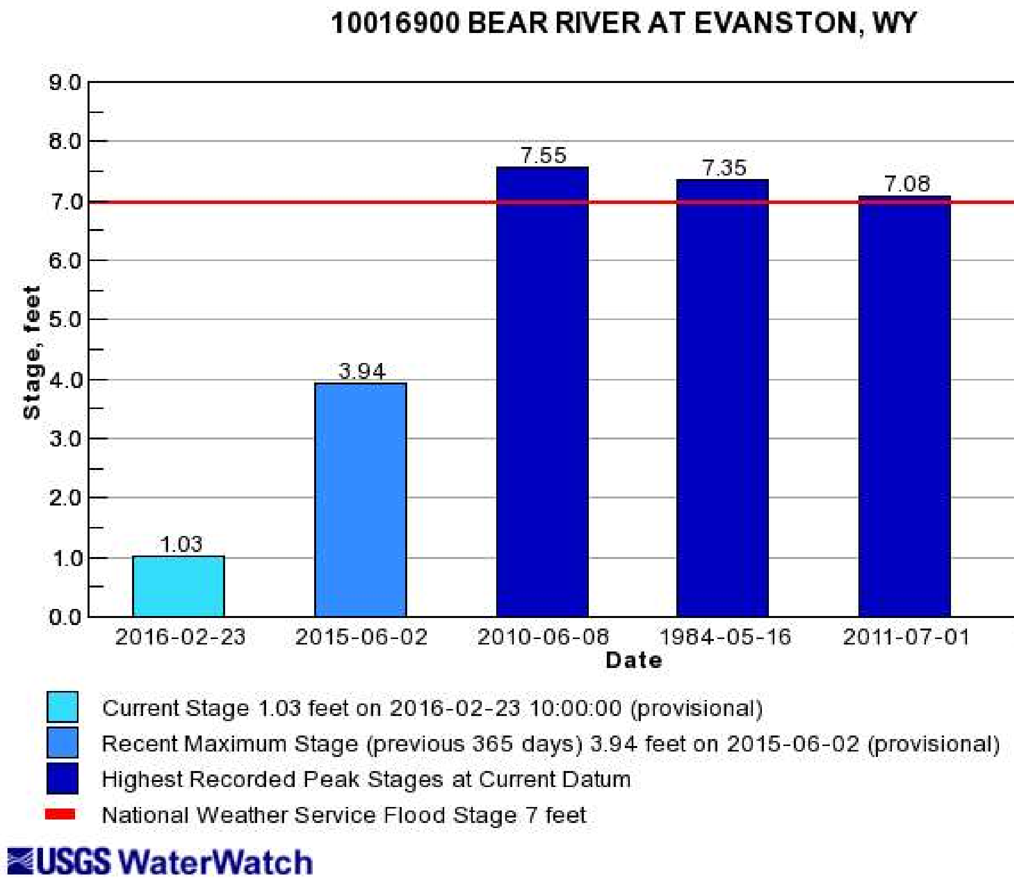


Figure 3.4.4.7.2. Historical peak stage levels (ft) at the Bear River at Evanston, WY USGS #10016900 gauge.

REFERENCES

Wyoming Water Development Office (WWDO). 2011. Bear River State Water Plan, Cheyenne.

3.4.5 FLUVIAL GEOMORPHOLOGY

Fluvial geomorphology is the study of the processes and physical form of riverine systems. Dependent variables such as channel dimension, pattern, and profile are influenced by the riverine system response to independent variables such as hydrologic regime, sediment conditions, and boundary conditions. Stable channel form is achieved when the physical attributes of dependent variables are maintained through time while the stream system conveys hydrologic and sediment inputs. Unstable conditions typically result when independent variables are altered, anthropogenically or naturally, and typically result in sudden changes in channel morphology through aggradation, degradation, lateral migration, or down-cutting.

The objective of the geomorphic classification is to describe channel form in order to better understand channel processes. Based on the concept that channel forms reflects processes, physical channel parameters are assessed in order to classify channel type, and the interpretation of channel type within the local setting enables further understanding of channel function, stability, and appropriate management approach.

A subset of sites were visited during the 2016 field season, and field assessment of channel morphology at those locations was completed in order to verify the preliminary classification results. Those sites are discussed in Section 3.4.5.1.

3.4.5.1 ROSGEN CLASSIFICATION SYSTEM (METHODS AND RESULTS)

A geomorphic classification was completed for the Bear River and all major tributaries within the watershed study area. Tributaries included:

Smiths Fork
Hobble Creek
Rabbit Creek
Rock Creek
Sulphur Creek
Coyote Creek
LaChapelle Creek
Giraffe Creek
Thomas Fork
Salt Creek
Clear Creek
Coantag Creek
Mill Creek
Shearing Corral Creek
Willow Creek
Yellow Creek
Bridger Creek
Twin Creek
Water Canyon Creek
Aspen Creek
Sublette Creek
Muddy Creek

Channel morphology descriptions conformed to the Rosgen Level I classification procedure, which is a broad morphological characterization of channel form based upon landform, lithology, soils, climate, basin relief, valley morphology, and general river pattern (Rosgen 1994). The typical objective of a Level I classification is to use remote sensing technologies, along with some field verification, to describe general valley and fluvial form to enable interpretation of dominant fluvial processes and identification of appropriate management strategies.

A Level II description is a more thorough morphologic description that incorporates substrate material, local slope, and field measurement of channel parameters. A Level III description incorporates riparian vegetation, depositional patterns, confinement, and channel stability to assess stream condition. A Level IV description requires direct measurement of sediment transport, bank erosion, and hydraulic conditions in order to verify classification results. Figure 3.4.5.1.3 depicts the hierarchy of the Rosgen classification system levels. A Level I geomorphic classification was completed as part of this study; the higher level classifications require thorough field investigations that are beyond the scope of this watershed assessment.

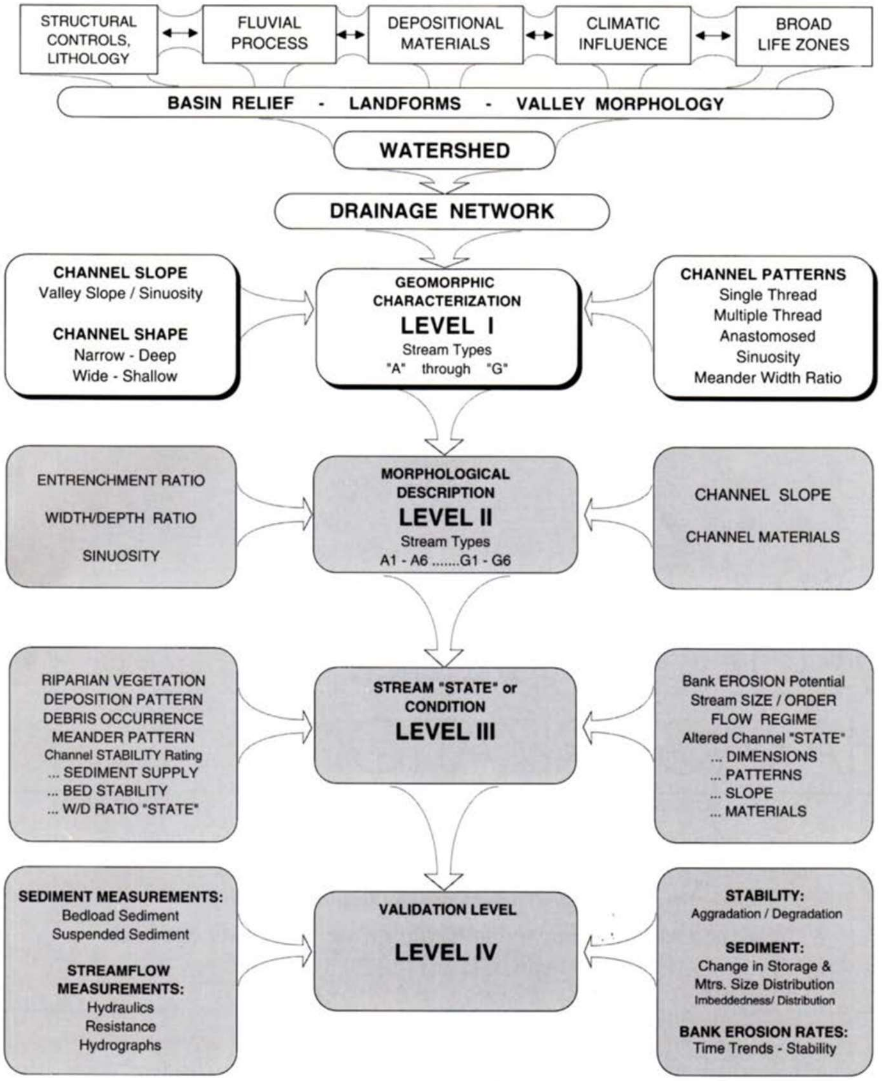
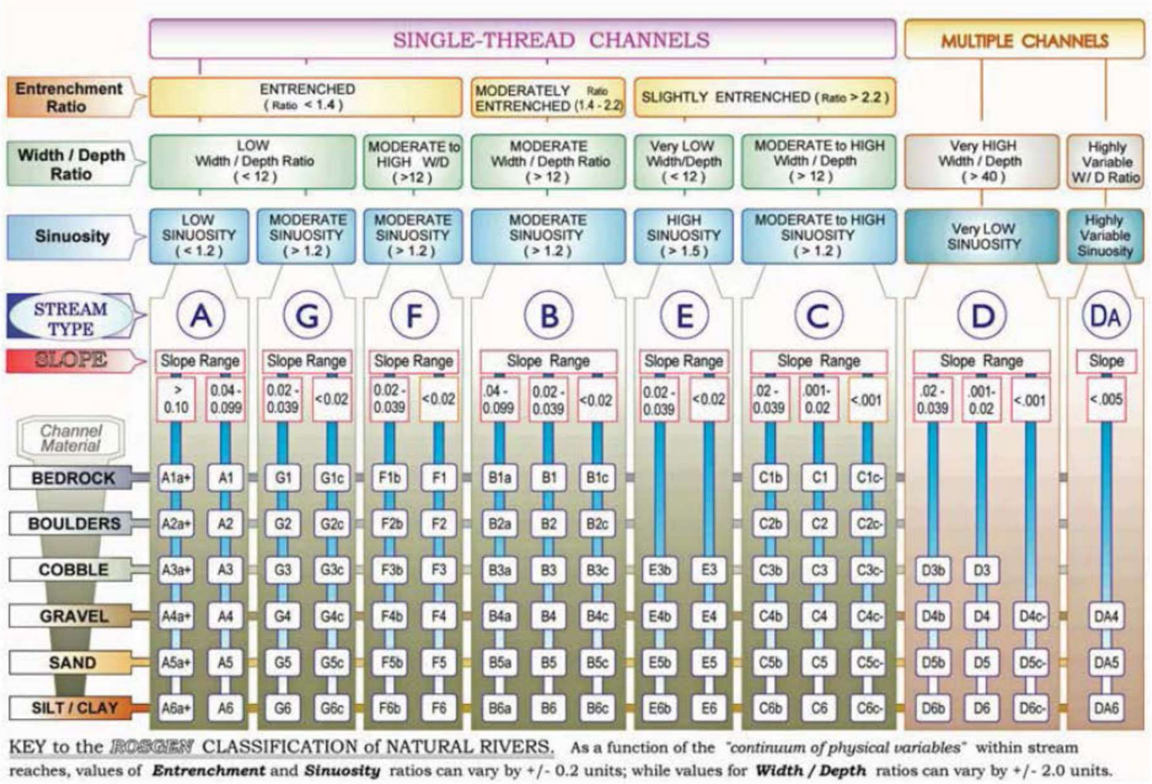


Figure 3.4.5.1.3. Schematic of the levels of Rosgen geomorphic channel classification.

The Rosgen Level I channel classification describes channel form in 8 general categories referred to by alphabetical identifiers A, G, F, B, E, C, D, and Da, as presented in Figure 3.4.5.1.3a.



(210–VI–NEH, August 2007)

Figure 3.4.5.1.3a Rosgen Level I geomorphic channel classification schematic. Figure taken from NRCS (2007).

"A" Stream Type - Channel slopes range from 4 to 10 percent, and typically display a step-pool morphology, with plunge or scour pools. "A" stream types are found within valley types with inherent steepness, and exhibit a high sediment transport potential and relatively low sediment storage capacity.

"B" Stream Type - The predominant landforms are narrow and moderately sloping basin, and valley side slopes result in narrow valleys that limit the development of a wide floodplain. Streams are moderately entrenched, have a moderate width/depth ratio, display low channel sinuosity, and exhibit bed morphology dominated by rapids.

"C" Stream Type - Typically located in narrow to wide valleys constructed from alluvial deposition. Channels have a well developed floodplain, slight entrenchment, relatively sinuous, channel slope of 2% or less, and a bedform morphology consisting of riffle/pool configuration.

"D" Stream Type - Multiple channel systems exhibiting braided, or bar-braided pattern, with high channel width/depth ratio and channel slope roughly equivalent to the local valley slope. Landforms typically consist of steep depositional fans, steep glacial trough valleys, glacial outwash valleys, broad alluvial mountain valleys, and deltas. Bank erosion rates are high, and sediment supply is generally unlimited and bed features are the result of convergence/divergence process of local bed scour and deposition.

"E" Stream Type - Channels are slightly entrenched, have low channel width/depth ratio, and high channel sinuosity. Bedform features are predominantly riffle/pool sequences. These stream types are sensitive to disturbance and rapidly adjust and convert to other stream types as the result of disturbance.

"F" Stream Type - Deeply incised in valleys of relatively low elevation relief with highly erodible materials. Channels have very high width/depth ratio, and bedform features include moderated riffle/pool sequence. Bank erosion rates, lateral extension rates, bar deposition, channel aggradation or degradation, and sediment storage capacities are high.

"G" Stream Type - Gully stream types are entrenched, narrow, and deep, with step/pool bedform and low sinuosity. Channel slopes generally exceed 2%. Channels exhibit high bank erosion rates, low channel width/depth ratios, and high bedload and suspended sediment transport rates. Channel degradation and side-slope rejuvenation processes are typical.

The typical relative locations of stream types within a watershed are presented in Figure 3.4.5.1.3b. Brief descriptions of the Rosgen classification system stream types are included in Table 3.4.5.1.3.

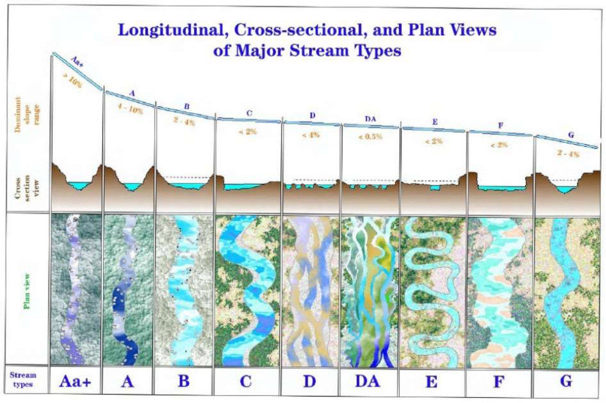


Figure 3.4.5.1.3b. Typical relative locations of stream types within a watershed.

Table 3.4.5.1.3. Rosgen Level I geomorphic channel classification description and characteristic parameters

Stream Type	Description	Entrenchment Ratio (ft/ft)	Width/Depth Ratio (ft/ft)	Sinuosity (ft/ft)	Slope (ft/ft)	Landform/Soils/Features
A	Steep, entrenched, stable, step pool streams w/ high energy & debris transport	<1.4	<12	1.0 to 1.2	0.04 to 0.10	High relief; erosional bedrock forms; entrenched & confined streams w/ cascading reaches; frequently spaced, deep pools associated w/ step-pool bed morphology
B	Moderately entrenched, moderate gradient, stable, riffle dominated channels w/ infrequent pools	1.4 to 2.2	>12	>1.2	0.02 to 0.039	Moderate relief, colluvial riffle deposition, and/or residual soils; moderate entrenchment & width-to-depth ratio; narrow, moderately-sloping valleys; rapids predominate w/ occasional pools
C	Low gradient, meandering, point-bar, riffle-pool, alluvial channels w/ broad defined floodplains	>2.2	>12	>1.4	<0.02	Broad valleys w/ terraces associated w/ floodplains & alluvial soils; slightly entrenched w/ well-defined meandering channel; riffle-pool bed morphology
D	Braided, wide, eroding and unstable channels w/ longitudinal and transverse bars	n/a	>40	n/a	<0.04	Broad valleys with alluvial & colluvial fans.; glacial debris & depositional features; active lateral adjustment w/ abundance of sediment supply

Table 3.4.5.1.3 (Cont.)

Stream Type	Description	Entrenchment Ratio (ft/ft)	Width/Depth Ratio (ft/ft)	Sinuosity (ft/ft)	Slope (ft/ft)	Landform/Soils/Features
Da	Anastomosing (multiple channels) that are narrow and deep w/ well vegetated floodplains & wetlands w/ stable stream banks	>4.0	<40	variable	<0.005	Broad, low-gradient valleys w/ fine alluvium and/or lacustrine soils; anastomosed (multiple channel) geologic control creating fine deposition w/ well-vegetated bars that are laterally stable w/ broad wetland floodplains; stream type common in estuaries
E	Low gradient, stable, meandering riffle-pool channels w/ low width/depth ratio & little deposition	>2.2	<12	>1.5	<0.02	Broad valley/meadows; alluvial materials w/ floodplain and/or lacustrine soil; highly sinuous w/ stable well-vegetated banks; riffle-pool morphology w/ very low width-to-depth ratio
F	Entrenched meandering riffle-pool channels w/ high width-depth ratio	<1.4	>12	>1.4	<0.02	Entrenched in highly weathered material; gentle gradients usually >0.02 ft/ft, but may range up to 0.04 ft/ft w/ a high width-to-depth ratio; meandering, laterally unstable w/ high bank erosion rates; riffle-pool morphology
G	Entrenched, high energy, gulley channels w/ low width-depth ratio	<1.4	<12	>1.2	0.02 to 0.039	Gully, step-pool morphology w/ moderate slopes & low width-to-depth ratio; narrow valleys or deeply-incised in alluvial or colluvial materials (fans or deltas); unstable w/ grade control problems & high bank erosion rates

The delineation of valley types is integral to properly classifying stream types because valley width, slope, vegetation, hill slope condition, sedimentology, and setting maintain fundamental influence over channel conditions. A given channel morphology may be considered appropriate in one valley type and inappropriate, or unstable, in another valley type; geomorphic channel classification cannot be fully interpreted without consideration of local valley type. The influence of independent variables (e.g., hydrologic regime, sediment conditions, and boundary conditions) on dependent variables of stream morphology is depicted in Figure 3.4.5.1.3c. To inform the channel geomorphic classification process and the interpretation of results, valley types within the watershed study area were delineated through remote sensing using various GIS datasets, including USGS 7.5 min quadrangles; current and historic aerial photography; and digital elevation models. Valley types were delineated in accordance with the numerical identifiers and descriptions presented in Table 3.4.5.1.4 (Rosgen 2012).

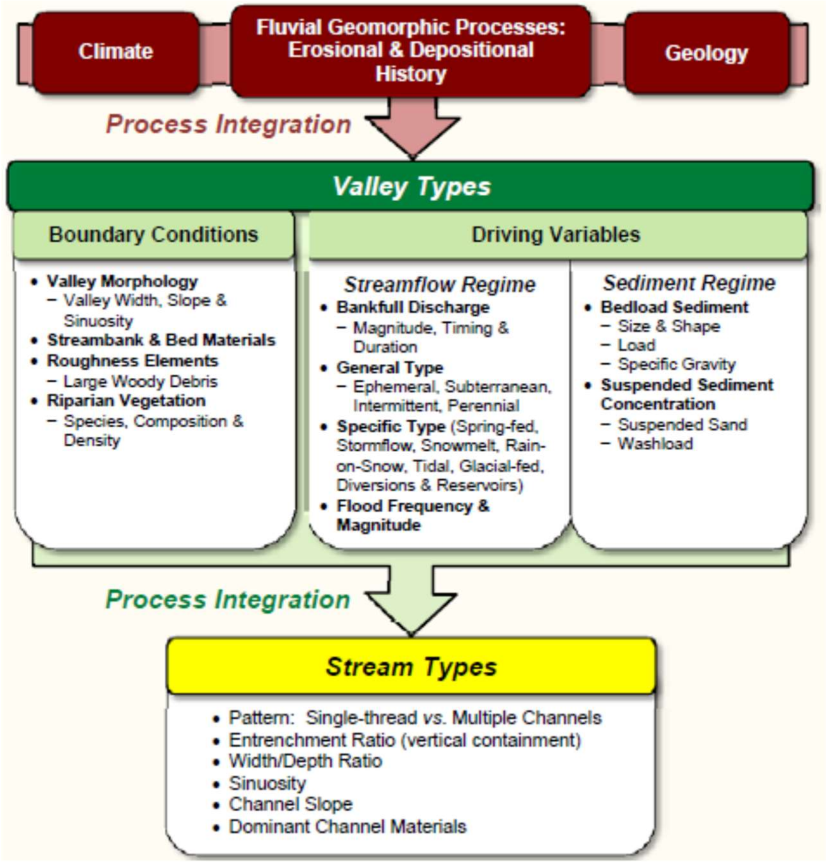


Figure 3.4.5.1.3c. The influence of independent variables on dependent variables of stream morphology.

Table 3.4.5.1.4. Valley types applied during preliminary geomorphic classification in the Bear River Watershed.

Valley Type	Name	Description
I	Steep, V-Notched Drainageway	Steep, confined, V-notched valley with rejuvenated side-slopes
II	Colluvial	Moderately steep valley slopes with gentle to moderate side-slopes associated with colluvial deposition of residual soils
IIIa	Alluvial Fan, Active	Actively building fan surface with high sediment supply storage
IIIb	Alluvial Fan, inactive	Non-building stable fan with low sediment supply and generally well established riparian vegetation

Table 3.4.5.1.4 (Cont.)

Valley Type	Name	Description
IV	Inter-Gorge	Canyons, gorges and confined alluvial valleys with gentle valley floor slopes, steep valley walls, and meandering, entrenched channels
V	Glacial Trough	Moderately steep U-shaped glacial trough valleys
VI	Bedrock	Bedrock controlled valleys with gentle to moderately steep valley slopes
VII	Fluvial Dissected	Steep fluvial dissected, high drainage density, alluvial landscape
VIIIa	Alluvial, Gulch Fill	Narrow valley widths (4 channel widths) with relatively steep valley side-slopes, and valley floor slopes greater than 0.5%
VIIIb	Alluvial Fill	Moderate valley widths (4 to 10 channel widths) with moderately steep valley side slopes and valley floor slopes less than 4%
VIIIc	Terraced Alluvial	Wide valley widths (10 channel widths) with gentle valley floor slopes less than 2% with river or glacial terraces
IX	Glacial Outwash	Broad, gentle valley slopes associated with glacial outwash
X	Lacustrine	Very broad and gentle valley slopes associated with flacio- and non-flacio-lacustrine deposits

Preliminary remote sensing valley type delineation results were corroborated during field investigations at a randomly selected subset of sample locations. However, the entire length of all classified valleys and streams within the watershed could not be visited for field verification. Preliminary valley type classification indicates that alluvial river valleys (valley type VIII) are the most prevalent valley type in the basin, comprising 628 miles (93.8%) of the nearly 670 total miles of stream. Table 3.4.5.1.5 depicts the total stream length of dominant valley types in the basin.

Table 3.4.5.1.5. Total stream length of dominant valley types in the Bear River Watershed.

Valley Type	Stream Length (mi)	Percent of Watershed
I	1	0.1%
II	32	4.8%
III	0	0.0%
IV	1	0.1%
V	5	0.7%
VIII	628	93.8%
X	6	0.9%

Several previous watershed studies have completed Level I geomorphic classification based primarily on channel sinuosity and slope, presumably because these channel attributes are most readily assessable using remote sensing data sets. However, the Rosgen channel classification system distinguishes channel types based upon physical parameters assessed in the following sequence: number of channels; entrenchment ratio; width/depth ratio; sinuosity; and then slope.

Arguably, the parameters with the most influence over channel process and, therefore, channel form, are entrenchment and width/depth ratio because these parameters dictate hydraulic conditions within the channel during peak flow events, which is when the majority of sediment transport and channel maintenance occur.

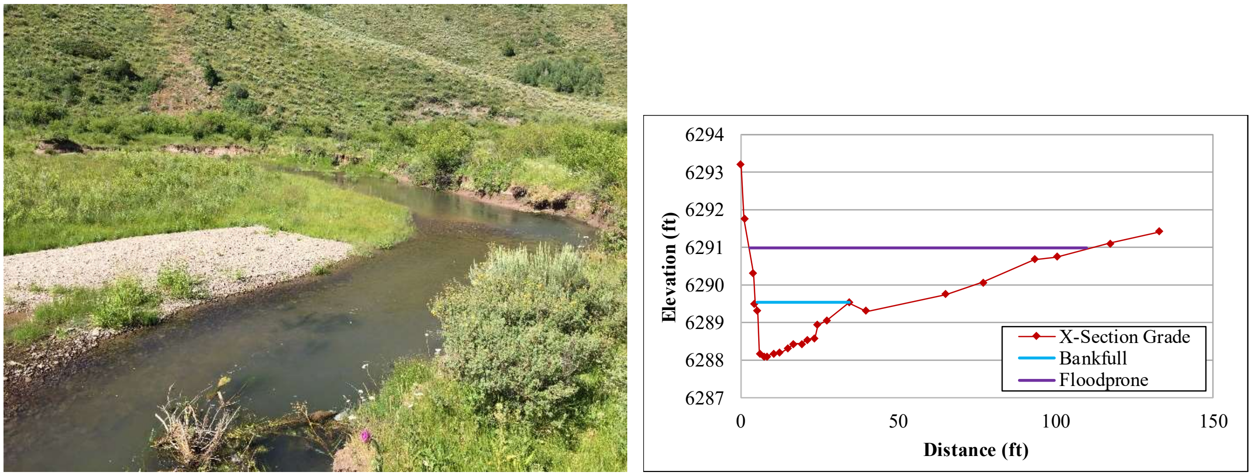
A remote sensing approach was used to complete a preliminary geomorphic classification of stream channels within the watershed study area. Assessment of primary classification attributes including entrenchment, width/depth ratio, sinuosity, and slope was conducted using current and historic aerial photography, digital elevation models, and GIS data. The preliminary classification effort was completed at a standard channel assessment scale defined as approximately 20 channel widths in length. Isolated changes in channel form were not considered reflective of overall channel morphology unless those changes occurred at the reach level. A randomly selected subset of sites was subsequently visited during the 2016 field season, and field assessment of channel morphology at those locations was completed in order to verify the preliminary classification results. Example photographs and surveyed channels geometry from the field verification are presented in the following figures. Generally, initial findings were found to be accurate and revisions were not necessary. However, the entire length of all classified streams within the watershed could not be visited for field verification, so results of the classification effort should be considered to be based on remote sensing and the data should be used accordingly. The locations of headcuts, geologic controls, and man-made grade control structures and hard points were identified during the preliminary assessment and field verification efforts, and the results are depicted in the Watershed Management Plan.

Bear River at Bear River State Park in Evanston (505,196E, 4,568,061N, NAD 83, UTM Zone 12) example of C-type channel with entrenchment ratio greater than 2.2, width/depth ratio greater than 12, and sinuosity greater than 1.2

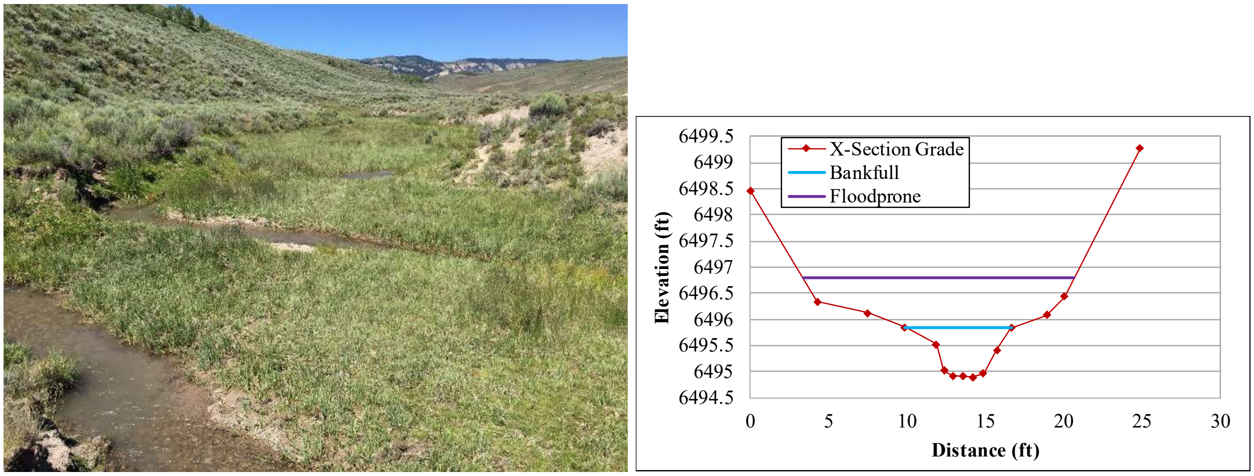
Bear River (498,508.63E, 4,579,937.93N, NAD 83, UTM Zone 12) example of C-type channel with entrenchment ratio greater than 2.2, width/depth ratio greater than 12, and sinuosity greater than 1.2

Smiths Fork River (510,868.9E, 4,680,801.77N, NAD 83, UTM Zone 12) example of C-type channel with entrenchment ratio greater than 2.2, width/depth ratio greater than 12, and sinuosity greater than 1.2

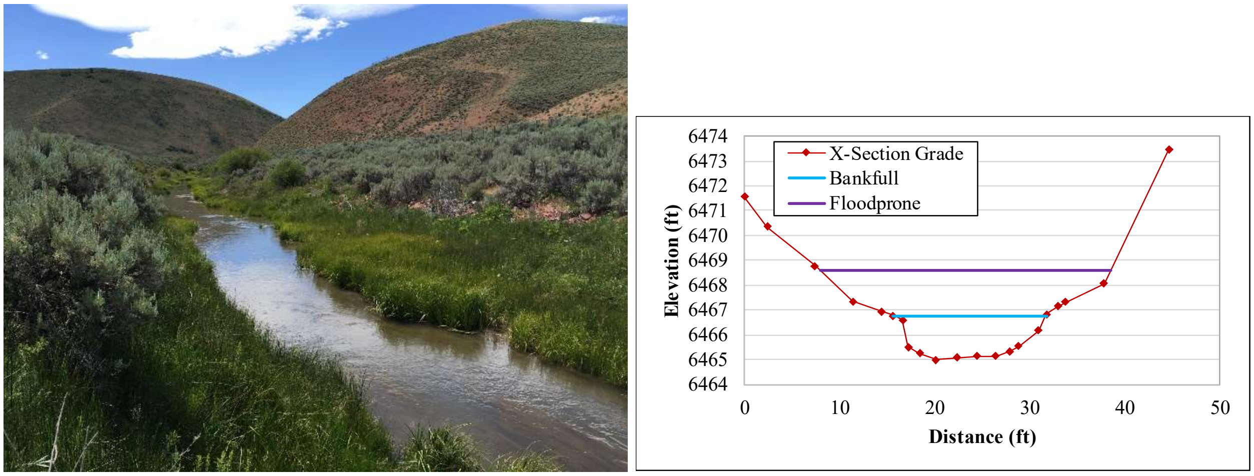
Twin Creek (509,123E, 4,629,930N, NAD 83, UTM Zone 12) example of F-type channel with entrenchment ratio less than 1.4, width/depth ratio greater than 12, and relatively low sinuosity.



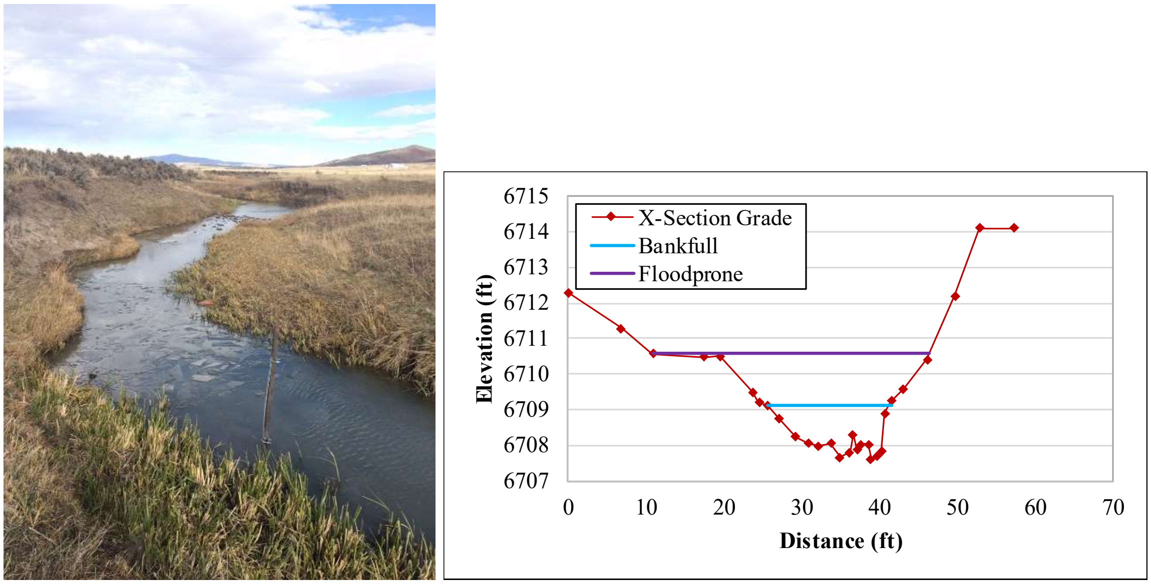
Salt Creek (500,531.49E, 4,694,179.78N, NAD 83, UTM zone 12) example of a C-type channel with entrenchment ratio of 3.7, width/depth ratio of 33, and sinuosity greater than 1.2.



Mill Creek (507,678E, 4,671,010.19N, NAD 83, UTM zone 12) example of a C-type channel with entrenchment ratio of 2.5, width/depth ratio of 13, and high sinuosity (greater than 1.2).



Rock Creek (514,171E, 4,630,177N, NAD 83, UTS zone 12) example of a Bc-type channel with entrenchment ratio of 1.9, width/depth ratio of 12, and sinuosity greater than 1.2.



Yellow Creek (498,785E, 4,562,509N, NAD 83, UTM zone 12) example of C-type channel with entrenchment ratio of 2.3, width/depth ratio of 16, and sinuosity greater than 1.2.

The results of the geomorphic classification are contained within the project GIS, in which spatial data attributes identify valley type and channel type classifications. Channel classification data are also presented in Figure 3.4.5.1.4. The figure depicts valley type and geomorphic channel classification of the mainstem Bear River and identified tributaries at the reach level. Table 3.4.5.1.6 depicts total length and relative percentages of the Bear River watershed streams by channel type. Table 3.4.5.1.7 presents results of the geomorphic classification by sub-basins within the watershed. The headwater reaches of most major streams within the basin are located in steep mountainous terrain comprised of colluvial deposits, bedrock, and forested landscapes. The dominant stream types in these reaches are A and B, with some isolated C and E stream types located in alpine meadows or lacustrine features. These stream reaches are generally laterally and vertically stable, and are typically resistant to local anthropogenic disturbances of independent variables.

The headwater streams change character as they enter the lower valley reaches. In these areas lateral confinement is reduced, sediment size tends to reduce, and boundary conditions typically weaken in conjunction with a change from narrow colluvial valleys to broad riparian alluvial valleys. The common stable stream types within these settings are C and E channel types, and these channel conditions are present within much of the watershed. However, these channel types are sensitive to anthropogenic activities that alter local hydrologic regime and boundary conditions. In numerous locations within the watershed, anthropogenic and natural changes in site conditions result in shifts in channel morphology to less stable D, F, and G stream types. These areas are typically isolated within discrete stream reaches in the watershed, and include disequilibrium channel types and isolated features such as nick-points, headcuts, meander cutoffs, avulsions, and lateral migration sites. Associated conditions result in loss of aquatic and riparian habitat and reduced reliability of surface water delivery to irrigation infrastructure. These localized areas present reasonable opportunities for specific channel restoration and stabilization efforts, and are discussed in more detail in Section 4.3.1.

Table 3.4.5.1.6. Total length and relative percentage of stream types in the Bear River Basin study area.

Stream Type	Stream Length (mi)	Percent of Watershed
A	6	0.8%
B	211	31.5%
C	376	56.2%
D	23	3.4%
E	5	0.7%
F	40	6.0%
G	4	0.6%

Table 3.4.5.1.7. Total length and relative percentage of stream types in sub-basins of the Bear River study area.

Subbasin Name	Stream Type	Length (miles)	Percent of Watercourse
Bridger Creek	A	0.1	0.3%
	B	1.4	8.0%
	C	11.3	64.1%
	F	3.1	17.3%
	G	1.8	10.3%
Clear Creek	B	12.0	98.7%
	C	0.2	1.3%
Coantag Creek	B	12.4	94.9%
	C	0.5	3.7%
	D	0.2	1.4%
Coyote Creek	B	8.8	78.3%
	C	0.6	5.6%
	F	1.8	16.1%
Dry Fork Smiths Fork	A	1.5	15.2%
	B	3.0	30.1%
	F	5.5	54.7%
Giraffe Creek	B	9.9	85.5%
	C	1.7	14.5%
Hobble Creek	B	4.8	23.0%
	C	15.3	73.3%
	D	0.8	3.7%
LaChapelle Creek	B	16.0	90.6%
	C	1.6	9.4%
Mill Creek	A	1.5	4.2%
	B	19.7	53.8%
	C	13.9	38.1%
	D	1.4	3.8%
Muddy Creek	A	1.3	10.6%
	B	10.6	83.8%
	C	0.7	5.6%
Rabbit Creek	B	9.3	95.5%
	F	0.4	4.5%
Rock Creek	A	0.7	3.6%
	B	15.2	77.1%
	C	2.1	10.9%
	D	0.2	1.2%
	F	1.4	7.2%
Salt Creek	A	0.4	1.5%
	B	14.9	54.9%
	C	10.8	39.7%
	D	0.2	0.7%
	G	0.9	3.3%
Shearing Corral Crk	B	8.7	93.9%
	E	0.6	6.1%
Smiths Fork	A	0.1	0.2%
	B	7.5	13.1%
	C	44.3	77.7%
	D	4.5	7.9%
	E	0.6	1.1%
Sublette Creek	B	6.3	77.5%
	C	0.3	3.4%
	E	1.6	19.0%
Sulphur Creek	B	16.9	69.4%
	C	7.5	30.6%
Thomas Fork	C	17.63	56.4%
	D	0.07	0.2%
	E	1.97	6.3%
	F	11.62	37.1%
Twin Creek	B	9.08	29.9%
	C	4.33	14.3%
	F	15.68	51.7%
	G	1.26	4.1%
Willow Creek	B	10.47	95.2%
	C	0.53	4.8%
Yellow Creek	B	6.36	12.8%
	C	42.51	85.9%
	D	0.21	0.4%
	F	0.40	0.8%

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3.4.6 WATER QUALITY

3.4.6.1 GENERAL ASSESSMENT

The following information is derived from the Wyoming Department of Environmental Quality (WDEQ) 2014 Integrated 305(b) and 303(d) Report. The Bear River Basin in Wyoming consists of sub-irrigated high valleys, foothills, low mountains, and some mid-elevation areas of the Uinta Mountains. These areas are underlain by predominately soft rock formations of fine-grained sedimentary geologic units that are naturally erodible, create naturally highly erodible soils, and thus contribute large volumes of fine sediment, salts, carbonates, sulphates, and phosphate. The high erodibility of these soils means that many of the stream channels are dependent on riparian vegetation to provide physical stabilization and are highly sensitive to disturbance.

Land use practices are often directly linked to water quality, and can be a major source of disturbance within the watershed. Livestock grazing is a major source of disturbance resulting from physical degradation to riparian areas and streambanks, as well as the fecal waste flowing into watercourses. Water conveyed by the Bear River is diverted to irrigate alfalfa, grains, hayfields, and pastures. Headwater streams are mostly perennial, but some downstream reaches may become intermittent or ephemeral due in part to irrigation diversions, channel down cutting, loss of riparian vegetation, and damming. Other land uses affecting water quality in the watershed include oil and gas production; historic phosphate and coal mining; and wildlife habitat and recreation on National Forest and BLM lands.

Pleasant Valley Creek (WYBR160101010301_01) above Crompton Reservoir in Uinta County was assessed by WDEQ in 1998 and found to be supportive of aquatic life other than fishes, and was subsequently classified as a “3B” watercourse. The WDEQ report indicated that there may be excess sediment and nutrient loading to Crompton Reservoir.

WDEQ evaluated Sulphur Creek (Uinta County) in 1998 and 1999 and found that excess sediment and nutrients were a concern at study sites above and below Sulphur Creek Reservoir. The report highlighted livestock grazing in riparian areas and bank erosion as major pollutant sources.

Historic channelization of Twin Creek has restricted lateral channel adjustments and caused the stream to down cut as much as 8-15 feet below its original floodplain. The channel has down cut through highly erodible shales that contribute carbonates, salts, and metals to the watershed. Other notable disturbances include historic livestock grazing which caused riparian degradation, as well as historic phosphate mining, which left tailing piles to be eventually eroded and deposited downstream.

The Smiths Fork watershed (Lincoln County) has been subject to historic disturbances including channelization and willow removal done in the mid-1990's to increase crop production which effectively caused bank erosion and widening of the channel. The Bureau of Land Management (BLM) manages the Smithsfork Grazing Allotment located northeast of Cokeville where concerns include the condition of riparian areas and springs which have been disturbed by past grazing activity and chemical spraying of vegetation (willows). The BLM has released the Smithsfork Allotment Management Plan (2005) to provide management strategies to improve riparian vegetation conditions and ultimately water quality in the Smiths Fork and Thomas Fork watersheds. Water quality assessments conducted by WDEQ in 2002 on Coantag Creek, Hobble Creek, and the Smiths Fork drainage above North Smiths Fork indicate the waters fully support their cold water fishery and aquatic life other than fish uses.

Water quality in the Salt Creek watershed (WYBR160101020303_01) has been studied by WDEQ to address high levels of sediment and nutrients likely derived from naturally erosive banks and channel confinement in a highway corridor. WDEQ found in 2005 that riparian conditions are improving and that Salt Creek supports its cold water fisheries use. Giraffe Creek (WYBR120101020304_00), a tributary to Salt Creek was found to fully support its cold water fishery and aquatic life other than fish in 2001.

3.4.6.2 STREAM CLASSIFICATION

The Wyoming Water Quality Rules and Regulations – Surface Water Standards (specifically Section 4, 33, 34, 35, and Appendix A) explains the background and process by which state classifications are assigned to waters within the state that are named on the USGS 1:500,000 scale hydrologic map or are contained in the WGFD database of state streams and lakes. Each water classification is associated with a specific combination of protected uses, including the following:

1. Agriculture – for purposes of water pollution control, agricultural uses include irrigation or stock watering;
2. Fisheries – use includes water quality, habitat conditions, spawning and nursery areas, and food sources necessary to sustain populations of game and nongame fish;
3. Industry – use protection involves maintaining a level of water quality useful for industrial purposes;
4. Drinking water – use involves maintaining a level of water quality that is suitable for potable water or intended to be suitable after receiving conventional drinking water treatment;
5. Recreation – use protection involves maintaining a level of water quality which is safe for human contact;
6. Scenic value – use involves the aesthetics of the aquatic systems themselves (odor, color, taste, 'settleable' solids, floating solids, suspended solids, and solid waste) and is not necessarily related to general landscape appearance;
7. Aquatic life other than fish – use includes water quality and habitat necessary to sustain populations of organisms other than fish in proportions which make up diverse aquatic communities common to the waters of the state;
8. Wildlife – use includes protection of water quality to a level which is safe for the contact and consumption by avian and terrestrial wildlife species;
9. Fish Consumption – use involves maintaining a level of water quality that will prevent any unpalatable flavor and/or accumulation of harmful substances in fish tissue.

Designated uses that are protected within each state water classification (identified by a unique numeric and alphabetic code) are presented in Table 3.4.6.2.1. Definitions of water classifications that are applicable to the Bear River watershed study area are subsequently presented, as quoted from the Water Quality Rules and Regulations, Chapter 1, Wyoming Surface Water Quality Standards (WDEQ, 2007).

Table 3.4.6.2.1. Protected uses within each Wyoming state water classification.

WDEQ Class	**Drinking Water**	**Game Fish**	**Non-Game Fish**	**Fish Consumption**	**Other Aquatic Life**	**Recreation**	**Wildlife**	**Agriculture**	**Industry**	**Scenic Value**
1*	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2AB	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2A	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2C	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3A	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3B	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3C	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4A	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4B	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
4C	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes

* Class 1 waters are not protected for all uses in all circumstances; actual uses on each particular water must be determined independently.

Class 1, Outstanding Waters *– waters in which no further water quality degradation by point source discharges other than from dams will be allowed. Nonpoint sources of pollution shall be controlled through implementation of appropriate best management practices. Pursuant to Section 7 of these regulations, the water quality and physical and biological integrity which existed on the water at the time of designation will be maintained and protected. In designating Class 1 waters, the Environmental Quality Council shall consider water quality, aesthetic, scenic, recreational, ecological, agricultural, botanical, zoological, municipal, industrial, historical, geological, cultural, archaeological, fish and wildlife, the presence of significant quantities of developable water and other values of present and future benefit to the people.*

Class 2AB *– waters known to support game fish populations or spawning and nursery areas at least seasonally and all their perennial tributaries and adjacent wetlands and where a game fishery and drinking water use is otherwise attainable. Class 2AB waters include all permanent and seasonal game fisheries and can be either "cold water" or "warm water" depending upon the predominance of cold water or warm water species* *present. All Class 2AB waters are designated as cold water game fisheries unless identified as a warm water game fishery by a "ww" notation in the "List". Unless it is shown otherwise, these waters are presumed to have sufficient water quality and quantity to support drinking water supplies and are protected for that use. Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic value uses.*

***Class 2C** – waters known to support or have the potential to support only nongame fish populations or spawning and nursery areas at least seasonally including their perennial tributaries and adjacent wetlands. Class 2C waters include all permanent and seasonal nongame fisheries and are considered "warm water". Uses designated on Class 2C waters include nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture, and scenic value.*

***Class 3B** – waters or tributary waters including adjacent wetlands that are not known to support fish populations or drinking water supplies and where those uses are not attainable. Class 3B waters are intermittent and ephemeral streams with sufficient hydrology to normally support and sustain communities of aquatic life including invertebrates, amphibians, or other flora and fauna which inhabit waters of the state at some stage of their life cycles. In general, 3B waters are characterized by frequent linear wetland occurrences or impoundments within or adjacent to the stream channel over its entire length. Such characteristics will be a primary indicator used in identifying Class 3B waters.*

Stream classifications within the Bear River watershed study area obtained from the latest Wyoming Surface Water Classification list (WDEQ, 2001) are presented (Table 3.4.6.2.2) from downstream to upstream, and indented entries are tributary to previous entries.

Table 3.4.6.2.2. Stream classifications in the Bear River Watershed Study Area.

Stream					**WDEQ Classification**
Bear River					2AB
Woodruff Narrows Reservoir					2AB
	Thomas Fork				2AB
		South Fork			2AB
	Smiths Fork				2AB
	Muddy Creek				2AB
		Dry Fork			2AB
		Hobble Creek			2AB
			Coantag Creek		2AB
			Lake Creek		2AB
				Alice Lake	2AB
	Sublette Creek				2AB
	Twin Creek				2AB
		Rock Creek			2AB
		North Fork			3B

Table 3.4.6.2.2 (Cont.)

Stream	WDEQ Classification
Clear Creek	3B
South Fork	3B
East Fork	3B
Raymond Creek	2AB
Bridger Creek	3B
Warner Spring	3B
Tunnel Ditch	4A
Whitney Canyon Creek	3B
Needles Creek	3B
Clear Creek	3B
Chapman Ditch	4A
Yellow Creek (below Utah state line)	2C
Yellow Creek (above Utah state line)	2AB
Salt Creek	2AB
Pleasant Valley Creek	3B
Long Hollow Creek	3B
Sims Canyon Creek	3B
Sulphur Creek	2AB
Mill Creek	2AB
Bazoo Hollow	3B
Harms Draw	3B
LaChapelle Creek	3B

3.4.6.3 WATERS REQUIRING TMDLS

Section 303(d) of the Clean Water Act requires states, territories, and authorized tribes to develop lists of impaired waters. Impaired waters are defined as those that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop Total Maximum Daily Loads (TMDLs) for these waters. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards.

Wyoming DEQ monitoring on the Bear River between 1995 and 1998 found that stream conditions supported aquatic life other than fish throughout the Upper Bear River sub-basin above Sulphur Creek, excluding Mill Creek. The Bear River below that portion of the watershed and between Sulphur Creek and Woodruff Narrows Reservoir was not found to be supportive of its aquatic life other than fish and cold water fishery uses due to large sediment fluxes and was added to the 303(d) list in 2002 (WYBR160101010303_01). The report cited sedimentation from Sulphur Creek and various habitat alterations along the Bear River as sources, and also noted the poor quality trout habitat and channelization of much of the river in this area. The Bear River Sediment TMDL Public Notice (May 2014) states that the primary source of sediment to the impaired segment is instream erosion, which makes up 77% of the total sediment load. That report goes on to state that point sources make up less than 1% of the total sediment load and requires an overall reduction in sediment loads of 13.1 tons per day, or a 19% overall reduction. Human influences highlighted in the TMDL report include land use changes such as agricultural expansion into riparian buffer zones; construction of seasonal push-up dams for irrigation; removal of wooded wetlands and riparian vegetation; high-pulse short-term releases of water from Sulphur Creek Reservoir; bridge, road, and railroad building in riparian zones; placement of concrete along stream banks; urban developments; and channelization of the Bear River through the City of Evanston.

The Bridger Creek watershed was added to the 303(d) list in 1998 due to its contributions of sediment and phosphates to the Bear River, which represent a threat to the aquatic life other than fish. Contributing factors to the high sediment loads in Bridger Creek include re-routing and channelization of 2,500 feet of stream which resulted in extensive head cutting and sedimentation in the lower watershed, and also livestock grazing and associated degradation of riparian cover. In 1996 the Bridger Creek Restoration Project addressed these issues by constructing seven small sediment retention reservoirs to trap sediment and provide water for livestock.

3.4.6.4 WYPDES PERMITTED DISCHARGES

The Clean Water Act authorized the creation of the National Pollutant Discharge Elimination System (NPDES) permit program in 1972. The NPDES permit program controls water pollution by regulating the discharge of pollutants from point sources into surface waters of the United States. Point sources are defined as discernible, confined, and discrete conveyances such as pipes, channels, conduits, and man-made ditches from which pollutants are or may be discharged.

The NPDES permit program is managed by the USEPA and is typically administered by authorized states and tribes. The Wyoming Pollutant Discharge Elimination System (WYPDES) Program administers the NPDES program in Wyoming. Through this program, operators of any point source discharges are required to receive coverage under a WYPDES discharge permit. The WDEQ places limitations and conditions on WYPDES permits to ensure that surface water quality standards are protected.

There are 10 active WYPDES permits in the Bear River Watershed. These permits are summarized in Table 3.6.4.4 and the associated point source locations are depicted on Figure 3.4.6.1-WYPDES Permitted Discharges. All permits are for sanitary wastewater discharges with one outfall for each of the permits. The effluent limits for these permits are based on the classification and designated uses of the receiving waterbody. Effluent from the Kemmerer Mine is discharged directly to the Middle Fork of Twin Creek (3B), which is a tributary to the Bear River. Effluent from the City of Evanston wastewater treatment facility is discharged directly to Yellow Creek (2C), which is a tributary to the Bear River. Effluent from the Town of Cokeville wastewater treatment plant is discharged directly to the Bear River (2AB). Effluent from the Yellow Creek Estates sewage treatment plant are discharged directly to an unnamed ephemeral tributary (3B) to Yellow Creek (2C), a tributary to the Bear River. Effluent from the Meadow Park Village wastewater treatment facility is discharged to the Chapman Ditch via Simms, Blight, and Turner irrigation ditches (4A), which connect to the Bear River. Effluent from the Town of Bear River wastewater lagoons is discharged directly to the Bear River (2AB). Effluent from the Painter Natural Gas Plant is discharged to Pleasant Valley Creek (3B) via an unnamed ephemeral drainage, a tributary to the

Bear River. Effluent from the Evanston Flying J Travel Plaza #761 is discharged directly to Yellow Creek (2C), a tributary to the Bear River. Effluent from the Pilot Travel Center No. 141 is discharged directly to the Rocky Mountain and Blythe ditches (4A), which are connected to the Bear River. Effluent from the NRC WYO 89 MP 55 Water Treatment System is discharged to the Thomas Fork (2AB) via Salt Creek (2AB), which are tributaries to the Bear River.

Table 3.4.6.4. Summary of WYPDES permitted discharges in the Bear River Watershed

Permit #	Permittee	Facility Name	Permit Type	# Outfalls
WY0000051	Westmoreland Kemmerer, LLC	Kemmerer Mine	Sanitary Wastewater	6
WY0020095	City of Evanston	Evanston WWTF	Sanitary Wastewater	1
WY0021032	Town of Cokeville	Cokeville Wastewater Treatment Plant	Sanitary Wastewater	2
WY0028665	Yellow Creek Estates Mobile Home Park	Yellow Creek Estates STP	Sanitary Wastewater	1
WY0031348	Meadow Park Village HOA	Meadow Park Village WWTF	Sanitary Wastewater	2
WY0031712	Town of Bear River	Town of Bear River Wastewater Lagoons	Sanitary Wastewater	1
WY0033073	Merit Energy Company	Painter Natural Gas Plant	Sanitary Wastewater	1
WY0035700	Pilot Travel Centers LLC	Evanston Flying J Travel Plaza #761	Sanitary Wastewater	1
WY0041084	Pilot Travel Centers LLC	Pilot Travel Center No. 141	Sanitary Wastewater	1
WY0095770	National Response Corp.	NRC WYO 89 MP 55 Water Treatment System	Sanitary Wastewater	1

3.4.6.5 SUITABILTY FOR IRRIGATION

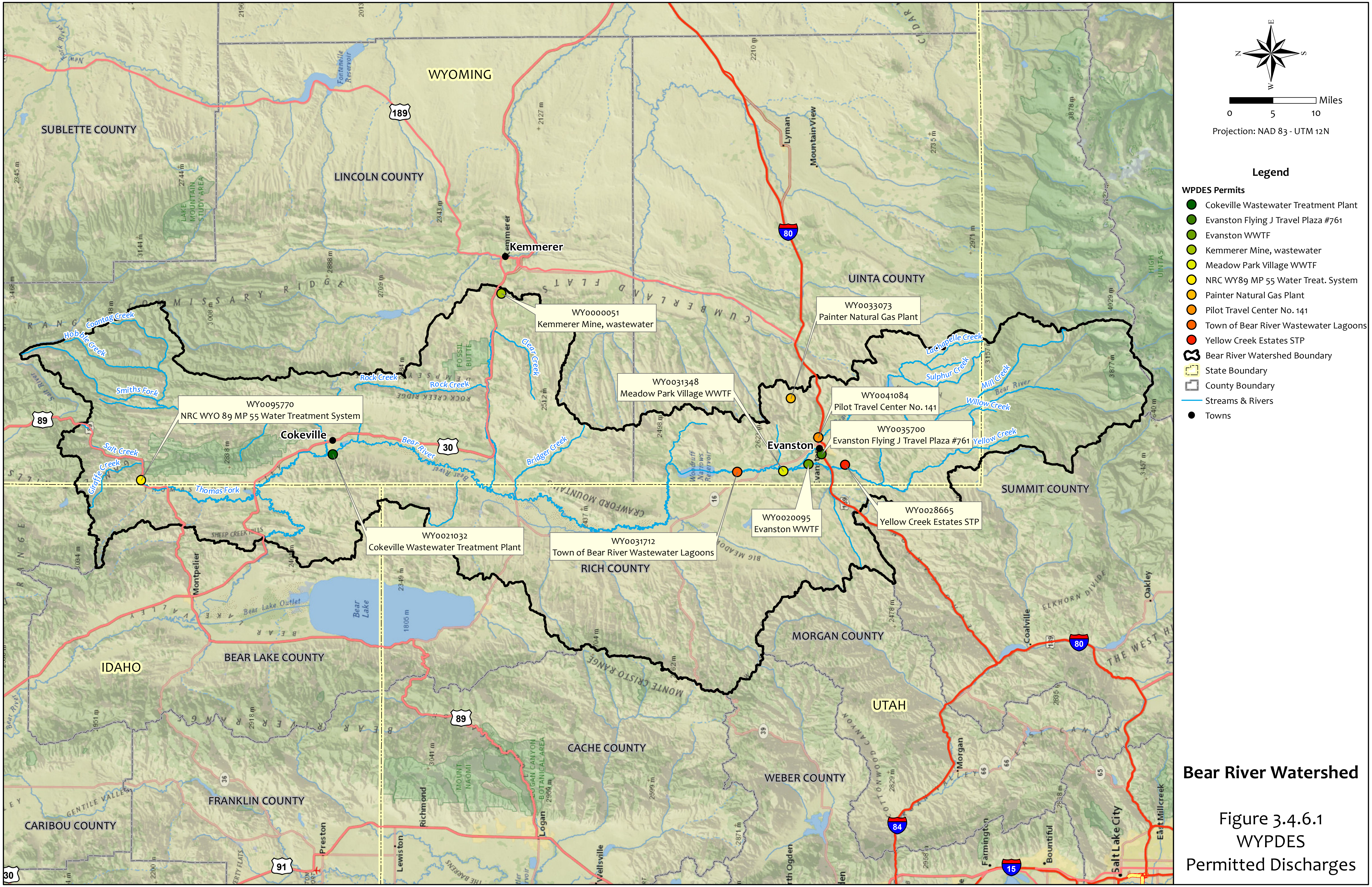
The water in the Bear River Drainage is suited for flood irrigation and also sprinkler type systems. Water traversing high alkali and benonitic type soils in small ephemeral basins can be degraded in aesthetic quality and increase in salt content although it remains useful for stock and native grasses.

The USGS has conducted water quality tests on samples taken at the following locations:

- Woodruff Dam - USGS 10020300 Bear River near (below) Woodruff Dam
- UTWY - USGS 10011500 Bear River Near Utah Wyoming state Line
- Pixley Dam _ USGS10028500 Bear River Below Pixley Dam
- Border WY – USGS 10036500 Bear River at Border Wyoming

Two important parameters used to evaluate water suitability is that of sodium adsorption ratio (SAR) and specific conductance measured in microsiemens/centimeter. These two parameters taken singly and together help identify potential irrigation restrictions.

Table 3.4.6.5 was taken from Water Quality for Agriculture by R.S. Ayers and D.W. Westcott and adapted with regard to salinity units to correspond with the USGS salinity records. The table illustrates water quality ranges for key indicators and associated restrictions on use.



Bear River Watershed

Figure 3.4.6.1
WYPDES
Permitted Discharges

Table 3.4.6.5 Guidelines for interpretation of water quality for irrigation

Potential Irrigation Problem				**Units**	**Degree of Restriction on Use**		
					None	**Slight to Moderate**	**Severe**
Salinity(affects crop water availability)[2]							
	EC_w			µS/m	< 700	700 – 3000	> 3000
	(or)						
	TDS			mg/l	< 450	450 – 2000	> 2000
Infiltration (affects infiltration rate of water into the soil. Evaluate using ECw and SAR together)[3]							
SAR	= 0 – 3	**and Specific Conductance**	=		> 700	700 – 200	< 200
	= 3 – 6		=		> 1200	1200 – 300	< 300
	= 6 – 12		=		> 1900	1900 – 500	< 500
	= 12 – 20		=		> 2900	2900 – 1300	< 1300
	= 20 – 40		=		> 5000	5000 – 2900	< 2900
Specific Ion Toxicity *(affects sensitive crops)*							
	Sodium (Na)[4]						
	surface irrigation			SAR	< 3	3 – 9	> 9
	sprinkler irrigation			me/l	< 3	> 3	
	Chloride (Cl)[4]						
	surface irrigation			me/l	< 4	4 – 10	> 10
	sprinkler irrigation			me/l	< 3	> 3	
	Boron (B)[5]			mg/l	< 0.7	0.7 – 3.0	> 3.0
	Trace Elements (see Table 21)						
Miscellaneous Effects *(affects susceptible crops)*							
	Nitrogen (NO3 - N)			mg/l	< 5	5 – 30	> 30
	Bicarbonate (HCO_3)						
	(overhead sprinkling only)			me/l	< 1.5	1.5 – 8.5	> 8.5
	pH				**Normal Range 6.5 – 8.4**		

Table adapted from University of California Committee of Consultants 1974.

[2] ECw means electrical conductivity, a measure of the water salinity, reported in deciSiemens per metre at 25°C (dS/m) or in units millimhos per centimetre (mmho/cm). Both are equiva-lent. TDS means total dissolved solids, reported in milligrams per litre (mg/l).

[3] SAR means sodium adsorption ratio. SAR is sometimes reported by the symbol RNa. See Figure1 for the SAR calculation procedure. At a given SAR, infiltration rate increases as watersalinity increases. Evaluate the potential infiltration problem by SAR as modified by ECw.Adapted from Rhoades 1977, and Oster and Schroer 1979.

[4] For surface irrigation, most tree crops and woody plants are sensitive to sodium and chlor-ide; use the values shown. Most annual crops are not sensitive; use the salinity tolerance tables (Tables 4 and 5). For chloride tolerance of selected fruit crops, see Table 14. With overhead sprinkler irrigation and low humidity (< 30 percent), sodium and chloride may be absorbed through the leaves of sensitive crops. For crop sensitivity to absorption, see Tables 18, 19 and 20 17 in Water Quality for Agriculture by R.S. Ayers and D.W. Westcott

[5] For boron tolerances, see Tables 16 and 17 in Water Quality for Agriculture by R.S. Ayers and D.W. Westcott

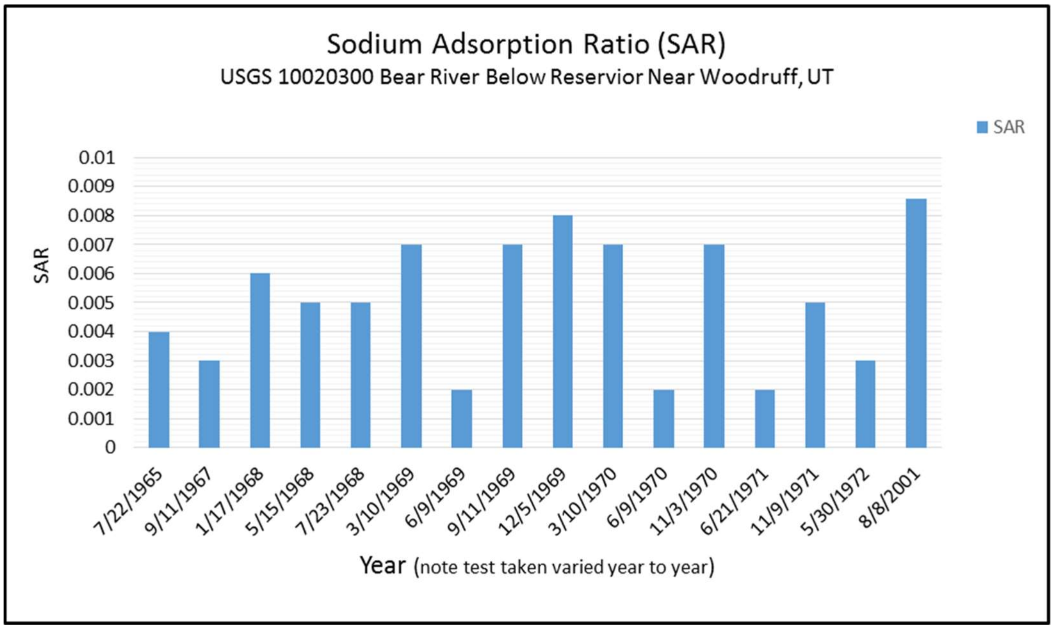
The following statement by the Water Quality for Agriculture authors regarding the use of the table provide some room for other factors.

> ***Restriction on Use:*** *The "Restriction on Use" shown in Table 1* (Table 3.4.6.5) *is divided into three degrees of severity: none, slight to moderate, and severe. The divisions are somewhat arbitrary since change occurs gradually and there is no clearcut breaking point. A change of 10 to 20 percent above or below a guideline value has little*

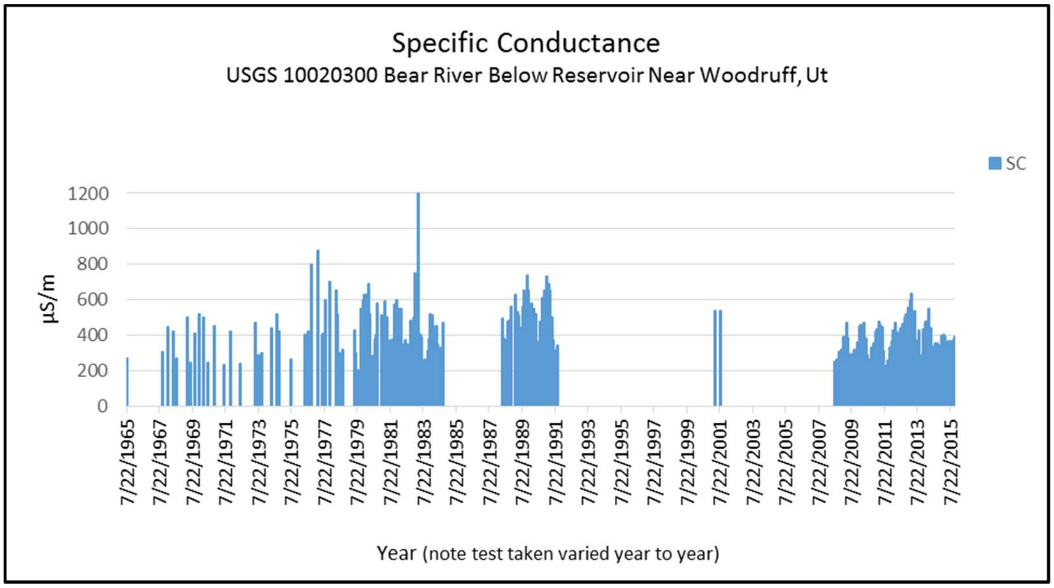
> *significance if considered in proper perspective with other factors affecting yield. Field studies, research trials and observations have led to these divisions, but management skill of the water user can alter them. Values shown are applicable under normal field conditions prevailing in most irrigated areas in the arid and semi-arid regions of the world*

The USGS records for SAR, Specific conductance and a combined graph for each of the sites are shown on the following Graphs 3.4.6.5a to 3.4.6.5l. The Sodium Absorption Ratio has been 0.1 for 95% of the test results. The Pixley results were notable in that they were much higher than the upstream and downstream results.

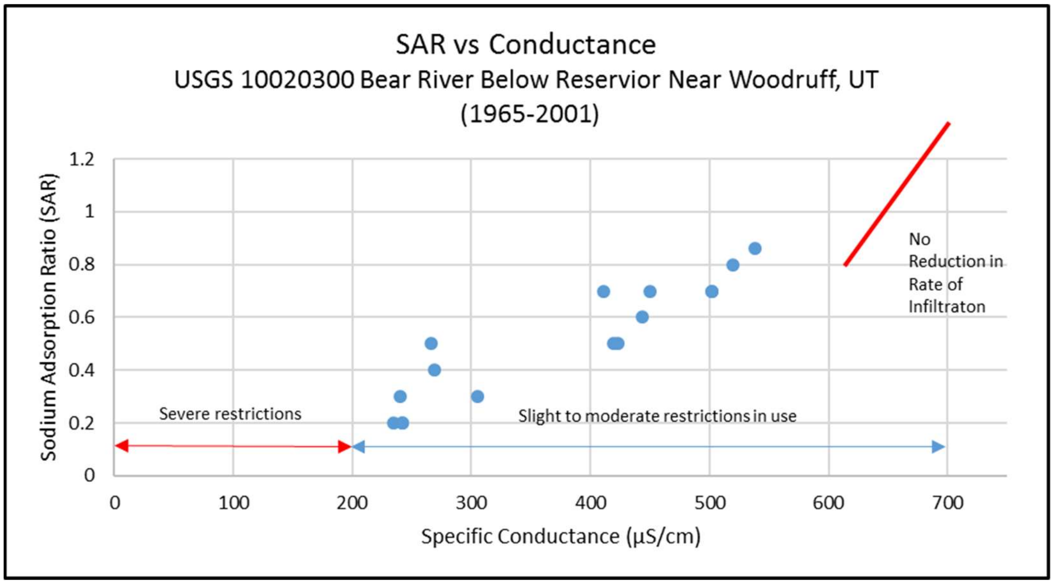
These two parameters (SAR and SC) when taken together indicate there are likely circumstances when restrictions are warranted. The third graph in each three graph set plots sodium adsorption ratio and specific conductance of the water quality samples (for those test dates that had both parameters on a common date). The low specific conductance of most samples places them in the slight to moderate degree of restriction category on the second section of Table 3.4.6.5. The test at the UT WY gauge indicates there may be circumstances when restrictions are warranted.



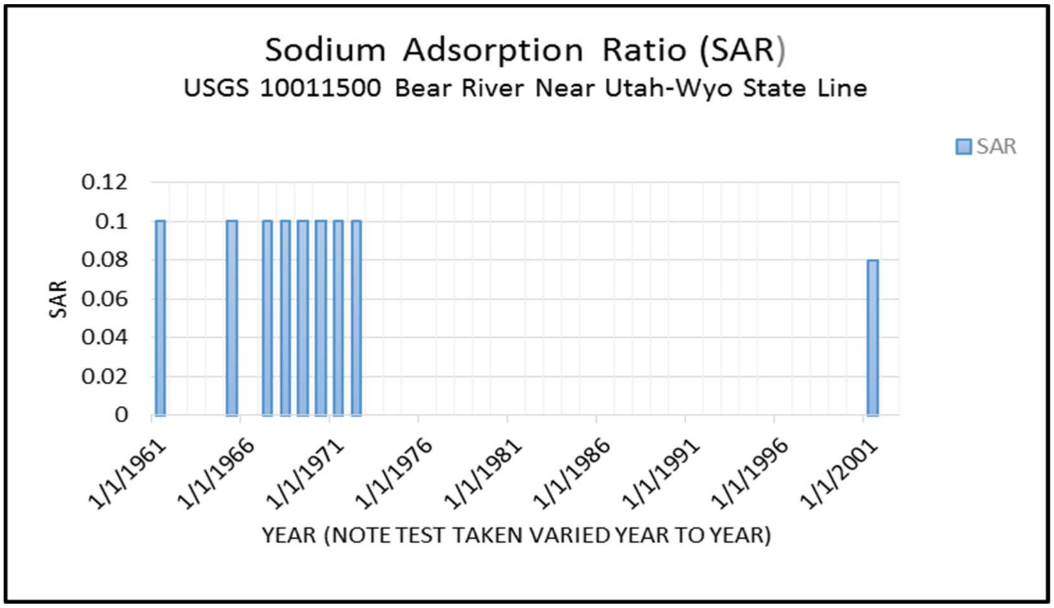
Graph 3.4.6.5a SAR Bear River USGS10020300



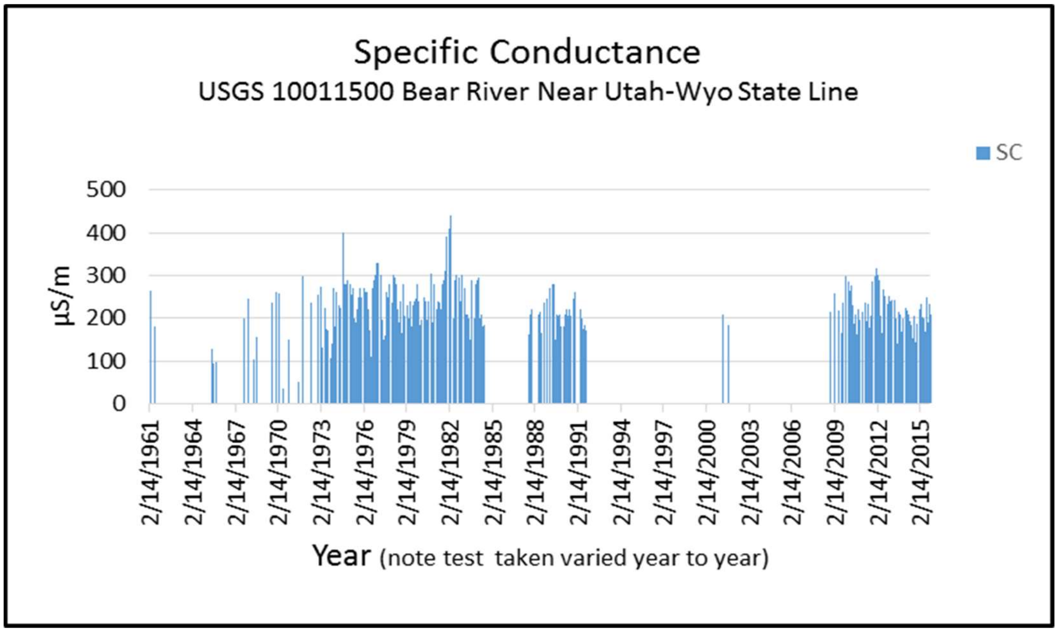
Graph 3.4.6.5b Specific Conductance Bear River USGS10020300



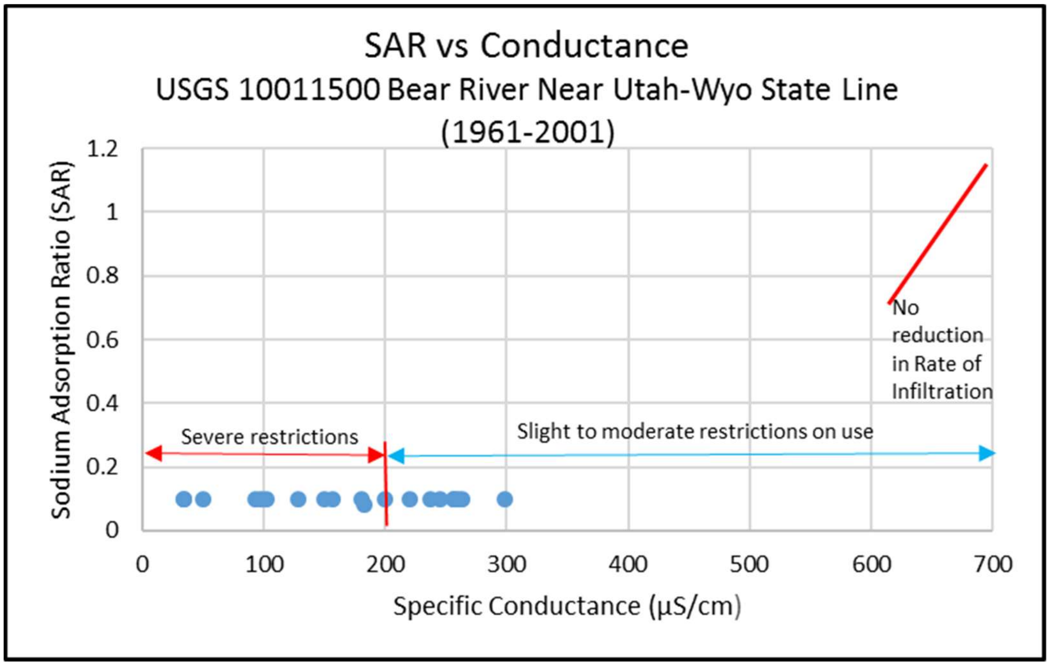
Graph 3.4.6.5c SAR vs Specific Conductance Bear River USGS10020300



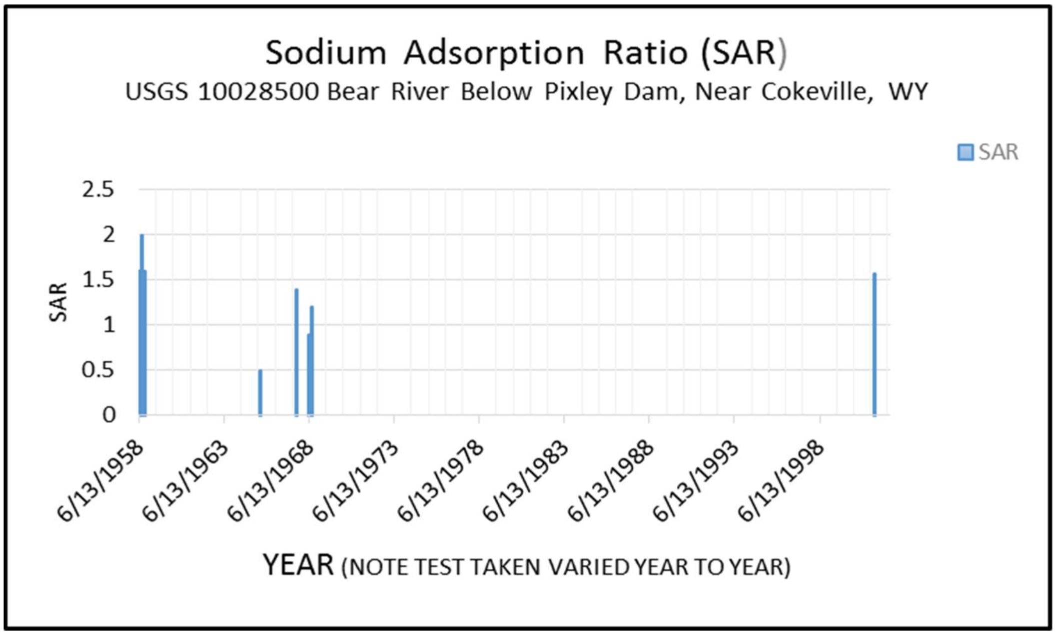
Graph 3.4.6.5d SAR Bear River USGS10011500



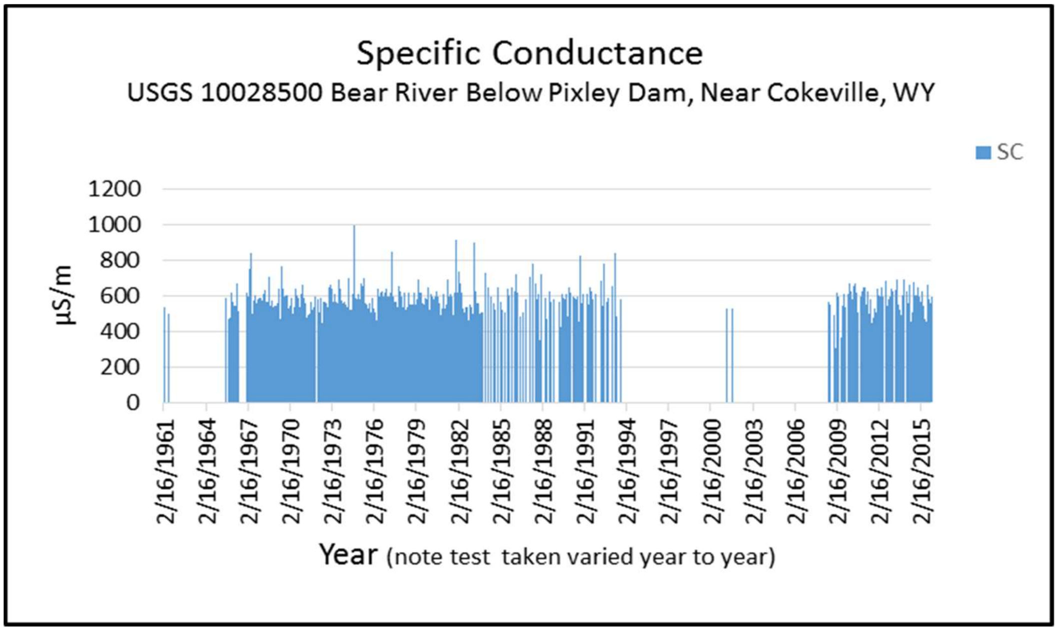
Graph 3.4.6.5e Specific Conductance Bear River USGS10011500



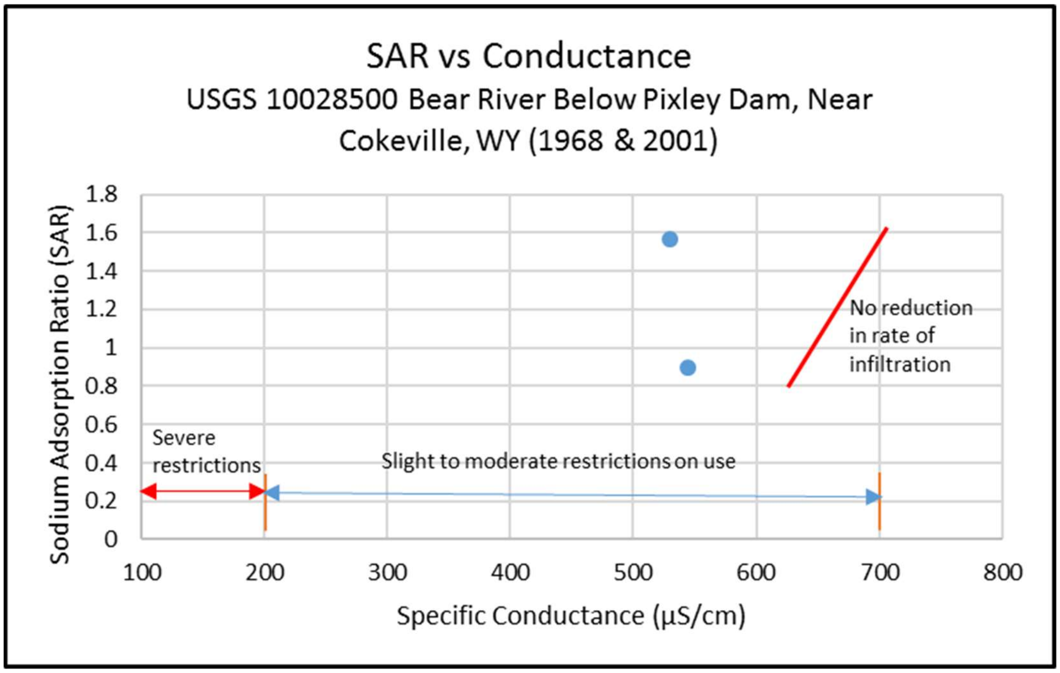
Graph 3.4.6.5f SAR vs Specific Conductance Bear River USGS10011500



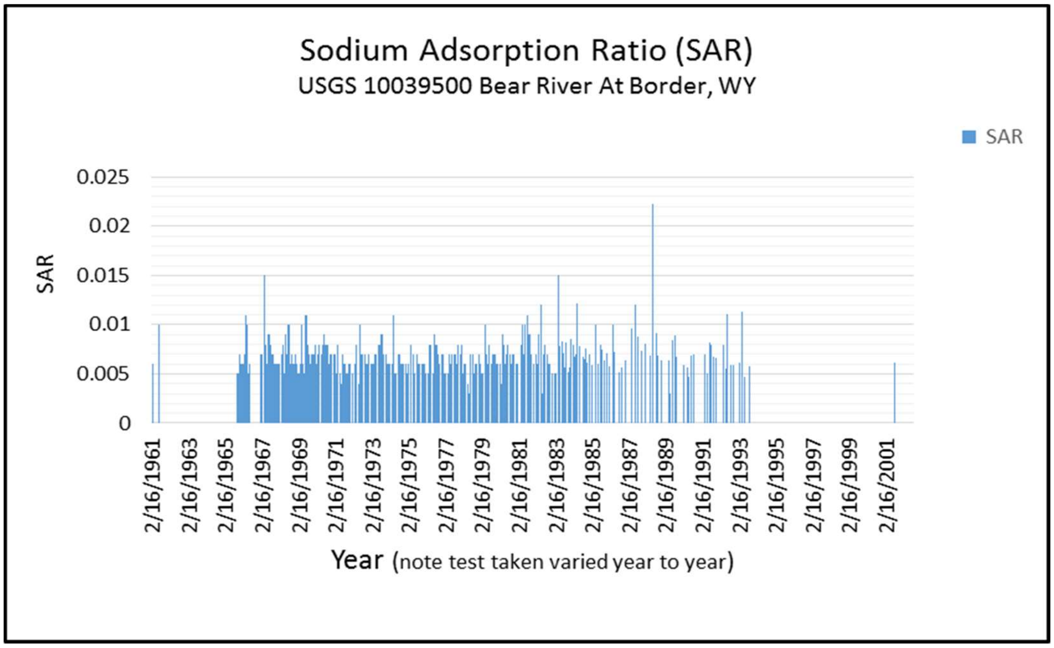
Graph 3.4.6.5g SAR Bear River USGS10028500



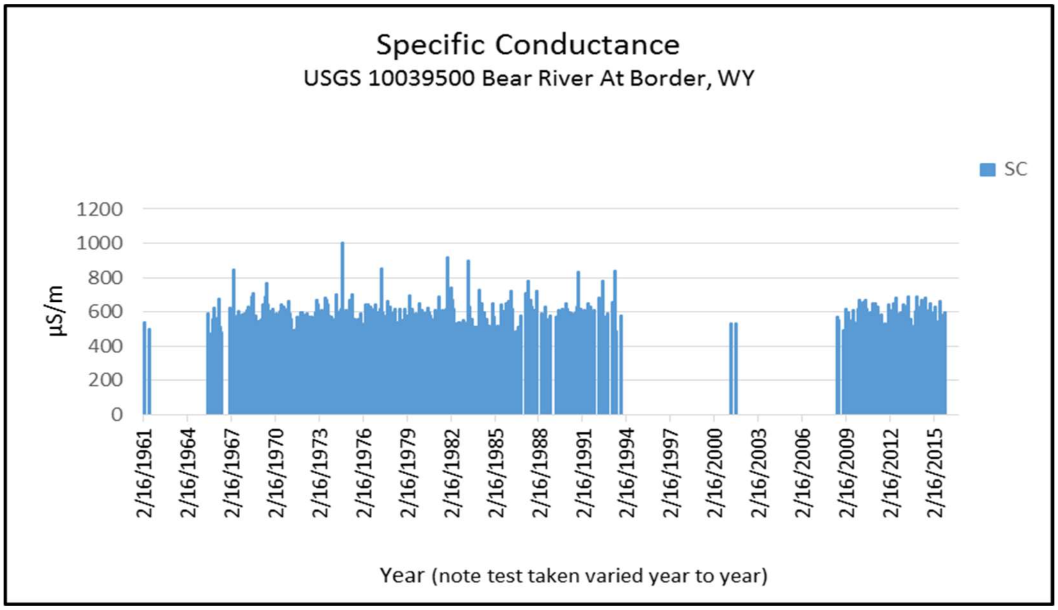
Graph 3.4.6.5h Specific Conductance Bear River USGS10028500



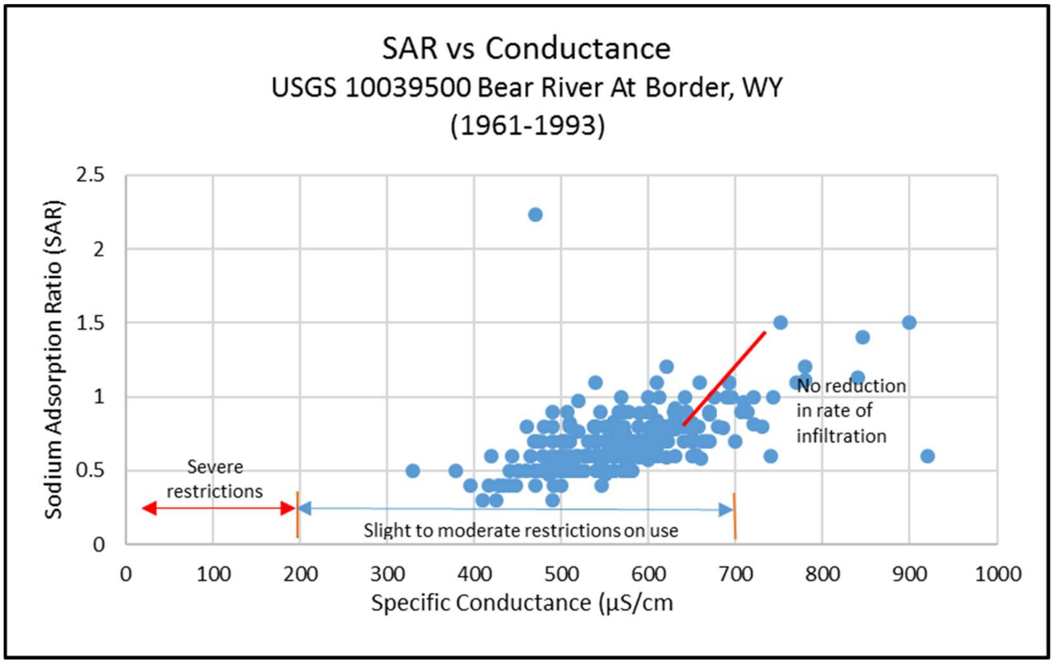
Graph 3.4.6.5i SAR vs Specific Conductance Bear River USGS10028500



Graph 3.4.6.5j SAR Bear River USGS10039500



Graph 3.4.6.5k Specific Conductance Bear River USGS10039500



Graph 3.4.6.5l SAR vs Specific Conductance Bear River USGS10039500

3.4.7 VEGETATION AND LAND COVER

Land cover within the study area is generally characterized by forest communities occupying the higher elevations, with sagebrush-steppe, pasture/hayland, and riparian forest/shrubland communities in the lower elevations. Sagebrush communities dominate the landscape and comprise more than 50% of the study area. The following plant community descriptions, adapted from the Kemmerer BLM Proposed RMP and Final EIS (2008), provide a general overview of plant communities in the study area.

Forest and Woodland Communities

The conifer forest communities consist of lodgepole pine, Douglas-fir, spruce-fir, spruce-fir/lodgepole pine, mixed aspen, and clear cut areas. Lodgepole pine dominates the canopy in the lodgepole pine forest, with subalpine fir and Engelmann spruce mixed with the canopy trees on most sites. Douglas-fir is dominant in both intact Douglas-fir forests and Douglas-fir forests influenced by logging. Engelmann spruce and/or subalpine fir are dominant or codominant in the canopy of the spruce-fir forest. At the lower end of its elevation range, this community occurs in relatively cool, mesic sites, such as north-facing slopes and along riparian corridors in canyons. It also mixes with aspen at lower elevation ranges. Subalpine fir tends to be dominant at lower elevations, with Engelmann spruce gaining importance toward the tree line. Spruce-fir/lodgepole pine mixed aspen forest communities exhibit spruce-fir/lodgepole pine as a major understory and co-dominant component which, with time and lack of fire and other natural disturbances, eventually will succeed aspen and dominate the canopy and become the major species in these stands. Clear-cut conifer communities are areas within conifer forests substantially altered by logging. This community comprises clear-cut areas within a matrix of conifer forests and, as such, is a mosaic of standing forest and logged areas with logged areas covering more than 40 percent of the total ground area. The logged areas may be in early succession stages, but classification as a forest requires trees to achieve a 25 percent canopy closure. Conifer forestlands are located in the mountains north of Kemmerer, Wyoming, in the Tunp Range, Sublette Range, and

Commissary Ridge areas, and south of Mountain View, Wyoming, on the lower north slope of the Uinta Mountains.

Aspen woodlands, or aspen forestlands with a major conifer component, include areas where aspen is the dominant tree species. Aspen communities occur in mountain foothills and in high valleys throughout Wyoming wherever the environment is sufficiently mesic. Aspen also occur in riparian zones in foothills. Aspen stands typically exhibit a diversity of understory vegetation, and are utilized by wildlife and livestock. They also serve as natural firebreaks, and often occur as part of an important riparian and wetland component of the forested ecosystem.

Juniper woodlands are found in foothills and rocky outcrops in most of Wyoming in association with big sagebrush, limber pine, and mountain mahogany species. The juniper woodlands include Rocky Mountain juniper and Utah juniper. Juniper encroaches into and dominates sagebrush communities after long periods without fire. Juniper woodlands are located in the hills and escarpments east of Evanston and south of Kemmerer, Wyoming.

Grasslands

Grasslands in the Kemmerer planning area include the Great Basin foothills grassland and mixed grass prairie cover types. Great Basin foothills grassland is a mesic grass-forb mix found in the foothills of northwestern Wyoming and includes species such as bluebunch wheatgrass, arrowleaf balsamroot, silvery lupine, Idaho fescue, spike fescue, Richardson's geranium, and avens-old man's whiskers. Mixed grass prairie contains a mixture of short and tall grass prairie species, including western wheatgrass, needle and thread, Indian ricegrass, and prairie junegrass. Shrub/subshrub species include Douglas rabbitbrush, winterfat, horsebrush, and prickly-pear cactus. When mixed grass prairie occurs in patches intermixed with shrub species (i.e., big sagebrush), grass patches must occupy more than 50 percent of the landscape for the primary vegetation type to be classified as a mixed grass prairie community. The vegetation type may also contain or be dominated by silver sagebrush. With the exception of silver sagebrush, trees or shrubs cannot occupy more than 25 percent of the total vegetative cover.

Meadows

Meadows in the Kemmerer planning area include subalpine meadow and grass dominated wetland cover types. Subalpine meadows occur in mountain parks within and below the upper treeline and include species such as American bistort, dwarf lewisia, alpine timothy, hairy arnica, slender wheatgrass, spiketrisetum, tufted hairgrass, and oatgrass. Grass-dominated wetlands comprise only a small percentage of the meadow habitat within the planning area and include non-riverine wetlands, such as wet and moist meadow grassland, marsh and swamp wetlands, cattail, bullrush and sedge-dominated wetlands, and inland saltgrass/alkali sacaton-dominated wetlands. Representative species include alkali sacaton, cattail, inland saltgrass, Baltic rush, and alkali cordgrass. Within both meadow cover types, trees or shrubs cannot occupy more than 25 percent of the total vegetative cover.

Sagebrush

Sagebrush communities include areas dominated by Wyoming big sagebrush and mountain big sagebrush and occupy the majority of the Kemmerer planning area. The Wyoming big sagebrush community is a shrub-steppe type, with Wyoming big sagebrush being the dominant shrub and total shrub cover comprising more than 25 percent of the vegetative cover. This plant community is variable in Wyoming and includes the full range of community types, from dense, homogeneous Wyoming big sagebrush to sparsely vegetated arid areas where Wyoming big sagebrush is the dominant shrub. Often, patches of Wyoming big sagebrush occur with patches of mixed grasses. In these cases, classification of the community as Wyoming big sagebrush steppe occurs if the sagebrush patches occupy more than 50 percent of the total landscape area, and as mixed grass if the grasses occupy more than 50 percent of the total area. Wyoming big sagebrush occurs throughout most of the state, with the exception of the extreme southeast corner. Often, rolling landscapes may feature Wyoming big sagebrush dominating broad slopes, but with sand sagebrush or various cushion plants on wind-swept ridges and knolls and with mountain big sagebrush in hollows. These landscapes are complex mixtures of several sagebrush-dominated types, but classified as Wyoming big sagebrush when dominated by this vegetation type.

The mountain big sagebrush plant community is dominated by mountain big sagebrush and is often found with mixed grasses. Total shrub cover typically comprises more than 25 percent of the vegetative cover. Sometimes this shrub type occurs as patches of dense sagebrush with patches of mixed grasses. Mountain big sagebrush occupies cooler sites than basin big sagebrush and more mesic sites than Wyoming big sagebrush and often occurs in mountain parks. Mountain big sagebrush is found at the lower margin of the treeline and can be intermixed with trees.

Desert shrubs

The desert shrubs community comprises a mixture of shrub species occurring in dry saline habitats. Shrub cover is often dominated by shadscale and saltbush, but can be a mixture of Gardner's saltbush, black greasewood, and/or desert cushion plants. When ground cover is pure Gardner's saltbush or pure greasewood, it is classified as such, but when these species are mixed and dominance is unclear, it is classified as desert shrub. This plant community also includes some cushion plant communities found in Wyoming basins. Total shrub cover comprises more than 25 percent of the total vegetative cover. Desert shrub usually is found in flats and fans in the central and western basins of Wyoming.

Mountain shrubs

Mountain shrub communities include xeric and mesic shrublands found on mountain slopes. In the xeric shrub community, the shrub cover is dominated by species of mountain mahogany, with shrub species comprising more than 25 percent of the vegetative cover. These communities usually occur on dry slopes or flats where bedrock is very close to the surface or outcropping. Xeric shrublands often are found along canyon walls around the margins of mountain ranges or on surfaces formed by tilted sedimentary strata. Xeric shrublands also are found at mid-elevations in shallow soils. Soil factors are probably the most important factors in controlling the distribution of these shrublands. A variety of shrub-dominated communities grow in relatively mesic sites in Wyoming, often in snow catchments or downslope from catchments or in ravines over a wide range of elevation. Most often, Rocky Mountain maple, bigtooth maple, serviceberry, snowberry, wax currant, and/or chokecherry are dominant or codominant, but other shrub species can be present. Mountain mahogany species cannot be dominant and mesic shrubs must comprise more than 25 percent of the vegetative cover. Mesic shrublands occur in foothill locations and in mesic microenvironments throughout Wyoming.

Greasewood fans and flats

Areas where greasewood comprises more than 75 percent of the total shrub cover and where shrubs comprise more than 25 percent of the vegetative cover are categorized as greasewood fans and flats. This vegetation type often is found mixed with grasses and generally found along streams at low to medium elevations, although it can occur on fine-textured saline upland areas and on basin fans and flats. Greasewood also occurs in riparian areas.

Riparian and Wetland Communities

Riparian and wetland communities are areas that exhibit persistent water or obligate vegetation (e.g., sedges, rushes, willows) reflecting the availability of surface or groundwater. Vegetation found in these communities typically is adapted to flooding disturbances or saturated (water-logged) soils. Riparian and wetland communities in the Kemmerer planning area include forest-dominated riparian, grass-dominated wetland, shrub-dominated riparian, and open water.

Forest-dominated communities include riparian zones in which tree species dominate the vegetation of the riparian corridor. In Wyoming, these are usually cottonwood species, but can also be aspen, boxelder, or a variety of conifer species. Trees must occupy more than 25 percent of the vegetative cover within the riparian zone. Forest-dominated riparian communities are found throughout Wyoming, from basins to treeline. In basins, larger drainages often support trees, while smaller drainages generally support shrubs and grasses.

Shrub-dominated riparian communities include riparian zones in which shrubs comprise more than 25 percent of the vegetative cover and trees occupy less than 25 percent of the vegetative cover. Shrubs often include willow species, hawthorn, wild plum, birch, alder, tamarisk, and shrubby cinquefoil, but other shrubs (e.g., sagebrush species, and (or) greasewood) may be present. Shrub-dominated communities also include alpine riparian zones dominated by willow species or other shrubs. Shrub-dominated riparian communities occur throughout Wyoming.

Grass-dominated wetlands include nonriverine wetlands with vegetation dominated by grasses or forbs. Trees or shrubs cannot occupy more than 25 percent of the vegetative cover. Grass-dominated wetlands are found throughout Wyoming and include communities such as wet and moist meadow grassland, marsh and swamp wetlands, cattail, bullrush- and sedge-dominated wetlands, and inland saltgrass and alkali sacaton-dominated wetlands. Grass-dominated wetlands also include both low and high salinity wetlands. Cattails, rushes, sedges, and prairie cordgrass characterize low-salinity wetlands. High-salinity wetlands include species such as alkali sacaton, alkali cordgrass, saltgrass, seablite, wildrye, and wheatgrass.

Mapping and analysis of major plant communities in the study area was facilitated through the use of remote sensing datasets.

3.4.7.1 NATIONAL LAND COVER DATABASE

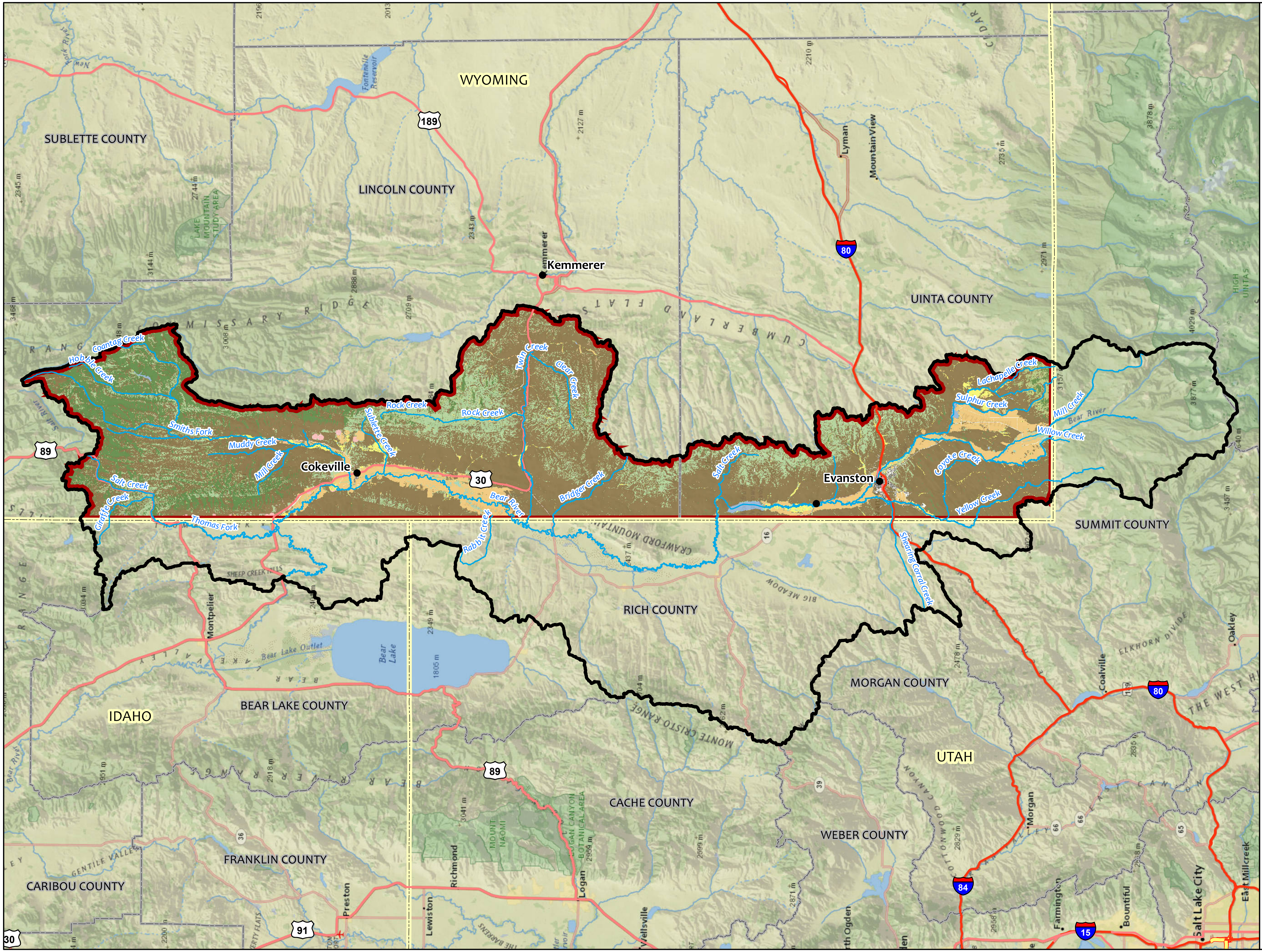
The National Land Cover Database (NLCD) is a nationwide spatial dataset based on Landsat satellite data that provides a generalized characterization of 16 land surface classes at a 30-meter resolution. The NLCD products are created through a cooperative project conducted by the Multi-Resolution Land Characteristics (MRLC) Consortium, which is a partnership of federal agencies, consisting of the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Environmental Protection Agency (EPA), the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), the U.S. Forest Service (USFS), the National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM), the National Aeronautics and Space Administration (NASA), and the Office of Surface Mining (OSM). NLCD land cover data for the study area are depicted in Figure 3.4.7-NLCD Land Cover. At 597,633 acres, the shrub/scrub cover class comprises more than 62% of the study area and is the dominant covertype on the landscape. These areas are dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. Please refer to the individual county supplements for detailed analysis of NLCD mapping in the respective subregions.

3.4.7.2 LANDFIRE

Landscape Fire and Resource Management Planning Tools (LANDFIRE) is a comprehensive nationwide spatial dataset that describes vegetation, wildland fuel, fire regimes and ecological departure from historical conditions (www.landfire.gov). The LANDFIRE program was developed to support fire and fuels management planning, and is a shared effort between the wildland fire management and research and development programs of the USDA and US Department of the Interior (USDI). The LANDFIRE data production framework integrates many geospatial technologies including biophysical gradient analyses, remote sensing, vegetation modeling, ecological simulation, and landscape disturbance and successional modeling (Rollins 2009). The LANDFIRE Existing Vegetation Type (EVT) layer describes vegetation communities at a high level of thematic detail and is not appropriate for display on a large watershed scale. The EVT layer represents the species composition currently present at a given site. Vegetation map units are primarily derived from NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units. Additional units are derived from NLCD, National Vegetation Classification Standard (NVCS) Alliances, and LANDFIRE specific types. The analysis of EVT data for the study area indicate that Artemisia tridentata ssp. vaseyana Shrubland Alliance and Inter-Mountain Basins Big Sagebrush Shrubland are the most dominant classes and comprise 31.4% and 22.5% of the study area respectively. Results of the EVT analysis on a per county basis are presented in the report supplements for each county. Descriptions of the LANDFIRE existing vegetation type classifications are available for download from the LANDFIRE website (http://www.landfire.gov/NationalProductDescriptions21.php).

3.4.7.3 GAP ANALYSIS

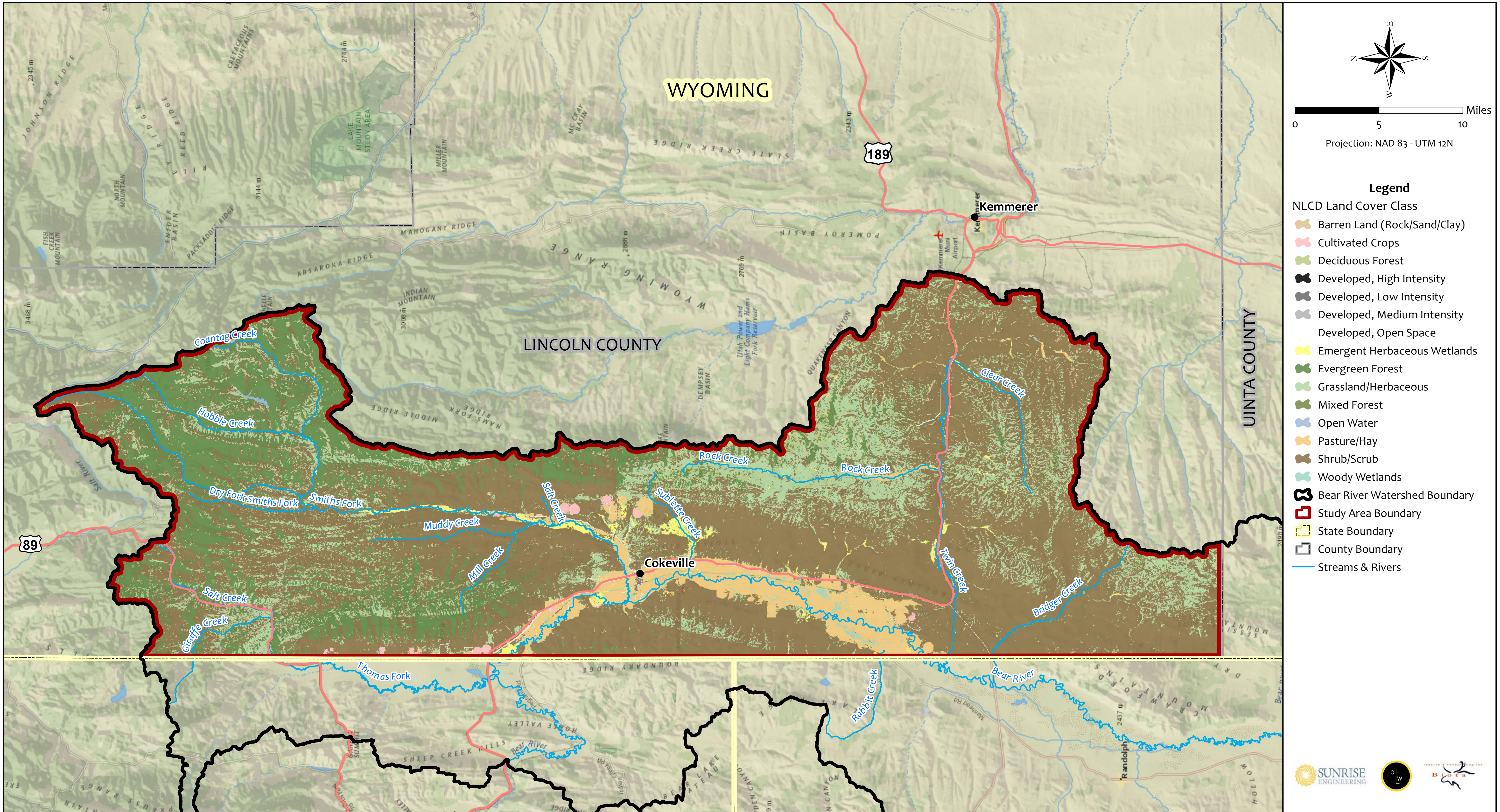
The USGS GAP National Land Cover dataset provides detailed information on vegetation and land use patterns based on satellite imagery (http://gapanalysis.usgs.gov/gaplandcover/). This national dataset combines land cover data generated by regional GAP projects with LANDFIRE data and incorporates the Ecological System classification system developed by NatureServe. At the Ecological System level, the GAP dataset describes vegetation communities at a high level of thematic detail, which is typically not appropriate for display at scales larger than 1:100,000. To facilitate display at a larger scale, the ecological systems have been cross-walked to the five highest levels of the NVCS. This allows the dataset to be displayed with varying levels of detail, from general (11 classes; NVCS Class) to most detailed (583 classes; Ecological System). The vegetation features used to distinguish these classes range from growth form, and climate regimes at the Class level to regional differences in substrate and hydrology at the Macrogroup level. GAP land cover data for the study area are depicted in Figure 3.4.7a-GAP Land Cover. According to the GAP analysis, Inter-Mountain Basins Big Sagebrush Steppe comprises 270,817 acres (28% of the watershed) and is the most abundant ecological system in the watershed. This is followed, in order of decreasing abundance, by Inter-Mountain Basins Montane Sagebrush Steppe, Pasture/Hay, and Wyoming Basins Dwarf Sagebrush Shrubland and Steppe. Detailed GAP land cover mapping is presented in the supplemental county report volumes. Descriptions of all ecological systems in the United States are available for download from the NatureServe website (http://www.natureserve.org/conservation-tools/terrestrial-ecological-systems-united-states).The NLCD, LANDFIRE, and GAP land cover datasets are included in the project GIS.



SUNRISE ENGINEERING

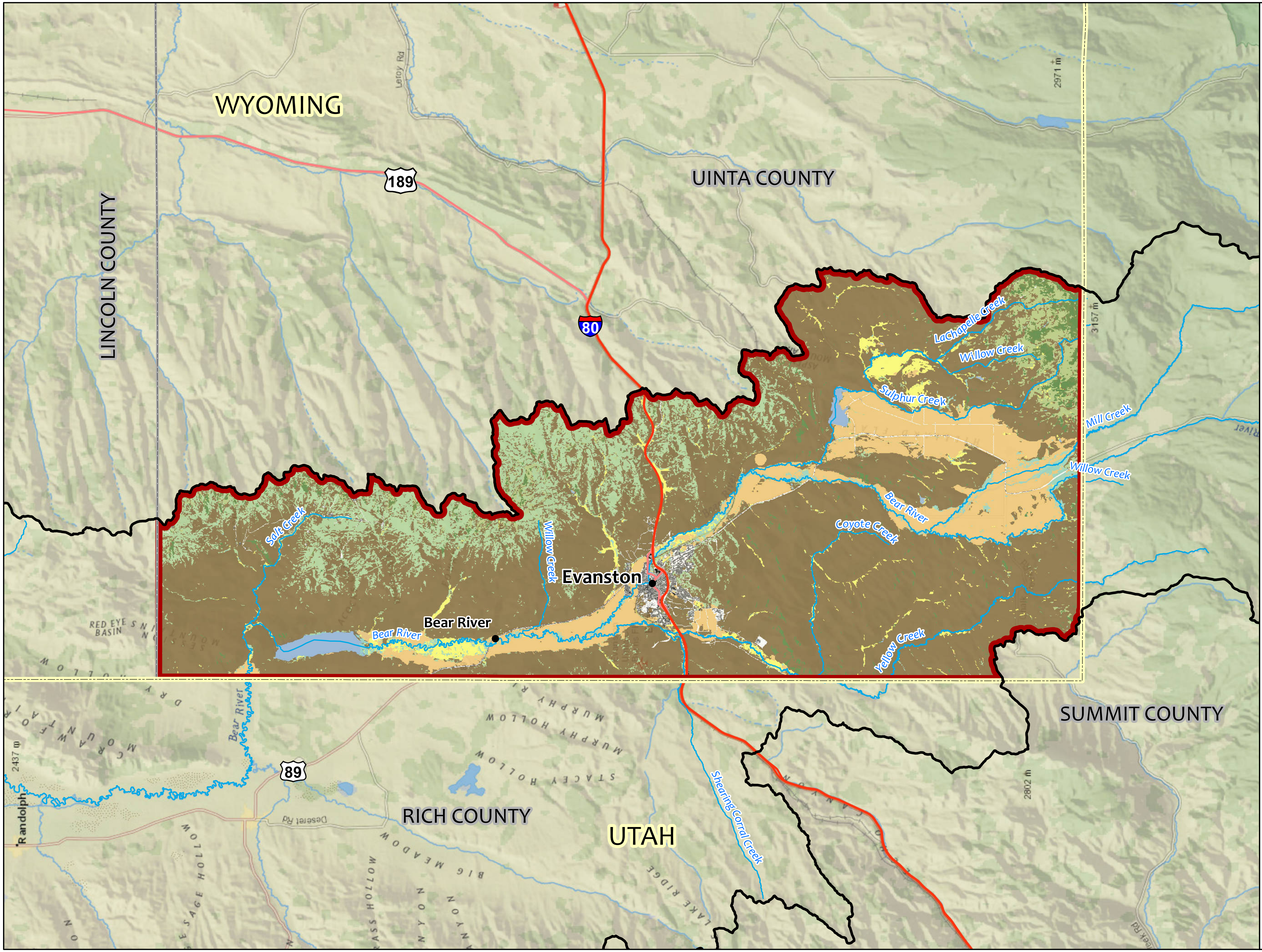
Bear River Watershed

Figure 3.4.7
NLCD Land Cover



Bear River Watershed Lincoln County

Figure 3.4.7
NLCD Land Cover



0 3 6 Miles

Projection: NAD 83 - UTM 12N

Legend

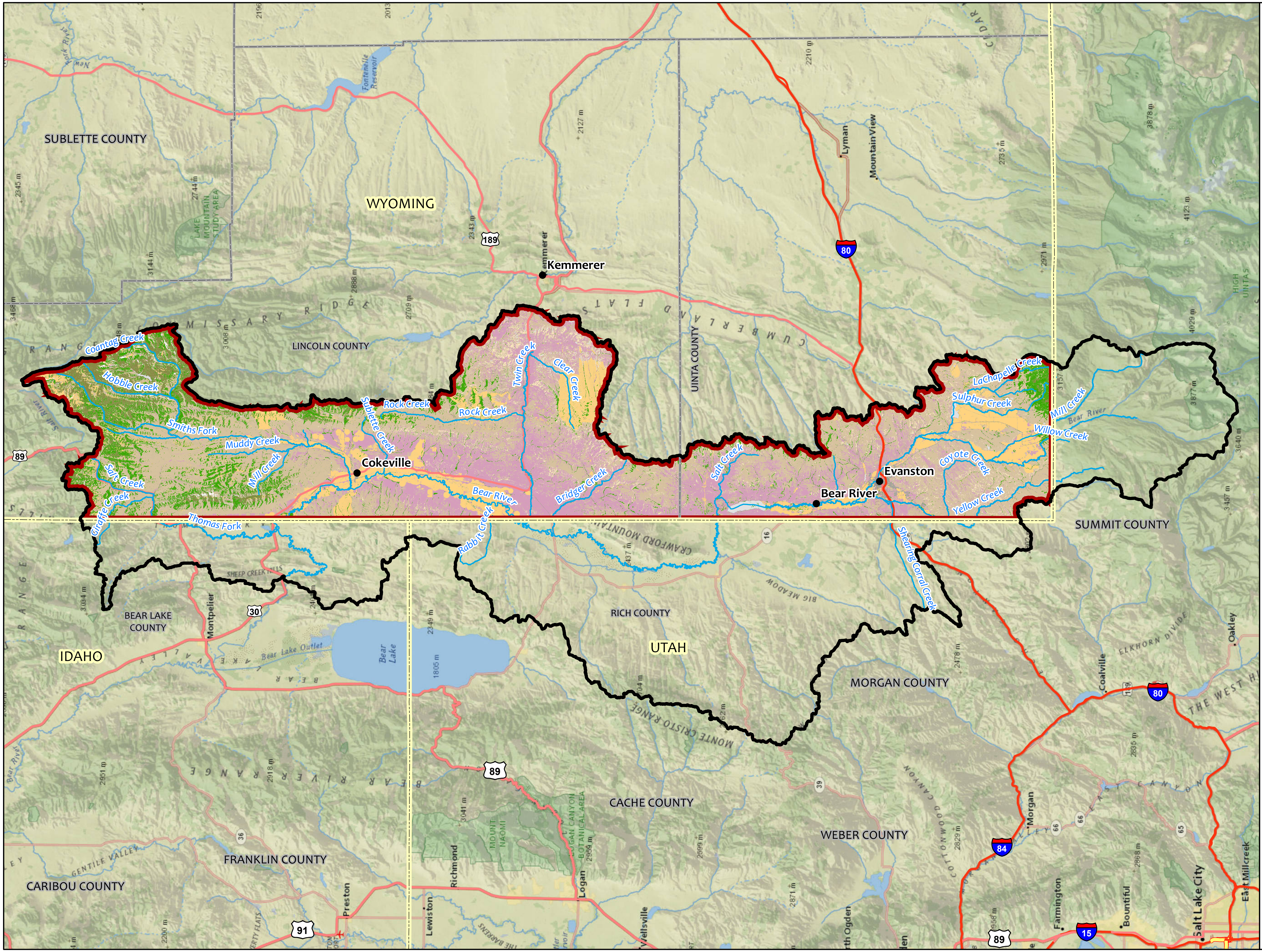
NLCD Land Cover Class

- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Developed, High Intensity
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, Open Space
- Emergent Herbaceous Wetlands
- Evergreen Forest
- Grassland/Herbaceous
- Mixed Forest
- Open Water
- Pasture/Hay
- Shrub/Scrub
- Woody Wetlands
- Bear River Watershed Boundary
- State Boundary
- County Boundary
- Study Area Boundary
- Streams & Rivers

SUNRISE ENGINEERING

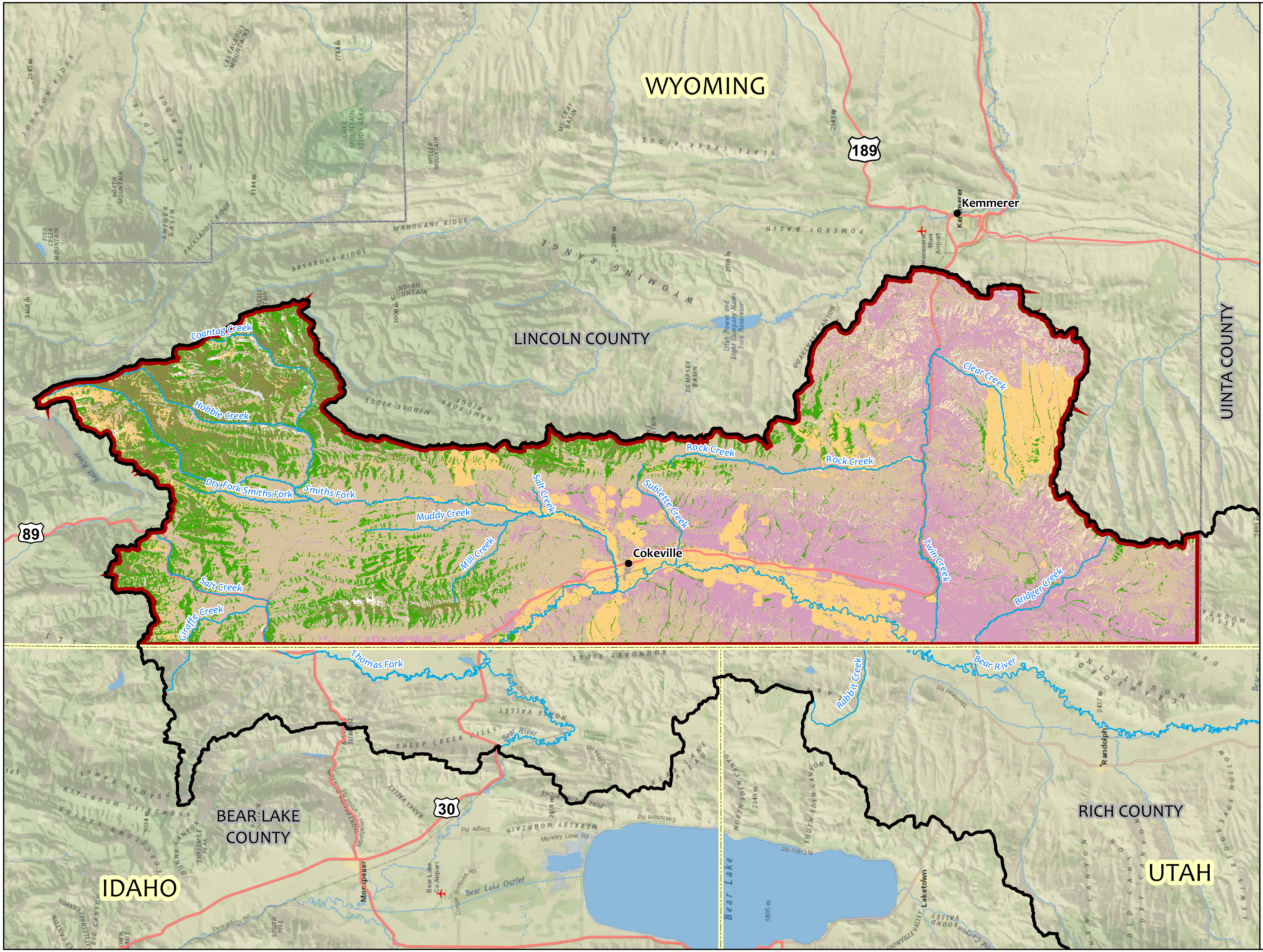
Bear River Watershed
Uinta County

Figure 3.4.7
NLCD Land Cover



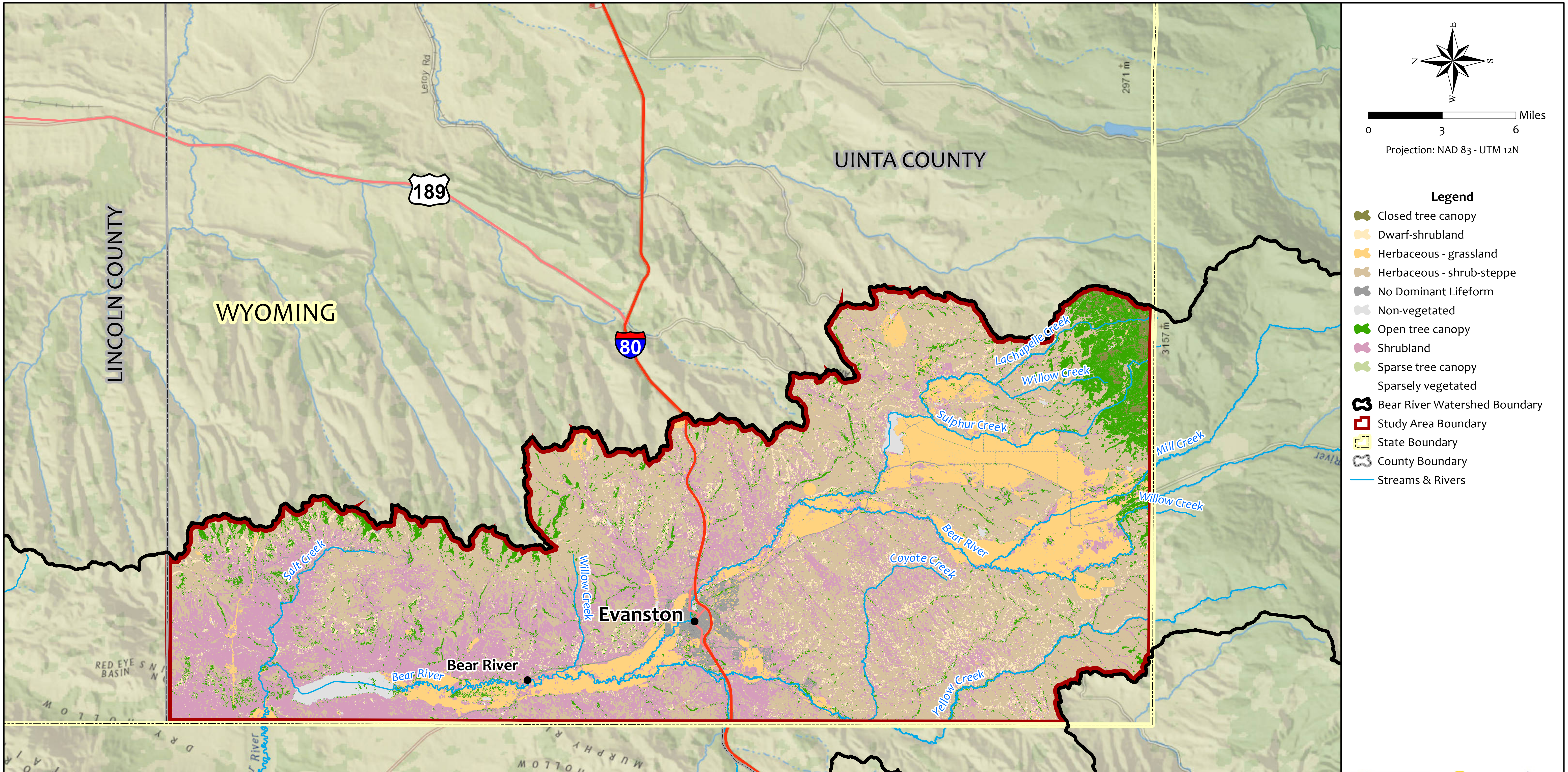
Bear River Watershed

Figure 3.4.7.2
Landfire Land Cover Classification



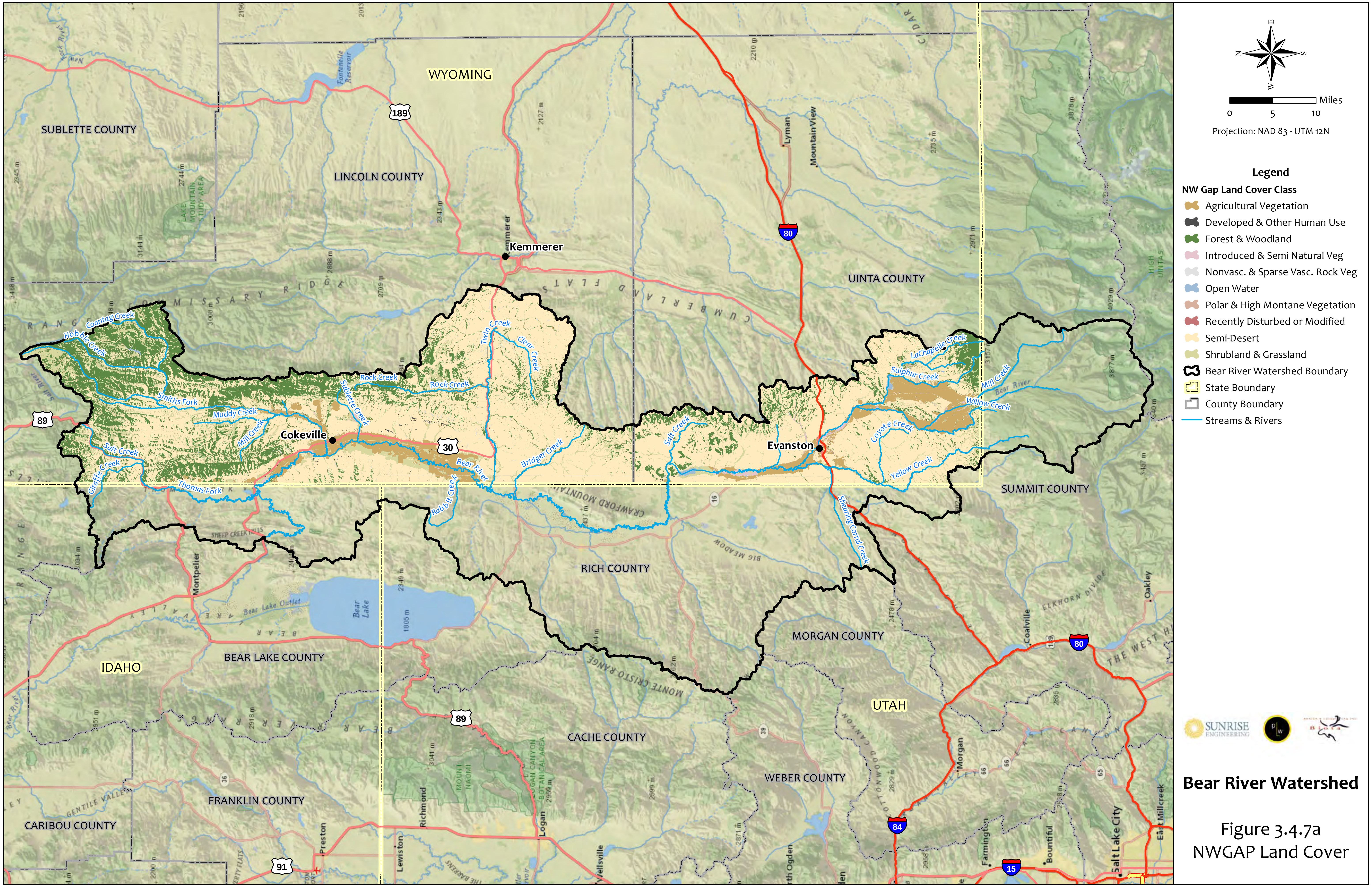
Bear River Watershed Lincoln County

Figure 3.4.7.2
Landfire Land Cover Classification



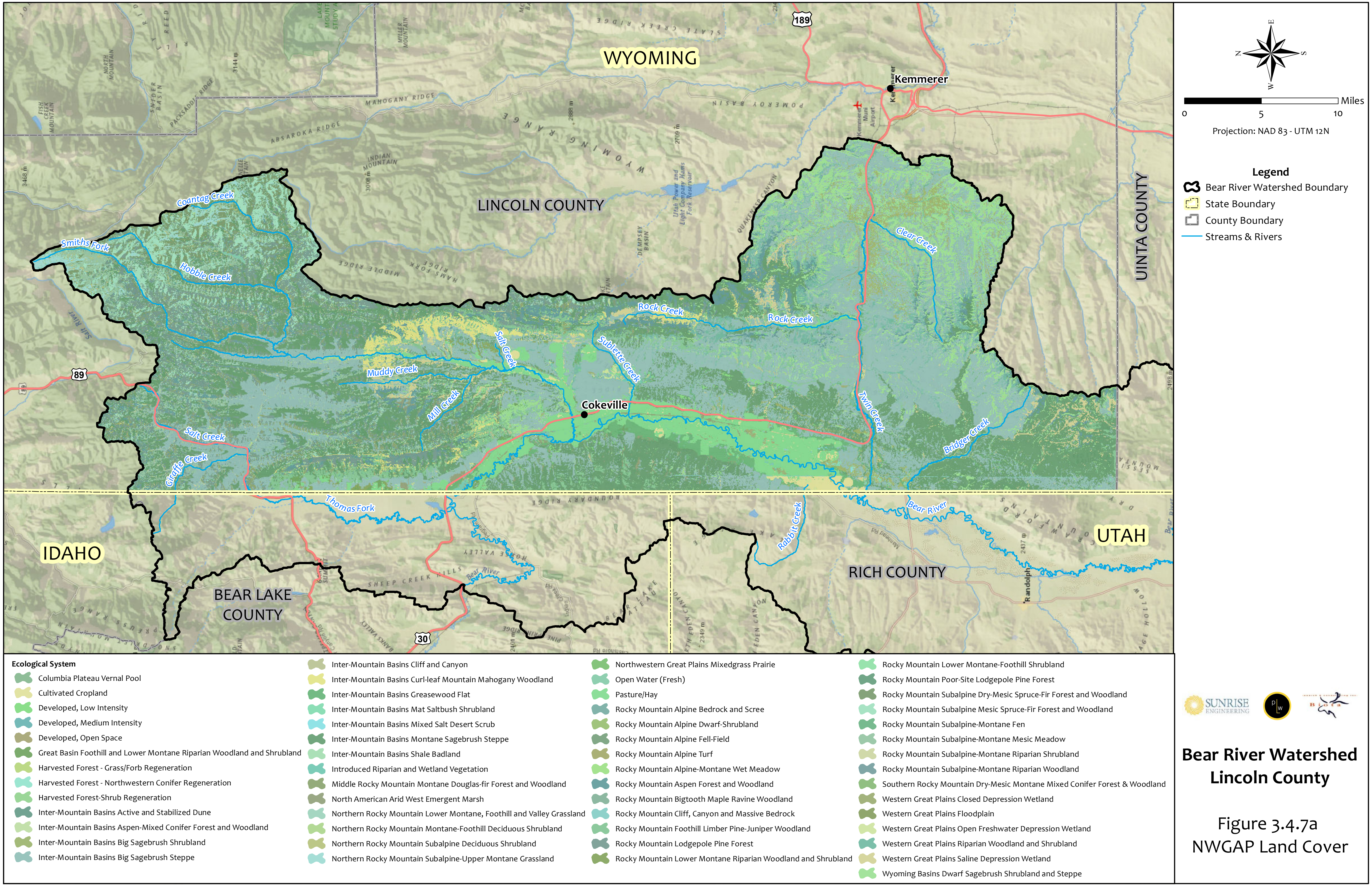
Bear River Watershed
Uinta County

Figure 3.4.7.2
Landfire Land Cover
Classification



Bear River Watershed

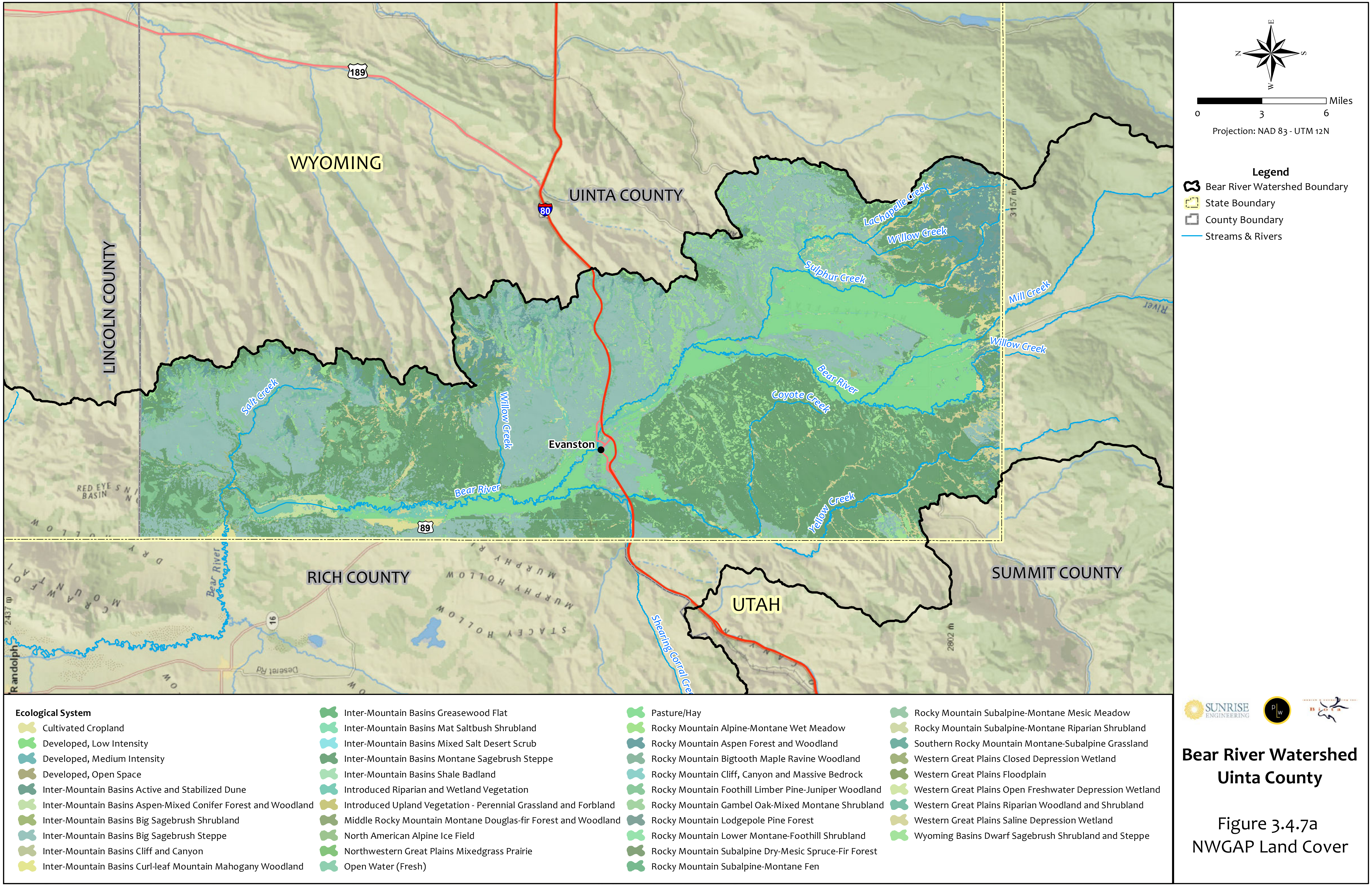
Figure 3.4.7a
NWGAP Land Cover



SUNRISE ENGINEERING

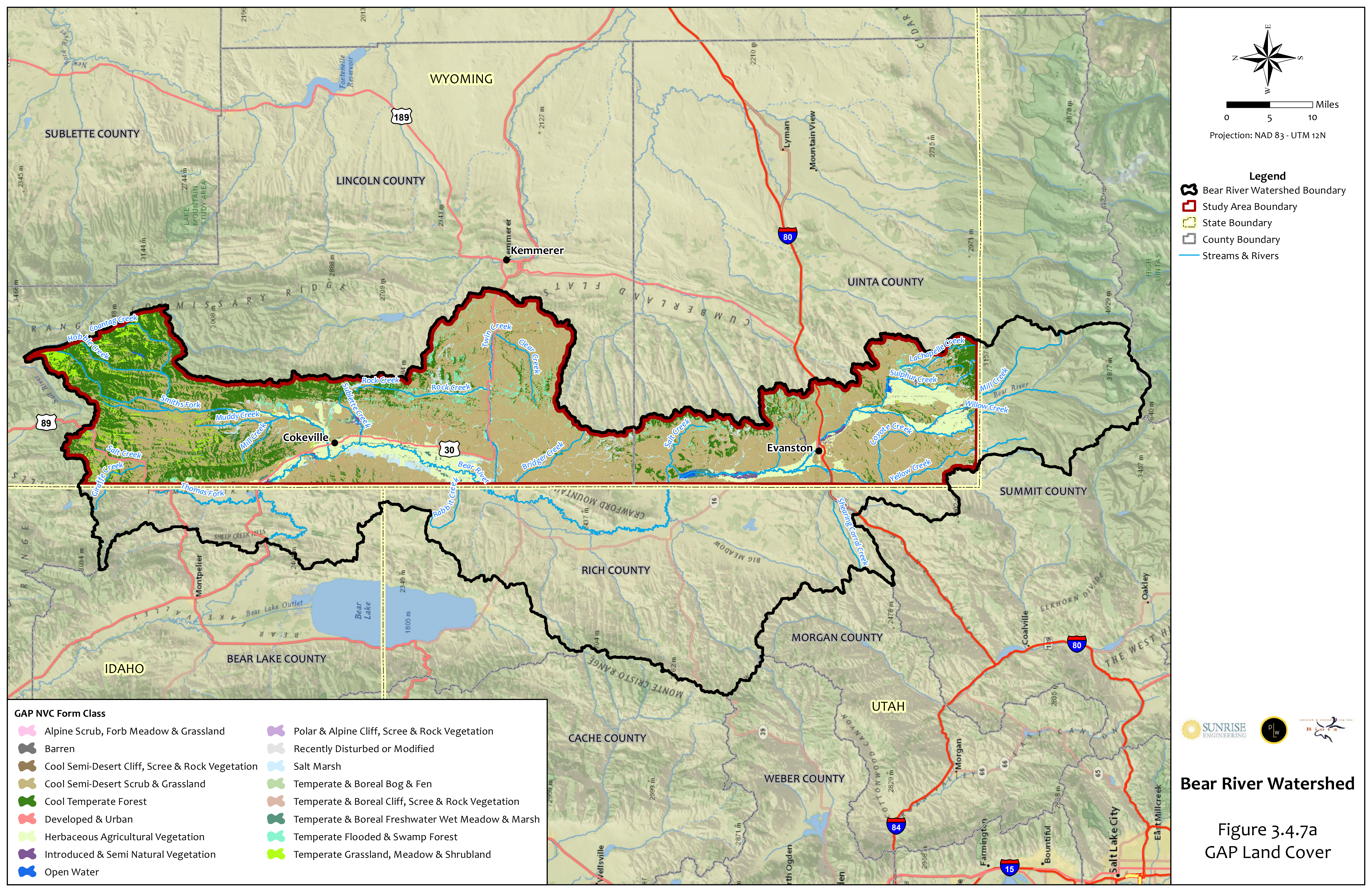
Bear River Watershed
Lincoln County

Figure 3.4.7a
NWGAP Land Cover



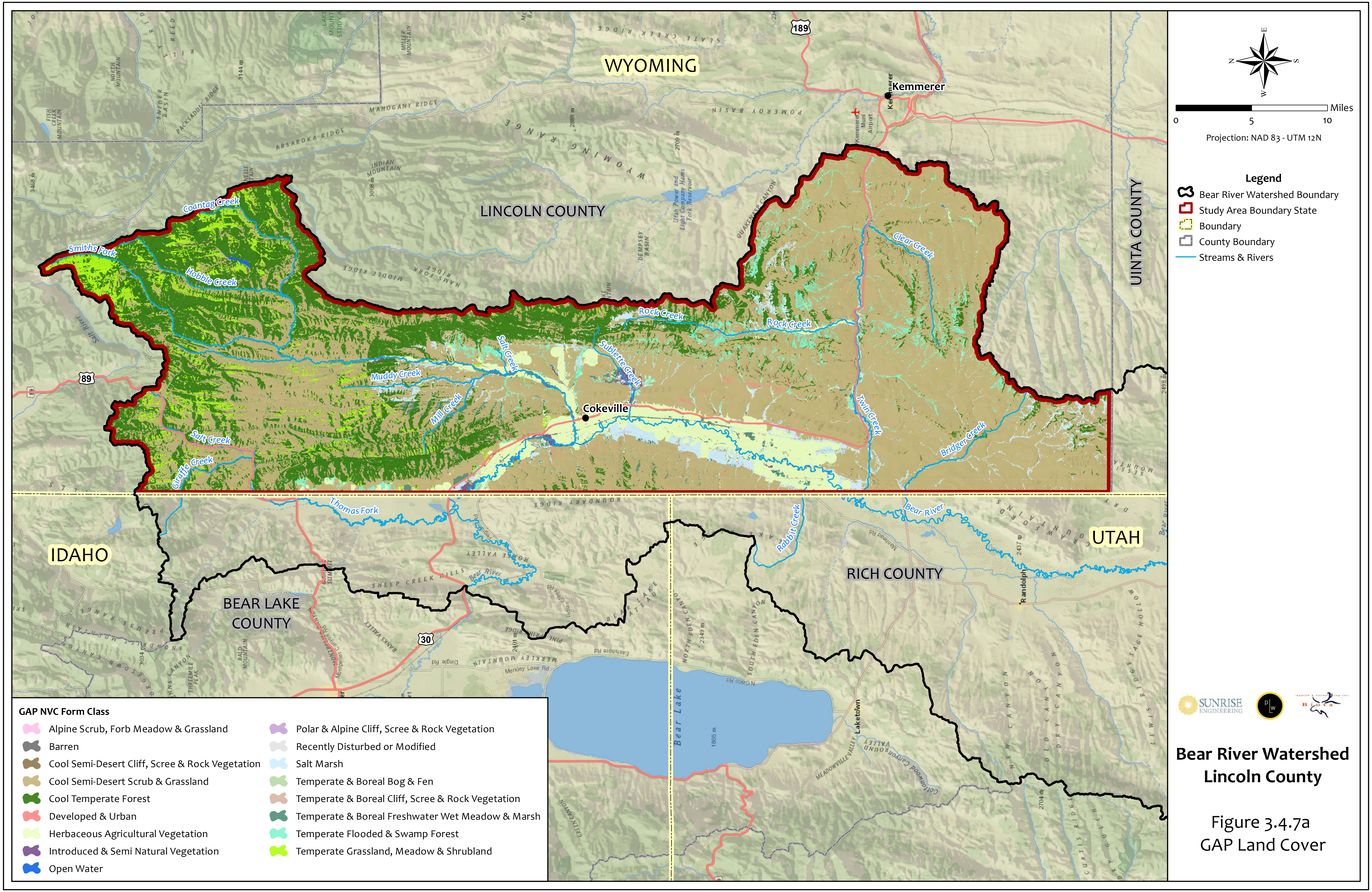
Bear River Watershed
Uinta County

Figure 3.4.7a
NWGAP Land Cover



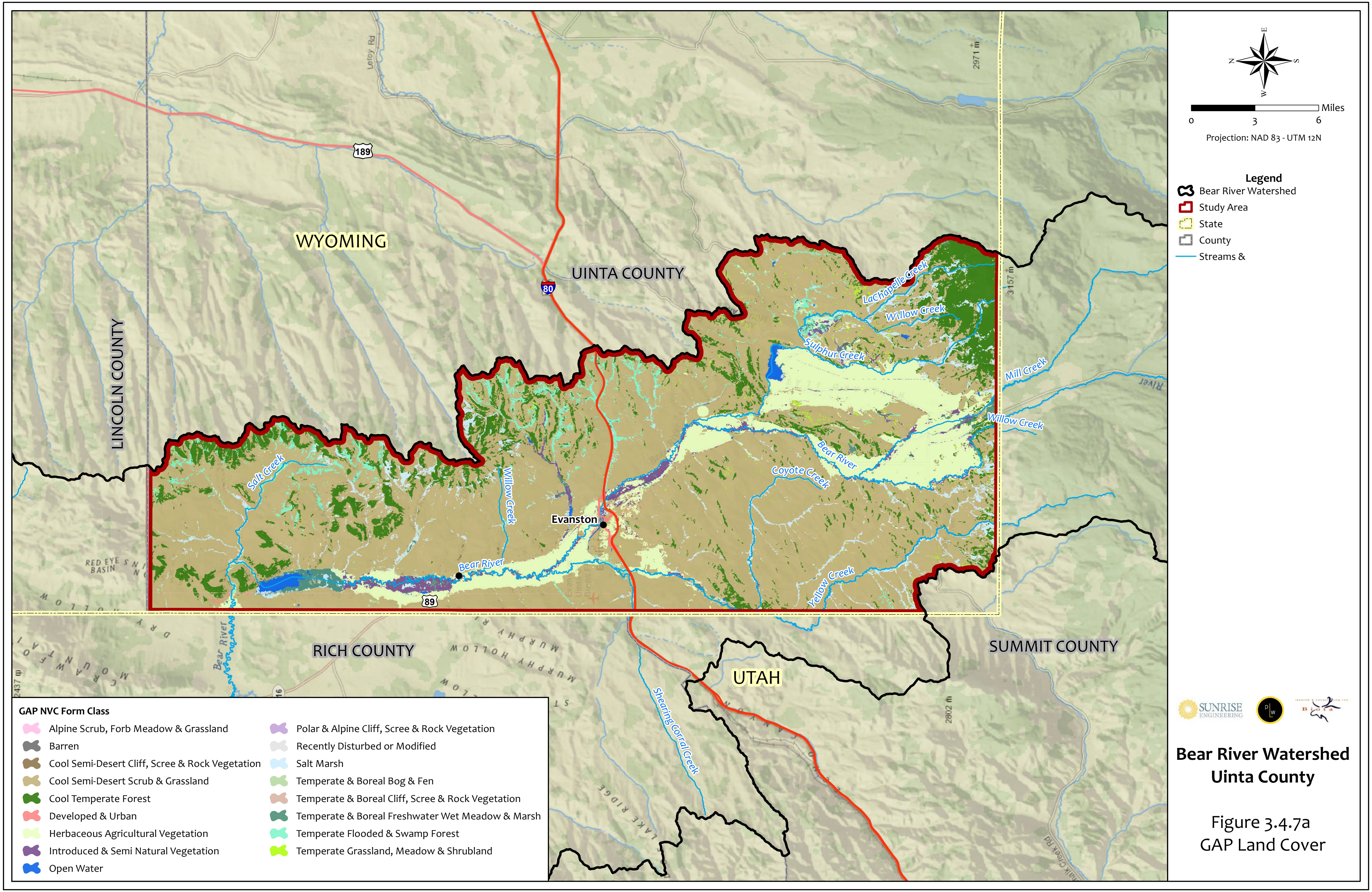
Bear River Watershed

Figure 3.4.7a
GAP Land Cover



Bear River Watershed
Lincoln County

Figure 3.4.7a
GAP Land Cover



Bear River Watershed
Uinta County

Figure 3.4.7a
GAP Land Cover

3.4.7.4 SENSITIVE SPECIES

Mapping from the Wyoming Natural Diversity Database (WYNDD) depicts 25 sensitive plant species with known occurrences within the study area. Fourteen (14) of these species are listed as critically imperiled in the state. The critically imperiled species are listed in Table 3.4.7.4 with State Rank classifications of S1.

Table 3.4.7.4. Sensitive plant species mapped by Wyoming Natural Diversity Database with known study area occurrences.

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Astragalus lentiginosus var. salinus	Sodaville milkvetch	G5T5	S1	N	N
Astragalus paysonii	Payson's milkvetch	G3	S2	N	Y
Astragalus shultziorum	Shultz's milkvetch	G3Q	S3	N	N
Ceanothus martinii	Utah mountain lilac	G4	S1	N	N
Cirsium barnebyi	Barneby's Thistle	G3G4	S1	N	N
Collomia grandiflora	Large-flower collomia	G5	SH	N	N
Cuscuta occidentalis	Western dodder	G4G5	S1	N	N
Downingia laeta	Great basin downingia	G5	S1	N	N
Ericameria discoidea var. linearis	Narrowleaf goldenweed	G4G5T4	S2	N	Y
Ericameria winwardii	Winward's goldenweed	G4G5T1	S1	Y	N
Hesperochiron californicus	California hesperochiron	G4G5	S1	N	N
Ipomopsis aggregata var. tenuituba	Slender-trumpet ipomopsis	G4G5	S1	N	N
Ipomopsis crebrifolia	Compact ipomopsis	G3G4	S3	N	N
Lathyrus lanszwertii var. lanszwertii	Nevada sweet pea	G4G5T4	S1	N	N
Lepidium integrifolium	Entire-leaved Peppergrass	G2G3	S1	Y	N
Lesquerella paysonii	Payson's bladderpod	G3	S3	N	Y
Lesquerella prostrata	Prostrate bladderpod	G2G3	S2	Y	N
Lomatium bicolor var. bicolor	Wasatch biscuitroot	G4T3T4	S2	N	N
Lomatium triternatum var. anomalum	Ternate desert-parsley	G5T4T5	S1	N	N
Penstemon paysoniorum	Payson's Beardtongue	G3	S3	N	N
Phlox albomarginata	White-margined phlox	G4	S1	N	N
Phlox pungens	Beaver Rim phlox	G3	S3	Y	N

Table 3.4.7.4 (Cont.)

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Physaria condensata	Tufted twinpod	G2G3	S2S3	Y	N
Physaria dornii	Dorn's twinpod	G1	S1	Y	N
Silene douglasii	Douglas' campion	G4	S1	N	N

G = Global: Range-wide probability of extinction by NatureServe (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)
S = Subnational: State-wide probability of extinction (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)
T= Trinomial Rank: Range wide probability of extinction (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)
H= possibly extinct or extirpated

3.4.7.5 THREATENED AND ENDANGERED SPECIES

According to the USFWS, the Ute ladies’-tresses orchid is the only ESA-listed plant species with known or suspected habitat within the study area. The whitebark pine (Pinus albicaulis) is listed as a candidate species eligible for ESA protection, but in 2001, the USFWS determined that adding the species to the Federal List of Endangered and Threatened Wildlife and Plants is precluded by the need to address other higher priority listing actions.

The existing and historical range of Ute ladies’-tresses includes western Nebraska, southeastern Wyoming, northeastern and southern Utah, east-central Idaho, southwestern Montana, southeastern Nevada, and central Washington (Fertig et al. 2005). Ute ladies’-tresses have been documented at elevations between 4,300 and 7,000 feet in the central Rocky Mountains and adjacent plains. Two isolated Ute ladies’-tresses populations found in Washington State are located in considerably lower elevations (i.e., 720-1,830 feet). In response to the Ute ladies’-tresses global rarity, and current threats to this species, the USFWS listed this orchid as a threatened species under the ESA in 1992.

Ute ladies’-tresses are typically found associated with dynamic hydrologic features, including perennial and seasonally flooded watercourses and terraces, floodplains, oxbows, and sub-irrigated or spring-fed abandoned channels, and valleys. Hydrologic regimes within these riverine systems provide periodic flood events that support alluvial processes and create early successional conditions conducive to the establishment of Ute ladies’-tresses populations. Since 1992, Ute ladies’-tresses populations have been discovered along irrigation canals, berms, levees, irrigated meadows, excavated gravel pits, roadside borrow pits, reservoirs, and other modified wetlands (Fertig et al. 2005).

Extensive Ute ladies’-tresses surveys have been conducted in eastern Wyoming, where known populations have been documented. Populations have been discovered in Goshen, Laramie, Niobrara, and Converse Counties, all of which are located in southeastern Wyoming (USFWS 2005). Surveys have been conducted in numerous other locations throughout Wyoming with negative results. Populations of Ute ladies’-tresses have been documented in the Utah portion of the Bear River watershed.

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3.4.8 WETLANDS

Wetlands are among the most important ecosystems on Earth, and they play an essential role in the landscape by providing productive and unique habitats for a diverse array of plants and animals (Mitsch and Gosselink 1986). This is especially true in the semiarid and arid portions of the Intermountain West, where precipitation is highly variable and strongly dependent on topography and elevation. Ecological processes associated with wetlands provide a variety of environmental maintenance functions on global, regional, and local scales. These functions include, but are not limited to: water quality improvement (e.g., nutrient uptake and sediment retention), erosion control, groundwater recharge, flood attenuation, and fish and wildlife habitat. Landscape position and hydrologic interactions help to determine prominent functions for each particular wetland.

Approximately 90% of the wildlife species in Wyoming utilize wetlands and riparian habitats at some point during their life cycle, and about 70% of Wyoming bird species are wetland or riparian obligates (Nicholoff 2003). In 2010, the Wyoming Joint Ventures Steering Committee developed the Wyoming Wetlands Conservation Strategy, which identified important wetland and riparian habitat areas throughout Wyoming (Wyoming Joint Ventures Steering Committee 2010). Nine wetland complexes were identified and prioritized for conservation due to the important habitat they provide for the state's wetland dependent wildlife. The Wyoming Bird Habitat Conservation Partnership (WBHCP) subsequently developed regional step-down plans addressing conservation needs within each of the priority wetland complexes. The Bear River Wetlands Complex encompasses 386,263 acres (40%) of the study area (Fig. 3.4.8.1), and was one of the wetland complexes identified as a statewide priority. A regional wetlands conservation plan for the Bear River Wetlands Complex, completed by the WBHCP in May of 2014, identifies threats to wetlands as well as wetland conservation opportunities in the Bear River Wetlands Complex.

As is common for arid basins throughout the intermountain west, wetlands in the Bear River watershed are concentrated along natural watercourses and manmade water features, such as irrigation ditches. Large expanses of low to mid-elevation wet meadows exist within the Bear River floodplain, and a substantial portion of these wet meadows are supported by irrigation activities. Traditional management of wet meadows on the Bear River floodplain includes flood irrigation in late spring and early summer; haying in late July or beginning of August; followed by flood irrigation in late summer/fall prior to grazing in the dormant season. This management regime and associated irrigation activities provide high quality feeding and stopover habitat for a diverse array of migrating waterbirds and waterfowl, and residual vegetation from the previous growing season provides nesting habitat in the vegetation surrounding the hay meadows. Common plant species in these wetland habitats include sedges (*Carex spp.*), rushes (*Juncus spp.*), bulrushes (*Schoenoplectus spp.*), cattails (*Typha spp.*), reed canarygrass (*Phalaris arundinacea*), and Garrison creeping foxtail (*Alopecurus arundinaceus*) (WBHCP 2014). Garrison creeping foxtail, an aggressive non-native species, dominates the plant community in many of the irrigated hay meadows.

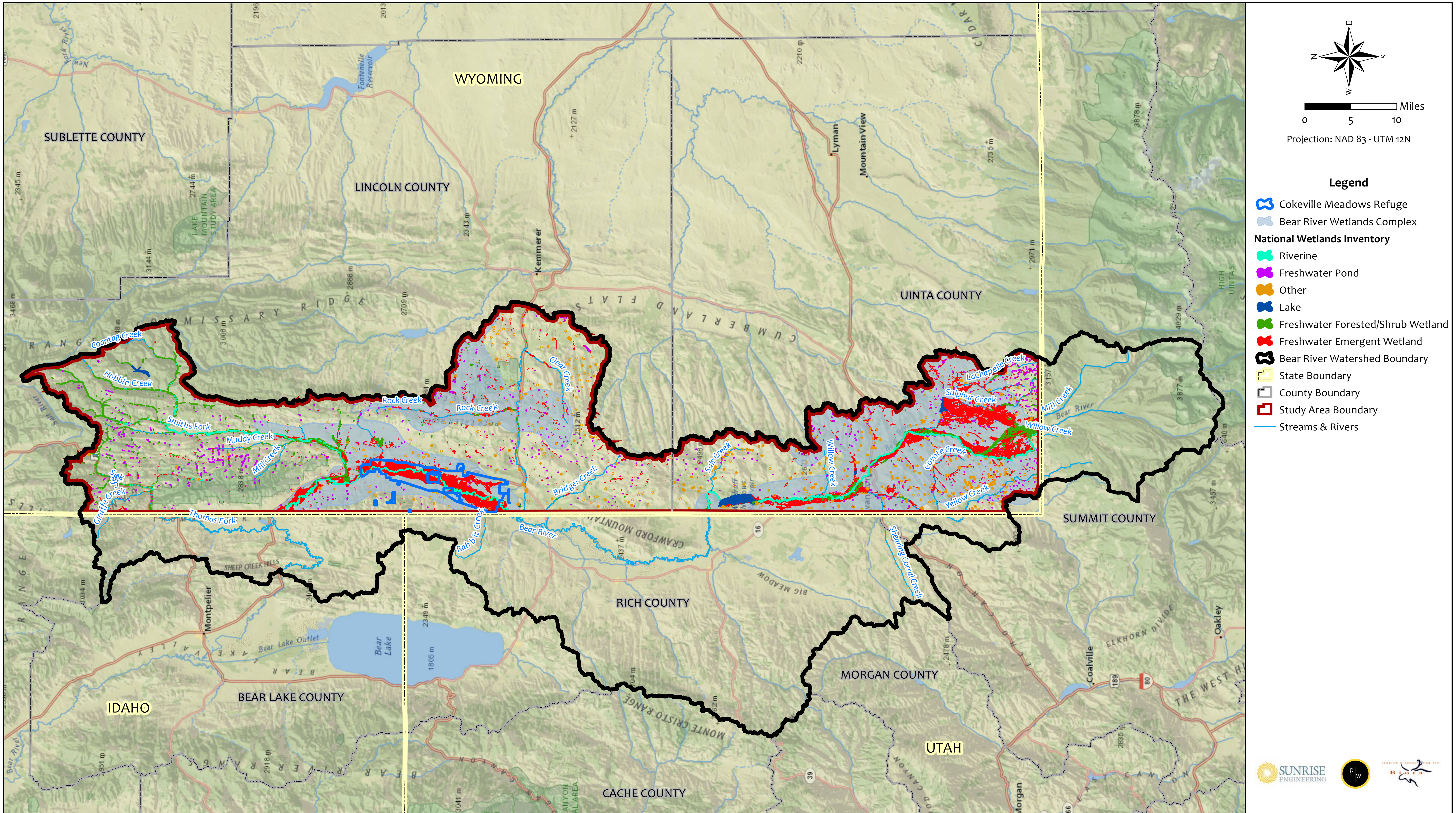
Cokeville Meadows National Wildlife Refuge

A large complex of wetlands in the central portion of the watershed is protected by Cokeville Meadows National Wildlife Refuge. The refuge was established in 1993 to preserve and protect breeding and migration habitat for migratory and resident birds including trumpeter swan, redhead, white-faced ibis, long-billed curlew, sandhill crane, greater sage-grouse, and many other conservation-priority species (USFWS 2014). The approved acquisition boundary for the refuge includes 26,547 acres, and as of 2014, the refuge consisted of 9,259 of fee-title and conservation easement lands. The USFWS is continually looking to add to this land base through fee title purchase from willing owners or placing properties under conservation easement. Refuge habitats include emergent wetlands, wet meadows, riparian corridors, and upland sagebrush/grassland communities. The refuge is primarily managed for waterfowl nesting and production, and the management regime is similar to that on many of the surrounding private lands. Grazing and haying are primarily used as vegetation management tools to enhance waterfowl and waterbird habitat, and the timing of these activities is managed to ensure nesting activities are not negatively affected. In addition, manipulation of water levels using irrigation control structures and irrigation ditches, irrigation, mowing, harrowing, and disking are used to improve grassland and wetland habitats.

3.4.8.1 WETLAND TYPES AND DISTRIBUTION

Wetland data for the watershed were obtained from the US Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI). The NWI was established by the USFWS in 1974 to conduct a nationwide inventory of wetlands and produce a series of topical maps to depict wetlands and deepwater habitats. NWI mapping is based on interpretation of aerial photography and is generally considered to provide a conservative estimate of wetland area. NWI mapping of larger, wetter wetlands is typically accurate; however due to limitations associated with photointerpretation, wetlands with a drier hydrologic regime and other wetlands that are difficult to interpret from aerial imagery (e.g., farmed wetlands, grazed wetlands, and forested wetlands) may be omitted (Tiner 1997).

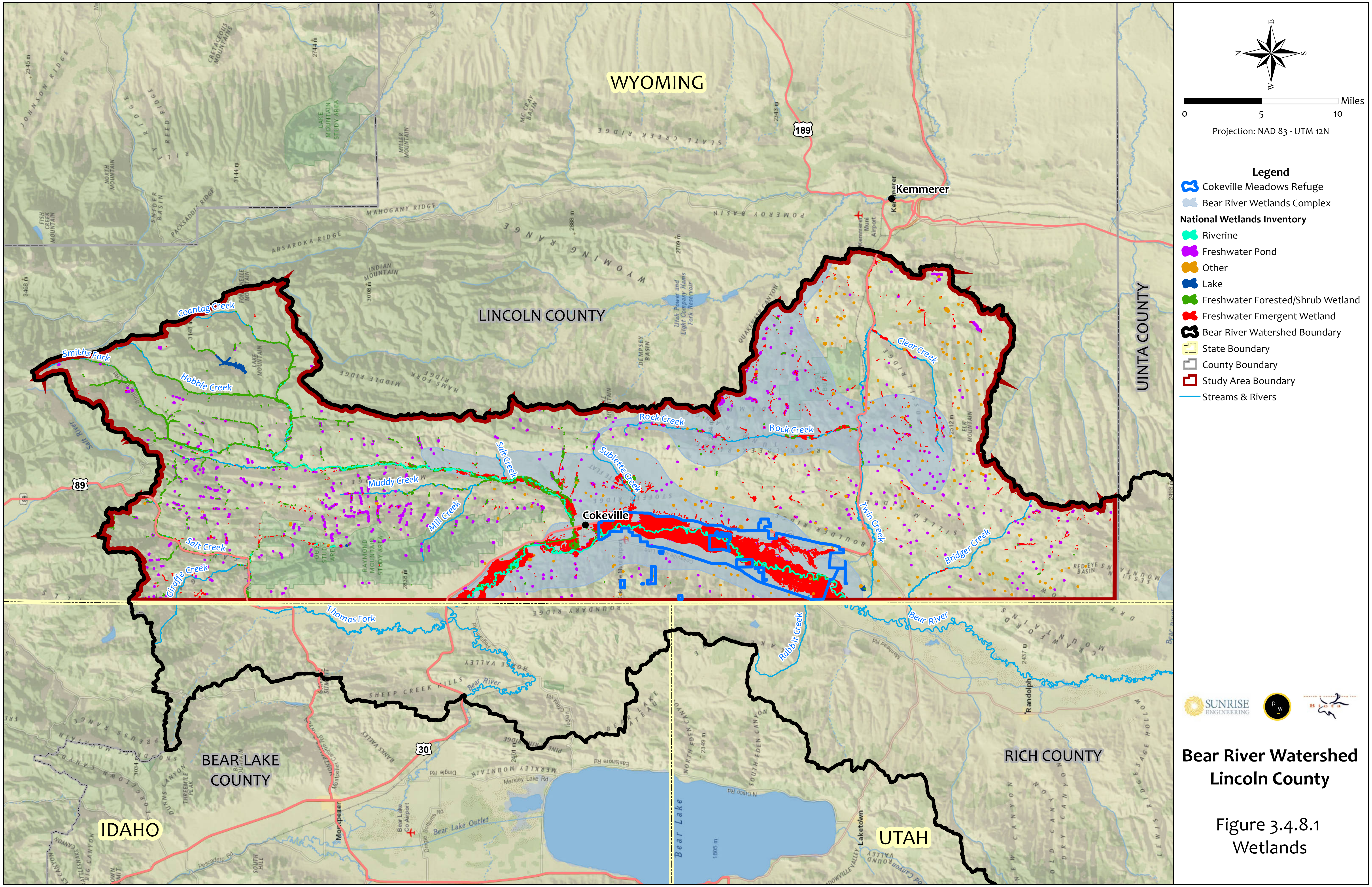
The NWI mapping provides the most comprehensive spatial dataset for wetland distribution in the study area. In the absence of a site-specific ground-truthing effort, it is not feasible to determine the accuracy of NWI mapping within the study area. Therefore, the NWI data should be considered a conservative estimate of wetlands. According to the NWI, 7.7% (144,743 acres) of the study area is comprised of wetlands and deepwater habitats (Table 3.4.8.1; Fig. 3.4.8.1). The NWI depicts 53 unique wetland classifications (per Cowardin et al 1979) for mapped wetlands within the study area, all of which are broadly defined as freshwater emergent wetlands or freshwater forested/shrub wetlands.



SUNRISE ENGINEERING

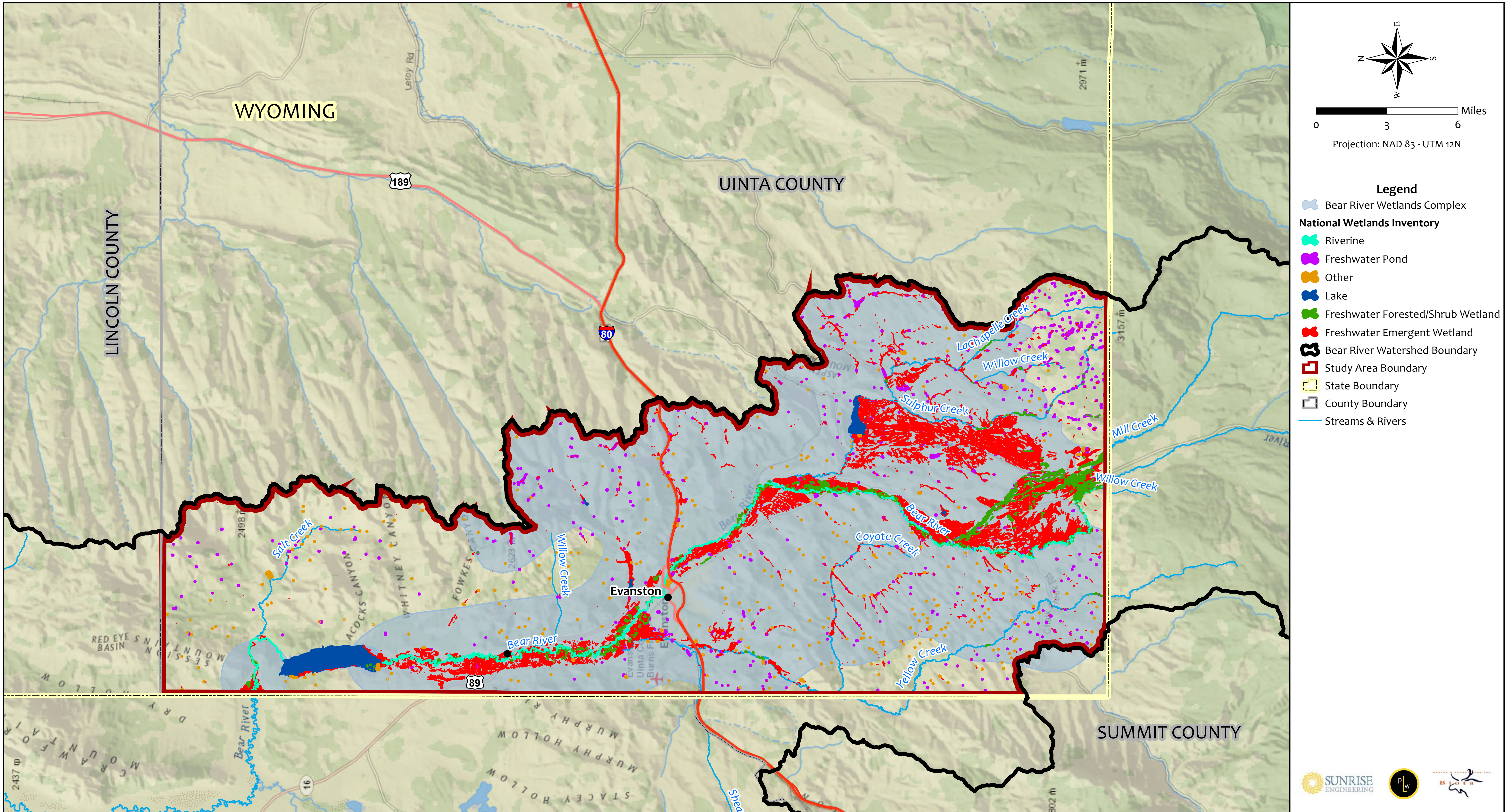
Bear River Watershed

Figure 3.4.8.1
Wetlands



Bear River Watershed
Lincoln County

Figure 3.4.8.1
Wetlands



SUNRISE ENGINEERING

Bear River Watershed
Uinta County

Figure 3.4.8.1
Wetlands

Table 3.4.8.1. A tabulation of NWI wetland and deepwater habitats in the Bear River watershed.

Habitat Type	Examples	Area	
		Acres	Percent of Watershed
Wetlands			
Freshwater Emergent Wetland	wet meadow, fen, marsh, swale	38,941	4.1%
Freshwater Forested/Shrub Wetland	scrub-shrub meadow, forested floodplain wetland	5,837	0.7%
Subtotal		**125,807**	**44,779**
Deepwater			
Freshwater Pond	excavated/impounded pond	1,048	0.1%
Lake	lake or reservoir	2,924	0.3%
Riverine	river or stream	1,696	0.2%
Other		297	0.0%
Subtotal		**18,936**	**5,965**
Total Wetlands and Deepwater Habitat		**144,743**	**7.7%**

3.4.8.2 WETLAND CONDITION ASSESSMENT

Wetlands are dynamic systems that provide many important ecological services and functions; the rate at which these services are provided is strongly dependant on landscape setting and associated level of direct or indirect anthropogenic disturbance. A number of protocols have been developed to assess wetland condition in the Rocky Mountain region (e.g., Montana Wetland Assessment Method, Functional Assessment of Colorado Wetlands Methodology, Hydrogeomorphic Approach to Assessing Wetland Functions of Riverine Floodplains in the Northern Rocky Mountains, etc.). Most of these protocols were developed for regulatory purposes, but they are also used to help design mitigation projects, assist with wetland management, and facilitate long-term monitoring projects.

A detailed assessment of wetland condition in the Bear River watershed has yet to be conducted and is beyond the scope of this watershed study. A Level 2 wetland condition assessment has been conducted in the Upper Green River wetland complex, and similar efforts are in-progress for several other priority wetland complexes. However, it will likely be several years before a Level 2 wetland condition assessment is conducted in the Bear River complex (S. Tessman pers. comm. 2016). For this reason, information regarding the condition of wetlands in the project area is summarized from several existing reports that primarily relied on geospatial assessment and expert opinion to develop wetland condition ratings.

In 2009, The Nature Conservancy assembled a team of experts to perform a system-wide ecological assessment and develop a Conservation Action Plan (CAP) for the entire Bear River watershed. Ecological indicators were assigned a rating based on expert opinion for wetlands in each section of the Bear River basin (i.e., lower, middle, and upper). The Bear River CAP was designed as a working plan to be continually refined as knowledge of the river system expands and conservation strategies are implemented (TNC 2010). The Wyoming portion of the watershed falls within the "Upper Bear" assessment area, and wetlands in this area were rated as follows

- "fair" for hydrology (flows comprised of <70 to 79% natural runoff, precipitation or groundwater; may include non-point source inputs; moderate effects of altered hydrology);
- "fair" for plant community (50 to 74% of species expected to naturally occur for each wetland type;
- "moderate" for introduced species and/or invasive native or non-native species);
- "moderate" for vegetation structure (plant community comprised of two structural layers)
- "moderate" for wetland function-land use intensity (moderately high intensity of surrounding land uses such as residential or exurban, fenced pasture park, field crops or hay, moderate grazing);
- "good" for wetland function-buffer quality (intermediate level of non-native vegetation, mostly undisturbed soils, little or no vegetation manipulation)
- "good" for wetland function-buffer size (50 to 74% of wetland has a buffer with an average buffer width of 100 to 324 feet).

A statewide landscape-scale geospatial assessment of Wyoming wetlands was conducted in 2010 (Copeland et. al. 2010). Using GIS analysis, wetland complexes were identified, mapped, and then assessed based on their biological diversity, susceptibility to climate change, protection status, and proximity to sources of impairment. Wetlands in the Bear River basin were rated as high for biological diversity; medium for rarity, vulnerability, climate variability, and oil and gas potential; and low for exurban development potential.

Figure 3.4.8.2b. Photograph of a wet meadow and surrounding nesting habitat in the Cokeville Meadows National Wildlife Refuge.

Figure 3.4.8.2c. Photograph of a shallow marsh supported by irrigation water in the Cokeville Meadows National Wildlife Refuge

3.4.8.3 WETLAND MITIGATION

In 1972, Congress enacted comprehensive national clean water legislation in response to growing public concern for water pollution. Today, the Clean Water Act is the primary federal law that protects waters, including lakes, rivers, coastal areas and wetlands in the United States. Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. The U.S. Army Corps of Engineers and U.S. Environmental Protection Agency are jointly charged with overseeing the permitting and enforcement of the Section 404 program. The Corps is responsible for the day-to-day administration and permit review, and the EPA provides program oversight.

The rationale of the program is that no discharge of dredged or fill material into waters of the U.S. should be permitted if there is a practicable alternative that would be less damaging to aquatic resources or if significant degradation would occur to the nation's waters. Permit review and issuance follows a sequence process that encourages avoidance of impacts, followed by minimizing impacts and, finally, requiring mitigation for unavoidable impacts to the aquatic environment. Figure 3.4.8.3 outlines potential wetland areas that may require mitigation for certain dredge or fill activities in order to comply with the Clean Water Act.

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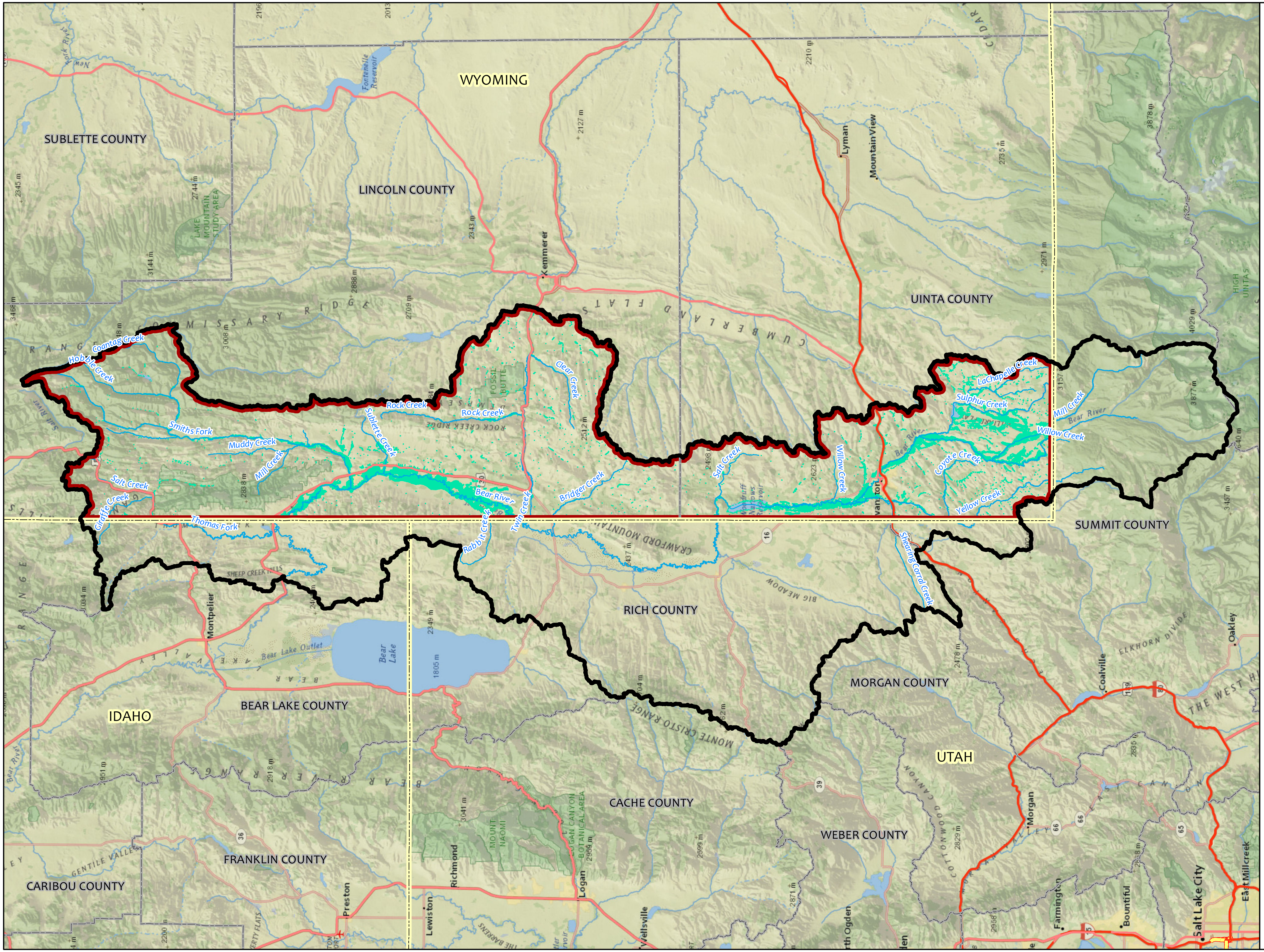
3.4.9 INVASIVE SPECIES

Noxious and invasive weeds inhabit approximately 1.3 million acres in the State of Wyoming (Wyoming Weed Management Strategic Plan 2003). Many of these weeds are aggressive invaders and pose a substantial threat to Wyoming's wildland, cropland, and rangeland. The Wyoming Weed Management Strategic Plan was developed in response to this threat. The strategic plan lays out three strategies to maintain healthy ecosystems in the state. These strategies include:

- cooperation among agencies, organizations, and individuals;
- development and integration of integrated weed management programs; and
- program assessment.

The current noxious weed list for the State of Wyoming includes 26 species. Lincoln County has an additional 5 species on their declared county weed list, and there are an additional 4 species on the Uinta County list (Table 3.4.9.1). Both counties have active weed and pest control districts that focus on education and outreach, as well as active identification, mapping, and treatment of invasive and noxious weeds in the region. Further information regarding invasive species management and programs offered by the weed and pest districts is presented in Section 4.5.4 of this report.



Legend

🟩 Potential Wetland Mitigation Sites
Bear River Watershed Boundary
🟥 Study Area Boundary
State Boundary
County Boundary
Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed

Figure 3.4.8.3
Potential Wetland Mitigation Sites

Table 3.4.9.1. State of Wyoming, Uinta County and Lincoln County noxious weed lists.

Common Name	Scientific Name
State of Wyoming Designated/Prohibited Noxious Weed List	
Field bindweed	*Convolvulus arvensis*
Canada thistle	*Cirsium arvense*
Leafy spurge	*Euphorbia esula*
Perennial sowthistle	*Sonchus arvensis*
Quackgrass	*Agropyron repens*
Hoary cress	*Cardaria pubescens*
Perennial pepperweed	*Lepidium latifolium*
Ox-eye daisy	*Chrysanthemum leucanthemum*
Skeletonleaf bursage	*Franseria discolor*
Russian knapweed	*Centaurea repens*
Yellow toadflax	*Linaria vulgaris*
Dalmatian toadflax	*Linaria dalmatica*
Scotch thistle	*Onopordum acanthium*
Musk thistle	*Carduus nutans*
Common burdock	*Arctium minus*
Plumeless thistle	*Carduus acanthoides*
Dyers woad	*Isatis tinctoria*
Houndstongue	*Cynoglossum officinale*
Spotted knapweed	*Centaurea maculosa*
Diffuse knapweed	*Centaurea diffusa*
Purple loosestrife	*Lythrum salicaria*
Saltcedar	*Tamarix sp.*
Common St. Johnswort	*Hypericum perforatum*
Common tansy	*Tanacetum vulgare*
Russian olive	*Elaeagnus angustifolia*
Black henbane	*Hyoscyamus niger*

Table 3.4.9.1 (Cont.)

Lincoln County Declared Noxious Weed List	
Golden pea	*Thermopsis rhombifolia*
Yellow star thistle	*Centaurea solstitialis*
Viper's bugloss	*Echium vulgare*
Sulphur cinquefoil	*Potentilla recta*
Uinta County Declared Noxious Weed List	
Common mullein	*Verbascum thapsus*
Wild oat	*Avena fatua*
Western Water Hemlock	*Cicuta douglasii*
Poison Hemlock	*Conium maculatum*
Bull thistle	*Cirsium vulgare*

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3.4.10 WILDLIFE

The Upper Bear River Watershed study area in Wyoming comprises the headwaters of the largest inland river that does not drain to an ocean and, as such, represents a closed basin. The headwaters originate in the alpine tundra zone of the Uinta Mountains of Utah, generally higher than 10,000 feet and above tree-line, and drains the western portion of Uinta County, from the lower north-facing slopes of the Uinta Mountains. The extreme southern extent of the watershed in Wyoming is comprised of the foothills of the Uinta Mountains, an east-to-west trending range mostly in northeastern Utah. The Bear River descends through lowland topography of mesas and buttes characteristic of the Wyoming Basin. Relatively steep ridges with narrow valleys on a north-south orientation are found in association with the Overthrust Belt that extends south of Evanston at the Utah stateline to the northern extent of the watershed in Wyoming. The lower portion of the watershed in Wyoming is bounded by the Salt River Range, which extends to the south in a series of ridges, the most prominent of which are the Tunp Range, Commissary Ridge, and Sillem Ridge. Portions of these ridges, in part, comprise the Bear River Divide. The diversity of wildlife throughout the Bear River watershed reflects this landscape of highly variable climate, terrain, and vegetation communities.

The watershed study, is based on a comprehensive review of research, gray literature, and agency management documents, all of which are consolidated in the associated digital library. The synthesis of natural resource information draws from the following specific sources, the University of Wyoming Natural Diversity Database (WYNDD); Wyoming Game and Fish Department (WGFD) Habitat Priority Areas and Conservation Initiatives; Wyoming Water Development Office (WWDO) Bear River Basin planning documents; Bureau of Land Management (BLM) Kemmerer Field Office Resource Management Plan; US Forest Service (USFS) Bridger-Teton National Forest (BTNF) planning documents; US Fish and Wildlife Service (US Fish and Wildlife Service) Wyoming Ecological Services Field Office, Cokeville Meadows National Wildlife Refuge (CMNWR) and Fossil Butte National Monument (FBNM) management documents; Lincoln County and Uinta County Conservation District long range planning documents; and watershed conservation initiatives spearheaded through interagency partnerships and non-profit organizations such as The Nature Conservancy (TNC).

The WYNDD was queried in order to generate a list of Species of Concern documented from within the study area. Species of concern are categorized by global and state status of species in Wyoming that are rare, endemic, disjunct, threatened, or otherwise biologically sensitive. In addition, species from the BLM or USFS Sensitive Species list are identified (Table 3.4.10.1). The most current iterations of the WGFD mapped seasonal, crucial, parturition, migration corridor and migration barrier mapping developed for big game species regularly occurring within the study area, and are presented in species'-specific figures. Greater Sage-grouse active lek sites, Governor's Executive Order Core Area Mapping, and applicable stipulation buffers as defined by WGFD are presented in an overview Figure 3.4.15, and described in greater detail in Appendix H as are the WGFD Crucial Priority Areas or Enhancement Priority Areas as definied by the WGFD Stragic Habitat Plan (2009).

Table 3.4.10.1. Sensitive wildlife species mapped by Wyoming Natural Diversity Database in the Upper Bear River watershed.

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Amphibians					
Anaxyrus boreas	Eastern Clade Boreal Toad	G4T2T3	S1	Y	Y
Lithobates pipiens	Northern Leopard Frog	G5	S3	Y	Y
Spea bombifrons	Plains Spadefoot	G5	S4		
Ambystoma mavortium	Tiger Salamander	G5	S4		
Birds					
Recurvirostra americana	American Avocet	G5	S3B		
Botaurus lentiginosus	American Bittern	G4	S3B		Y
Cinclus mexicanus	American Dipper	G5	S4		

Table 3.4.10.1 (Cont.)

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Picoides dorsalis	American Three-toed Woodpecker	G5	S3		Y
Pelecanus erythrorhynchos	American White Pelican	G4	S1B		
Myiarchus cinerascens	Ash-throated Flycatcher	G5	S3B,S5N		
Haliaeetus leucocephalus	Bald Eagle	G5	S3B,S5N	Y	Y
Tyto alba	Barn Owl	G5	S2		
Leucosticte atrata	Black Rosy-Finch	G4	S1B,S2N		
Chlidonias niger	Black Tern	G4	S1		Y
Picoides arcticus	Black-backed Woodpecker	G5	S1		Y
Nycticorax nycticorax	Black-crowned Night-Heron	G5	S3B		
Himantopus mexicanus	Black-necked Stilt	G5	S3B		
Setophaga nigrescens	Black-throated Gray Warbler	G5	S2		
Passerina caerulea	Blue Grosbeak	G5	S3B		
Dolichonyx oryzivorus	Bobolink	G5	S2		
Aegolius funereus	Boreal Owl	G5	S2		Y
Spizella breweri	Brewer's Sparrow	G5	S5	Y	Y
Bucephala albeola	Bufflehead	G5	S2B		
Athene cunicularia	Burrowing Owl	G4	S4B	Y	Y
Psaltriparus minimus	Bushtit	G5	S1		
Larus californicus	California Gull	G5	S2B		
Selasphorus calliope	Calliope Hummingbird	G5	S3		
Hydroprogne caspia	Caspian Tern	G5	S1		
Aimophila cassinii	Cassin's Sparrow	G5	SNA		Y
Aechmophorus clarkii	Clark's Grebe	G5	S1B		

Table 3.4.10.1 (Cont.)

Scientific Name	Common Name	Global Rank	State Rank	BLM Sensitive Species	USFS Sensitive Species
Tympanuchus phasianellus columbianus	Columbian Sharp-tailed Grouse	G4T3	S1	Y	Y
Bucephala clangula	Common Goldeneye	G5	S3B		
Gavia immer	Common Loon	G5	S1B,S2N		Y
Junco hyemalis	Dark-eyed Junco	G5	S5B,S5N		
Buteo regalis	Ferruginous Hawk	G4	S4B,S5N	Y	Y
Psiloscops flammeolus	Flammulated Owl	G4	S1?		Y
Sterna forsteri	Forster's Tern	G5	S1		
Aquila chrysaetos	Golden Eagle	G5	S4B,S4N		
Regulus satrapa	Golden-crowned Kinglet	G5	S3B,S4N		
Ammodramus savannarum	Grasshopper Sparrow	G5	S4		Y
Centrocercus urophasianus	Greater Sage-Grouse	G3G4	S4	Y	Y
Empidonax hammondii	Hammond's Flycatcher	G5	S4		
Larus argentatus	Herring Gull	G5	SNA		
Lanius ludovicianus	Loggerhead Shrike	G4	S3	Y	Y
Numenius americanus	Long-billed Curlew	G5	S3B	Y	Y
Falco columbarius	Merlin	G5	S3B,S4N		
Charadrius montanus	Mountain Plover	G3	S2B,S3N	Y	Y
Accipiter gentilis	Northern Goshawk	G5	S2B,S3N	Y	Y
Contopus cooperi	Olive-sided Flycatcher	G4	S4B		Y
Pandion haliaetus	Osprey	G5	S3B		
Falco peregrinus anatum	Peregrine Falcon	G4	S2	Y	Y
Sitta pygmaea	Pygmy Nuthatch	G5	S2		
Phalaropus lobatus	Red-necked Phalarope	G4G5	S3N		

Table 3.4.10.1 (Cont.)

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Larus delawarensis	Ring-billed Gull	G5	S2		
Aythya collaris	Ring-necked Duck	G5	S4B		
Oreoscoptes montanus	Sage Thrasher	G5	S5	Y	
Artemisiospiza nevadensis	Sagebrush Sparrow	G5	S3	Y	Y
Grus Canadensis	Sandhill Crane	G5	S3B,S5N		
Asio flammeus	Short-eared Owl	G5	S2		Y
Egretta thula	Snowy Egret	G5	S3B		
Anthus spragueii	Sprague’s Pipit	G4	SNA		
Setophaga townsendi	Townsend's Warbler	G5	SNA		
Cygnus buccinators	Trumpeter Swan	G4	S3B,S3N	Y	Y
Cygnus columbianus	Tundra Swan	G5	S2N		
Rallus limicola	Virginia Rail	G5	S3B		
Oreothlypis virginiae	Virginia's Warbler	G5	S1		
Plegadis chihi	White-faced Ibis	G5	S1B	Y	
Lagopus leucura	White-tailed Ptarmigan	G5	S1		Y
Loxia leucoptera	White-winged Crossbill	G5	S2		
Grus Americana	Whooping Crane	G1	S1N		
Sphyrapicus thyroideus	Williamson's Sapsucker	G5	S2		
Troglodytes hiemalis	Winter Wren	G5	SNA		
Crustacean					
Lepidurus couesii	Couse tadpole shrimp	G4	S3		
Pacifastacus gambelii	Pilose Crayfish	G4G5			

Table 3.4.10.1 (Cont.)

Scientific Name	Common Name	Global Rank	State Rank	BLM Sensitive Species	USFS Sensitive Species
Fish					
Catostomus discobolus	Bluehead Sucker	G4	S3	Y	Y
Oncorhynchus clarkii utah	Bonneville Cutthroat Trout	G4T4	S1	Y	Y
Catostomus latipinnis	Flannelmouth Sucker	G3G4	S3	Y	Y
Lepidomeda copei	Northern Leatherside Chub	G3	S1	Y	Y
Mammal					
Mustela nigripes	Black-footed Ferret	G1	S1		
Lynx Canadensis	Canadian Lynx	G5	S1		
Sorex nanus	Dwarf Shrew	G4	S4		
Tamias umbrinus fremonti	Fremont’s Uinta Chipmunk	G5TNR	SNR		
Canis lupus	Gray Wolf	G4G5	S1		
Ursus arctos arctos	Grizzly Bear	G4T4	S1		
Thomomys idahoensis	Idaho Pocket Gopher	G4	S2	Y	
Mustela nivalis	Least Weasel	G5	S1		
Myotis lucifugus	Little Brown Myotis	G3	S5		
Myotis evotis	Long-eared Myotis	G5	S4	Y	
Myotis volans	Long-legged Myotis	G5	S3B		
Gulo gulo luscus	North American Wolverine	G4T4	S2		
Lontra Canadensis	Northern River Otter	G5	S3		Y
Martes caurina	Pacific Marten	G4G5	S3		Y
Bos bison bison	Plains Bison	G4TU	S1		
Urocyon cinereoargenteus ocythous	Prairie Gray Fox	G5	S2		
Brachylagus idahoensis	Pygmy Rabbit	G4	S1	Y	Y

Table 3.4.10.1 (Cont.)

Scientific Name	**Common Name**	**Global Rank**	**State Rank**	**BLM Sensitive Species**	**USFS Sensitive Species**
Bassariscus astutus	Ringtail	G5	S1		
Lasionycteris noctivagans	Silver-haired Bat	G5	S3B		
Ictidomys tridecemlineatus	Thirteen-lined Ground Squirrel	G5	S5		
Urocitellus armatus	Uinta Ground Squirrel	G5	S3S4		
Tamias umbrinus umbrinus	Utah Uinta Chipmunk	G5TNR	SNR		
Microtus richardsoni	Water Vole	G5	S2		Y
Myotis ciliolabrum	Western Small-footed Myotis	G5	S3B		
Cynomys leucurus	White-tailed Prairie Dog	G4	S3	Y	Y
Urocitellus elegans	Wyoming Ground Squirrel	G5	S3S4		
Ochotona princeps princeps	Yellowstone Pika	G5T5Q	S2		
Myotis yumanensis	Yuma Myotis	G5	S1		
Mollusc					
Anodonta californiensis	California Floater	G3Q	S2		
Lymnaea stagnalis	Swamp Lymnaea	G5	S3		
Margaritifera falcata	Western Pearlshell	G4G5	S3		
Reptile					
Charina bottae	Northern Rubber Boa	G5	S2		
Thamnophis sirtalis fitchi	Valley Gartersnake	G5TNR	S2		

G = Global rank assigned by NatureServe: Range-wide probability of extinction (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)

S = State-wide probability of extinction (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)

T = Trinomial rank: refers to the range-wide probability of extinction for a subspecies or variety (1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure)

B = Breeding rank: indicates the status of a migratory species during the breeding season; applied only to animals
N = Non-breeding rank: indicates the status of a migratory species during the non-breeding season; applied only to animals

H = possibly extinct or extirpated
A = Accidental or vagrant: taxon appears irregularly and infrequently

Q = Taxon has Taxonomic questions

NR = Not ranked
TU = Subspecies or variety rank unrankable

3.4.10.1 BIG GAME

Crucial ranges have been defined within the study area by the WGFD, as well as other seasonal ranges, parturition areas, major migration routes and known migration barriers (Figs. 3.4.10-3.4.15). Irrigated crops and grazing dominate the primarily private agricultural lands of the lower elevations the Unita County foothills, while pinion-juniper woodlands and pine forests are found on higher slopes. Rabbitbrush, saltbush, and greasewood are typically the primary vegetative cover under certain conditions, although big sagebrush is the common, dominant vegetation type across a large percentage of the landscape. The uplands east of the Bear River valley in Lincoln County constitute the divide between the watershed feeding into the Great Salt Lake and the Green River and Colorado River watersheds. Sagebrush ecosystems within the study area support crucial habitats for big game.

Pronghorn Antelope - Interstate 80 divides the Uinta County pronghorn herds within the watershed study area, the Carter Lease to the north and the Uinta-Cedar Mountain to the south (Fig. 3.4.11). Seasonal, spring, summer, and fall ranges overlap upper elevation xeric, shrublands, while winter yearlong range occurs at lower elevations. Although no crucial winter range was identified by WGFD, a small area of crucial winter yearlong habitat has been mapped at lower elevations in proximity to the Bear River, and the Cokeville-Meadows NWR in Lincoln County. It is widely accepted that free movement across habitat types and seasonal ranges is essential for pronghorn to meet their year-round energetic and nutritional requirements.

Mule Deer - The Kemmerer/Evanston winter range complex provides crucial winter yearlong range to the southern-most extent of the Wyoming Range herd (Fig. 3.4.12), a herd of great importance for sportsman and wildlife enthusiasts, that has been in decline for several years. Crucial winter ranges are vital to the survival of animals during critical periods of winter and mule deer will find food and/or cover here during the most inclement and difficult winter weather conditions due to physiographic and vegetative characteristics. Habitat assessments are underway to address habitat improvements and protection of migration routes, in part, within the watershed area. WGFD has instituted special hunts on irrigated lands to offer relief to landowners from localized wildlife damage in the southern portion of the watershed study area.

Moose - Moose populations within the study area are comprised of the Lincoln and Uinta herds. Crucial winter range for moose is found in the major river corridors and tributary drainages where suitable riparian habitat is available (Fig. 3.4.13). According to state monitoring efforts, moose populations in the region stabilized in mid-2000's, and have been moderately increasing, despite localized declines in southwest Wyoming. The detection of several documented cases of carotid artery worm (*Eleaophora schneiderii*) indicates that Elaeophorosis may have had a significant population effect in recent years. Population models are not available for either herd extant within the study area, and hunt opportunities remain conservative in an effort to sustain recovery.

Elk - The upper Bear River watershed provides extensive seasonal, migratory and crucial ranges for the western portions of the Uinta and West Green River elk herd units (Fig. 3.4.14). These herd units represent "unfed" portions of the regional elk herd and, therefore, habitat integrity is of critical importance. For this reason there is significant acreage in Lincoln County managed as crucial winter range for elk. Without the benefit of access to winter feedgrounds that are common to the north, this herd is reliant on native winter ranges and has the propensity to move onto private, agricultural lands at the lower elevations. To the north, the herd size is above prescribed herd objective; however, observed to be within 20% of the population goal of 3,100 elk. Throughout the predominantly private, managed agricultural lands there is significant public dissatisfaction with wintering elk in this area, due to perceived reduction of livestock forage and comingling of elk with cattle where livestock feeding operations occur. The infectious disease caused by the *Brucella* bacteria, brucellosis continues to be a significant management concern for elk, and the elk winter range within the West Green River herd unit was recently added to the brucellosis surveillance area.

3.4.10.2 GREATER SAGE-GROUSE

The greater sage-grouse was a candidate for the federal list of threatened or endangered species under the Endangered Species Act (ESA) of 1973, as amended. In 2010, greater-sage grouse were found to warrant the protections afforded to a listed species under ESA, but the action was precluded by higher priority listing efforts. Since that time a combination of new information about the status of the species, implementation of conservation efforts and regulatory mechanisms, and evaluation of on-going potential threats resulted in a revision of the 2010 finding. A decision from the USFWS published on October 2, 2015 indicated that listing greater sage-grouse as threatened or endangered under the Act was not warranted.

Greater sage-grouse, in large part, avoided listing due to conservation efforts implemented by Federal, State, and private landowners. In 2008, the Governor of Wyoming implemented a Core Area Protection strategy for greater sage-grouse by executive order. This strategy was designed to implement protective stipulations for sage-grouse habitats, populations and connectivity areas to conserve sage-grouse and preclude the need for listing the bird as a threatened or endangered species. Figure 3.4.15 illustrates known active leks (38), associated protective stipulation areas, and the most recent Core Area mapping (WOG 2015), which constitutes 255,200 acres, or 27% of the Bear River watershed study area in Wyoming.

3.4.10.3 THREATENED, ENDANGERED, AND SENSITIVE SPECIES

SENSITIVE SPECIES

A list of documented rare species occurrences within the Bear River watershed was solicited from the WYNDD in 2015 (Table 3.4.10.1). The resulting list of all documented occurrences of rare or otherwise sensitive species includes wildlife species organized in seven common taxonomic groupings including amphibians (4), birds (68), crustaceans (2), fish (4), mammals (28), molluscs (3) and reptiles (2); Sensitive plant species that were included in the list are treated in a separate section of this report. The ranking system presented in Table 3.4.10.1 denotes the global rank (G) indicating range-wide probability of extinction and a state rank (S) reflecting degree of sensitivity assigned by WYNDD biologists for species in peril within the state. The ranks indicate a numeric score from 1 to 5, with 1 being “critically imperiled” and 5 being “demonstrably secure”. At least 50% of the sensitive wildlife species have life history requirements tied directly to some form of aquatic habitat, whether wetland, riparian or open water. A large proportion of the sensitive species of the Upper Bear River watershed are dependent upon grassland or shrub steppe habitats for at least a portion of their lifecycle, underscoring the relative significance of sagebrush steppe to a wide range of wildlife species that are believed to be of conservation concern. Given the expansive landscape and changes in elevation within the watershed, rare species are documented from alpine, subalpine, cliff face and rock, montane forests both coniferous and deciduous, as well as upland tall shrub communities.

THREATENED AND ENDANGERED SPECIES

A query of the USFWS Information, Planning and Conservation System (IPAC) on October 15, 2015 provided the most up-to-date information regarding federal Natural Resources of Concern including threatened and endangered species within the Bear River watershed. The list generated is derived from a digital file created in GIS of the precise watershed study area in Wyoming.

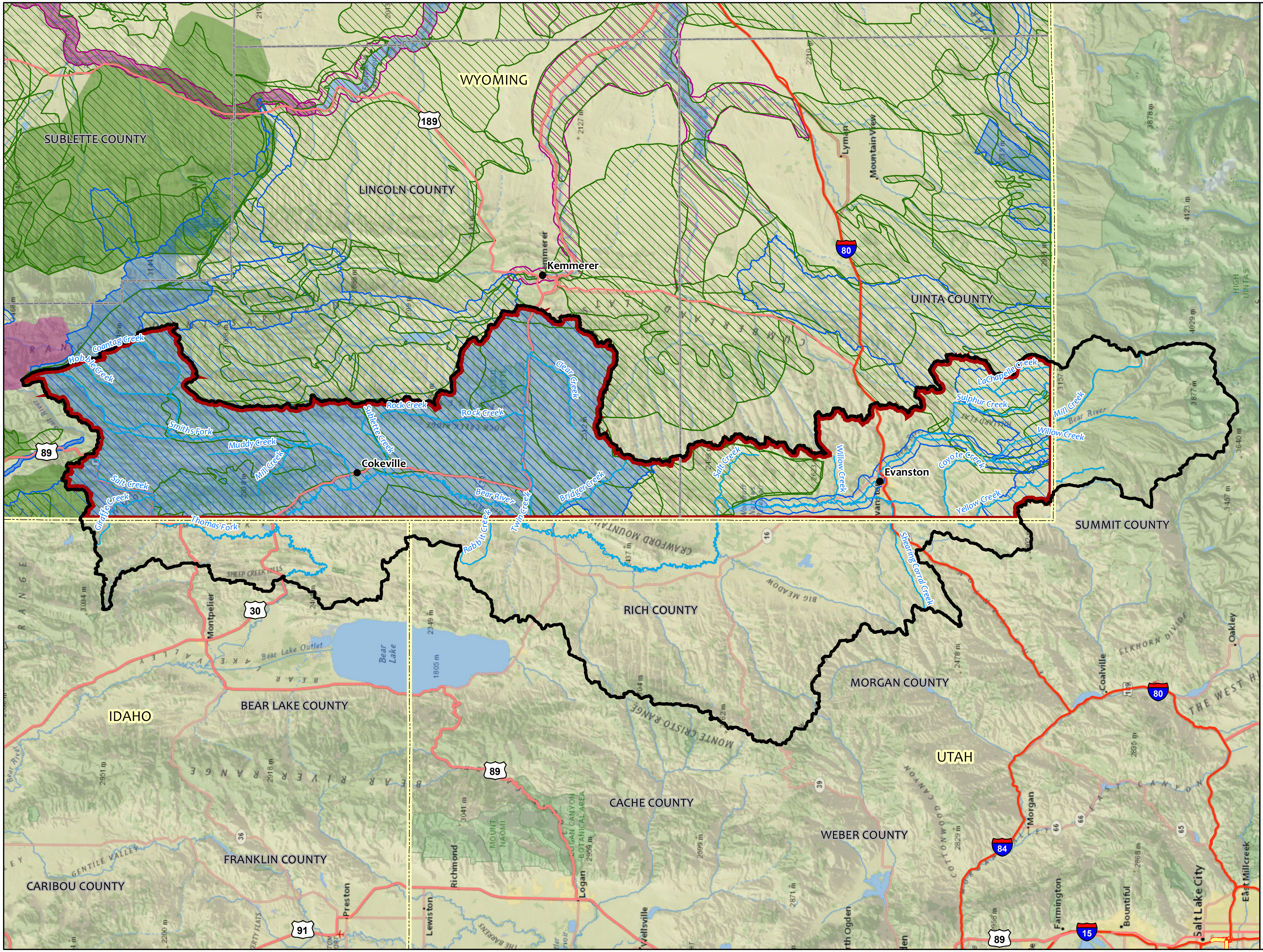
There are no animal species presently listed as endangered under the Act that either occur or have protected habitat within the watershed study area. Three threatened mammals listed under the ESA occur within the watershed study area, gray wolf, grizzly bear and Canada lynx.

Gray Wolves - Gray wolves (*Canis lupus*) were extirpated from the western United States by the 1930s. Between 1995 and 1996, 66 wolves from southwestern Canada were reintroduced into Yellowstone National Park (31) and central Idaho (35). Following the reintroduction, species objectives were met in 2002. Subsequently, wolves were delisted and managed under state authority in Montana and Idaho in 2011. Wolves were also delisted in Wyoming in 2012, but were relisted and returned to federal authority in 2014. In 2015, the Northern Rocky Mountain wolf population (in Montana, Idaho, and Wyoming only) totaled more than 1,704 wolves in more than 282 packs (USFWS et al., 2016). Minimum count estimates suggest that Wyoming had 382 wolves in 48 packs with 30 breeding pairs in 2015. No established wolf packs are present within the watershed study area, although individual wolves may irregularly move through the study area.

Grizzly Bears - Listed as threatened under the Endangered Species Act in the lower 48 states in 1975, a Distinct Population Segment (DPS) of grizzly bears in the Yellowstone area has since been delisted and the species as a whole has recently been relisted again. The federal action vacating the original delisting rule in March of 2010 effectively eliminated the designation of a Greater Yellowstone Area (GYA) grizzly bear DPS. The US Fish and Wildlife Service recently announced (March 3, 2016) that grizzly bears will again be delisted unless a legal challenge blocks this delisting.

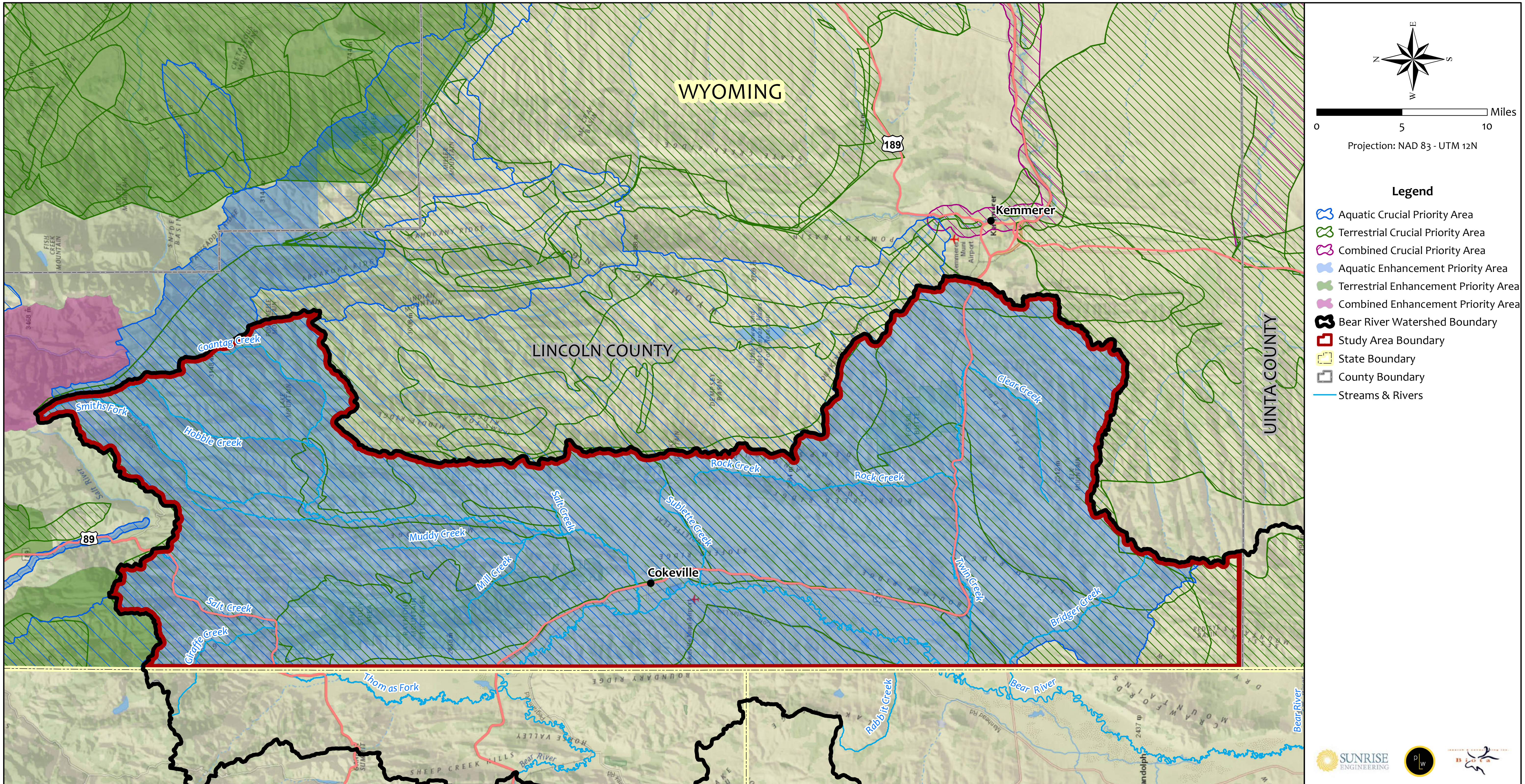
Currently there is no critical habitat designated for this species in any of the recovery ecosystems, including the Greater Yellowstone Area. The GYA grizzly bear population and its habitat are managed using an approach that identifies a Primary Conservation Area (PCA) and adjacent areas where occupancy by grizzly bears is anticipated and acceptable. The project area lies greater than 80 miles south of the PCA boundary, in an area that is not prioritized for grizzly bear monitoring or recovery. Section 7 consultations with the USFWS in consideration of potential effects to grizzly bear and grizzly bear habitat are required for proposed actions in the upper elevations of the watershed study area.

Canada Lynx - The Canada lynx was first proposed for listing as a threatened species under ESA in July of 1998 and was formally listed in April 2000. The USFWS determined the lynx population in the United States was at risk as a result of human alteration and fragmentation of montane and boreal forests. Their low numbers were a result of past exploitation, inter-specific competition for prey with bobcats and coyotes, and elevated levels of human access to their habitat. Lynx are solitary carnivores generally occurring at low densities in boreal forests. Distribution and abundance of this species is closely tied to that of the snowshoe hare, their primary prey. Densely regenerating coniferous forests and regenerating burned areas in mixed species forests provide excellent habitat for snowshoe hares and, therefore, are also important habitat for lynx. Lynx are less likely to occur at lower elevations where competition with coyotes, mountain lions, bobcats, and domestic animals depletes available prey. Critical habitat for the Canada lynx has been



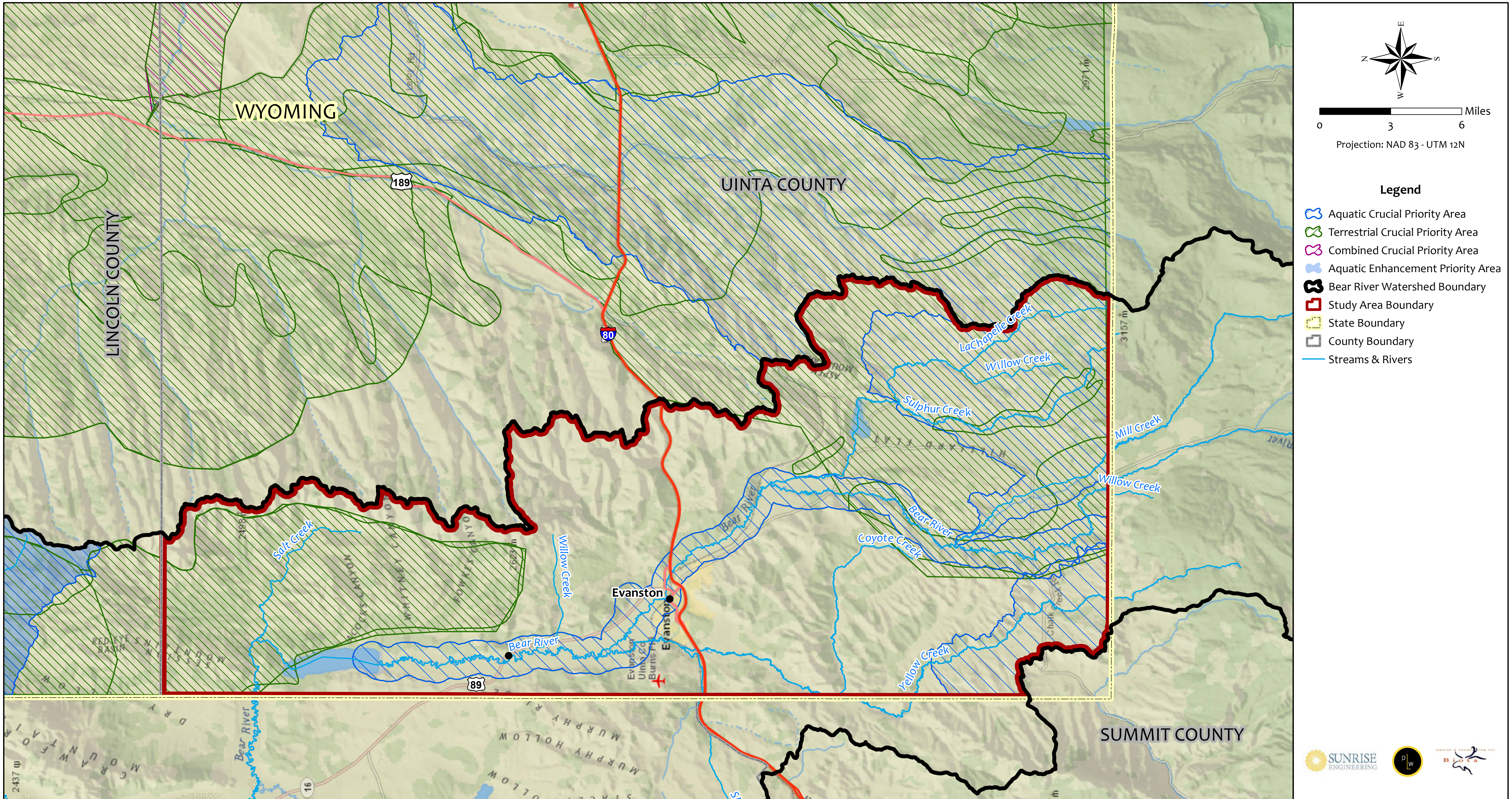
Bear River Watershed

Figure 3.4.10
WFGD Habitat
Priority Areas



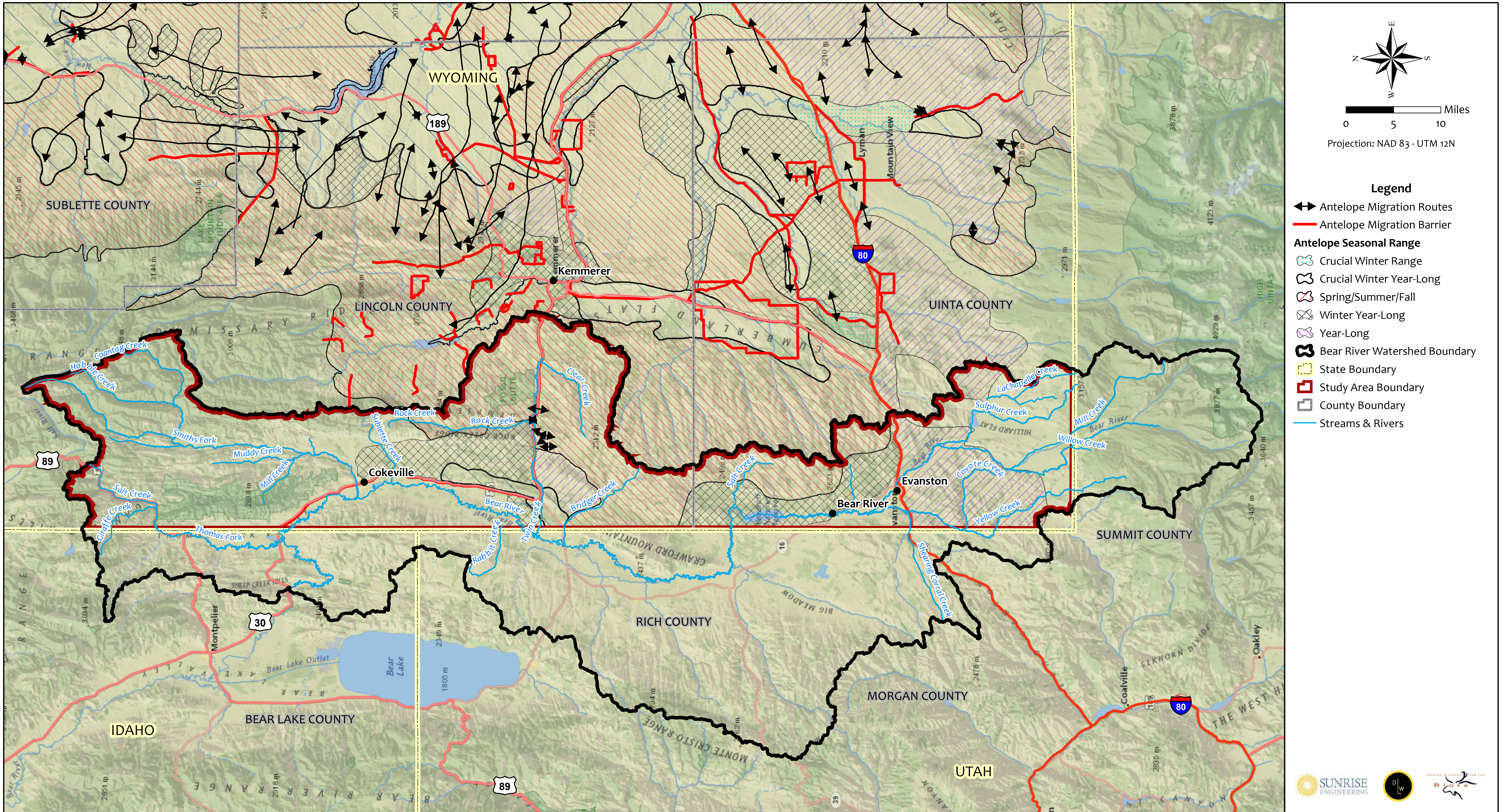
Bear River Watershed Lincoln County

Figure 3.4.10
WFGD Habitat
Priority Areas



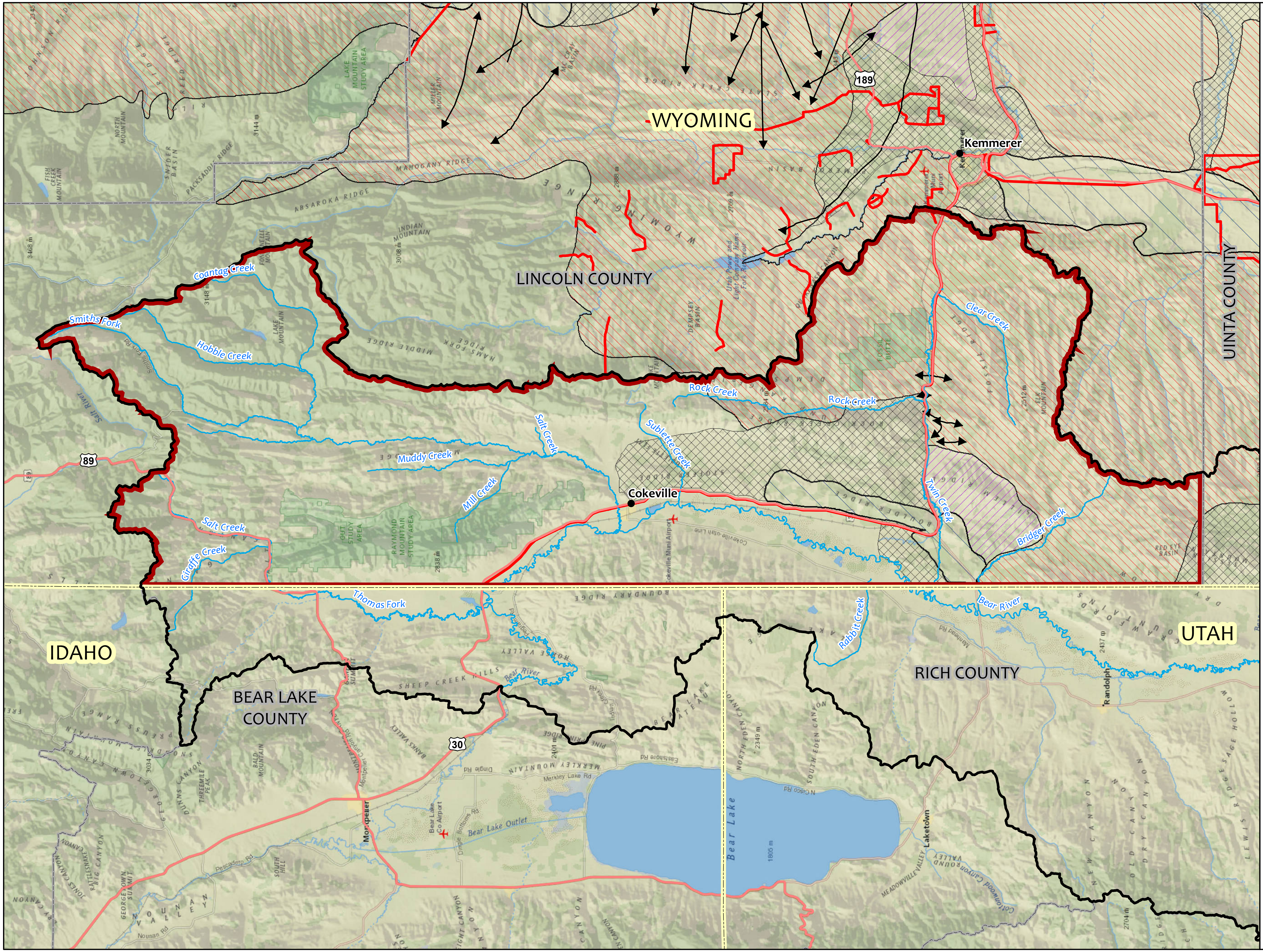
Bear River Watershed
Uinta County

Figure 3.4.10
WFGD Habitat
Priority Areas



Bear River Watershed

Figure 3.4.11
Pronghorn
Antelope Ranges



N
E
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0 5 10 Miles

Projection: NAD 83 - UTM 12N

Legend

↔ Antelope Migration Routes

🟥 Antelope Migration Barrier

Antelope Seasonal Range

▨ Crucial Winter Year-Long

▨ Spring/Summer/Fall

▨ Winter Year-Long

▨ Year-Long

☐ Bear River Watershed Boundary

☐ Study Area Boundary

☐ State Boundary

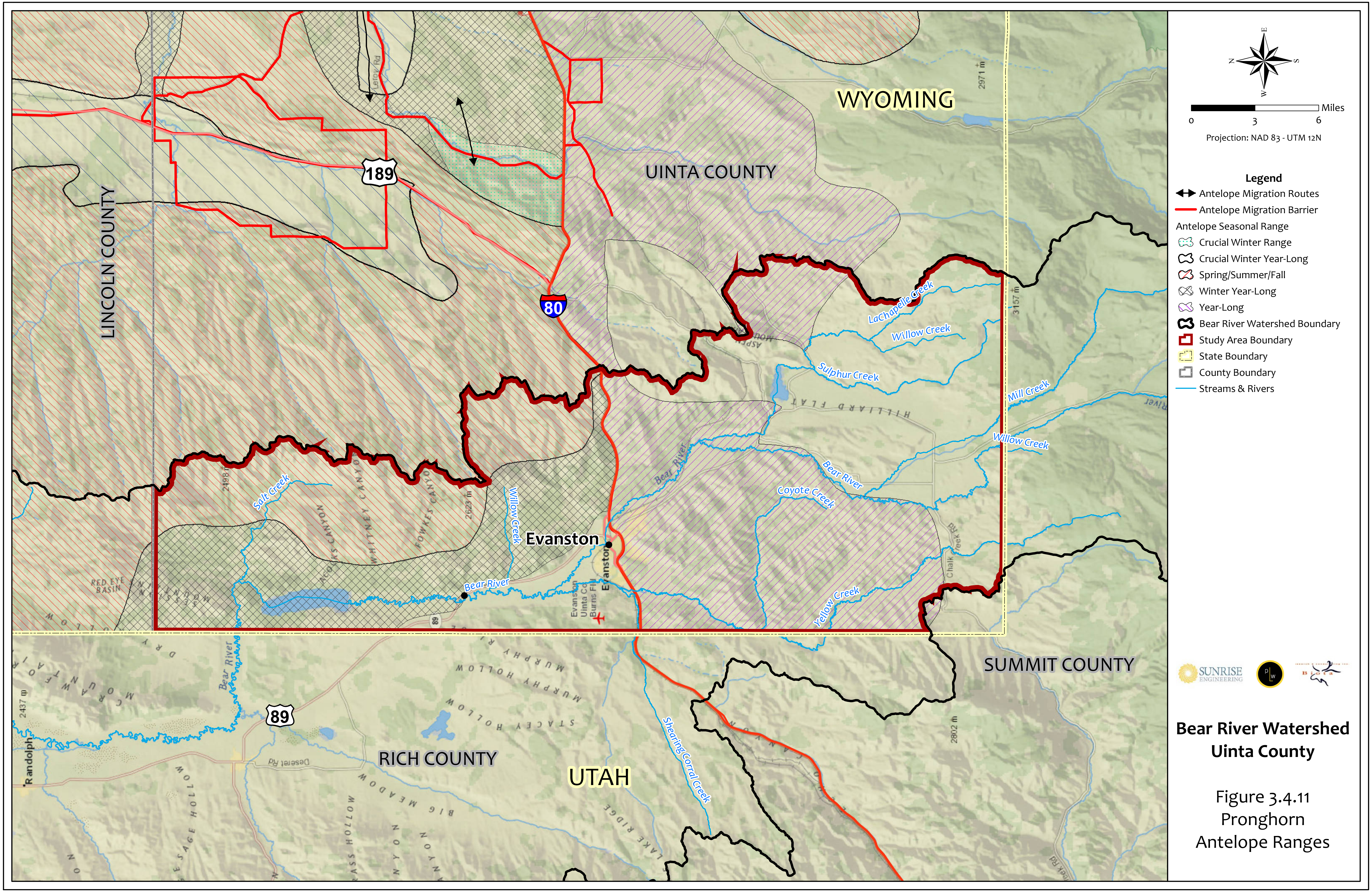
☐ County Boundary

— Streams & Rivers

SUNRISE ENGINEERING

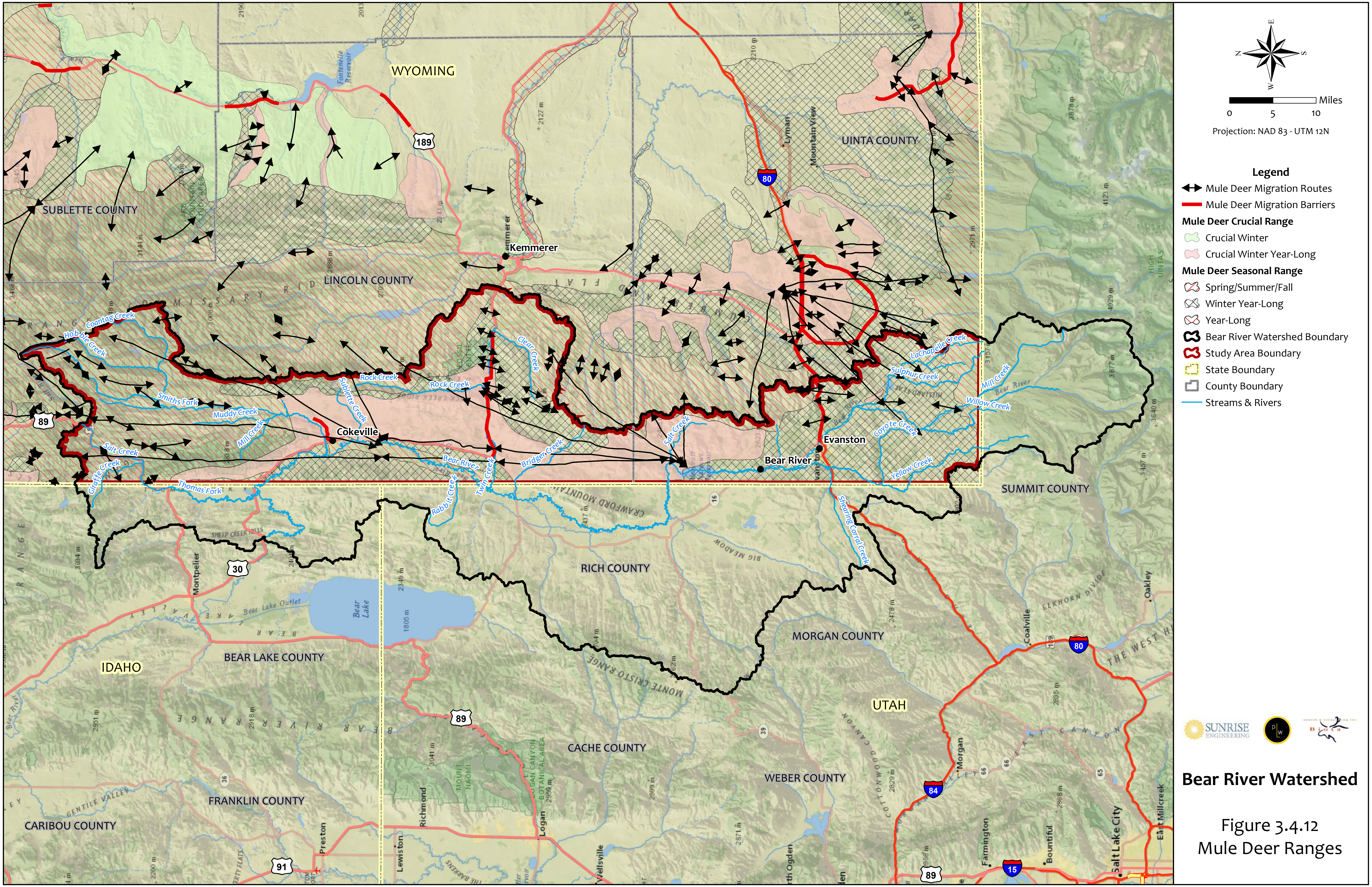
Bear River Watershed Lincoln County

Figure 3.4.11
Pronghorn
Antelope Ranges



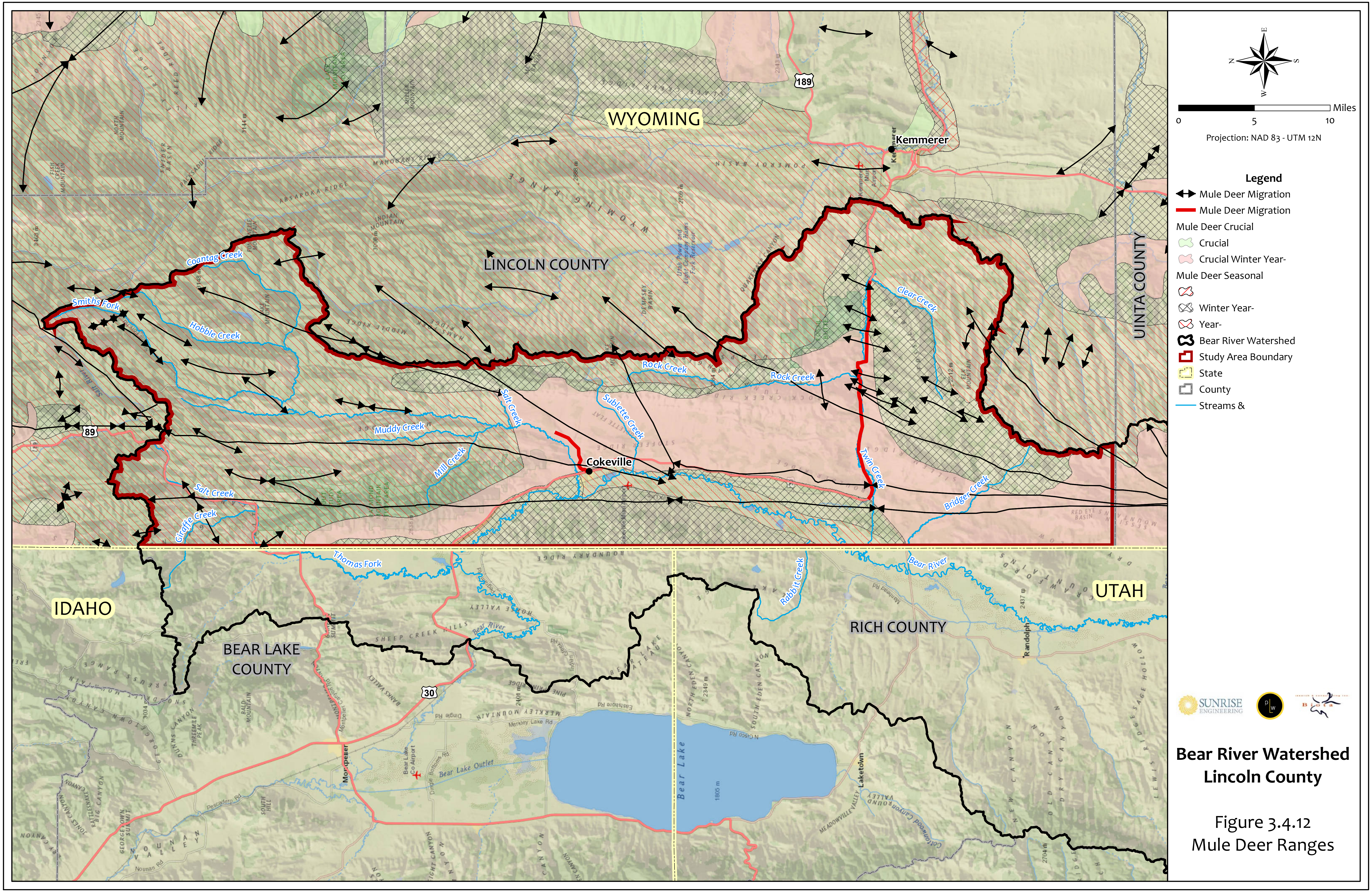
Bear River Watershed Uinta County

Figure 3.4.11
Pronghorn
Antelope Ranges



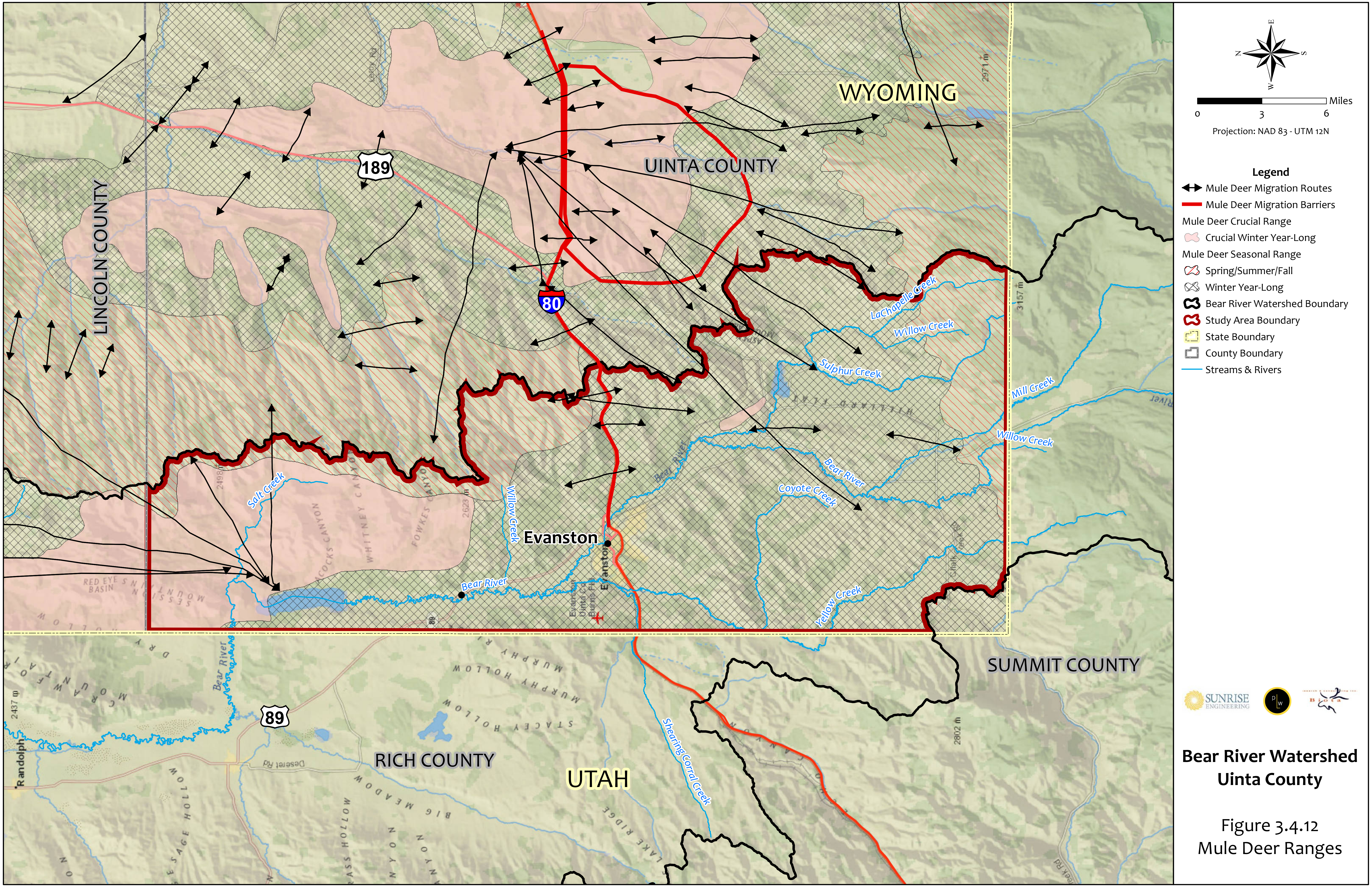
Bear River Watershed

Figure 3.4.12
Mule Deer Ranges



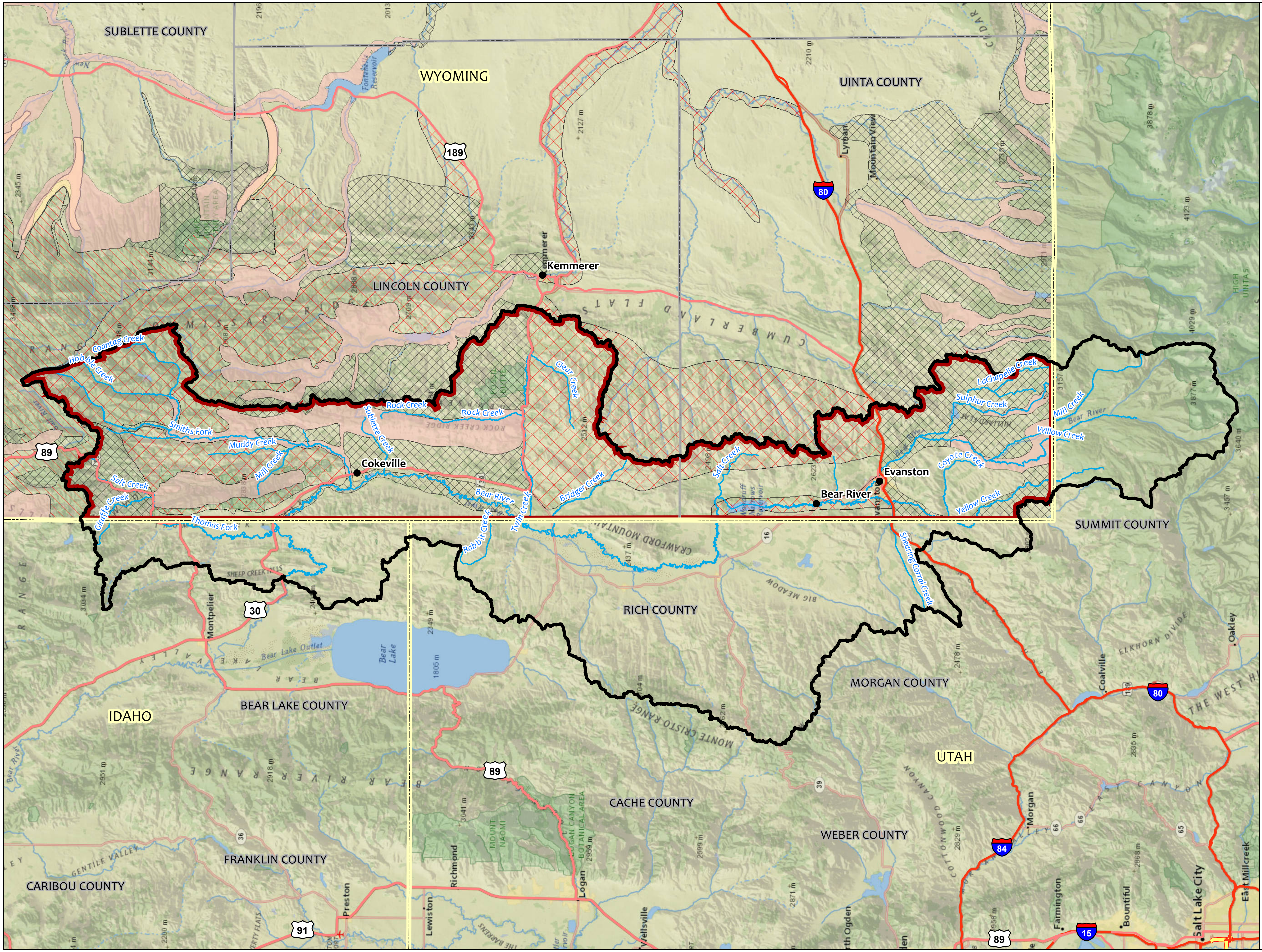
Bear River Watershed Lincoln County

Figure 3.4.12
Mule Deer Ranges



Bear River Watershed
Uinta County

Figure 3.4.12
Mule Deer Ranges



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Projection: NAD 83 - UTM 12N

Legend

Moose Crucial Range

- Crucial Winter Year-Long
- Moose Parturition Areas

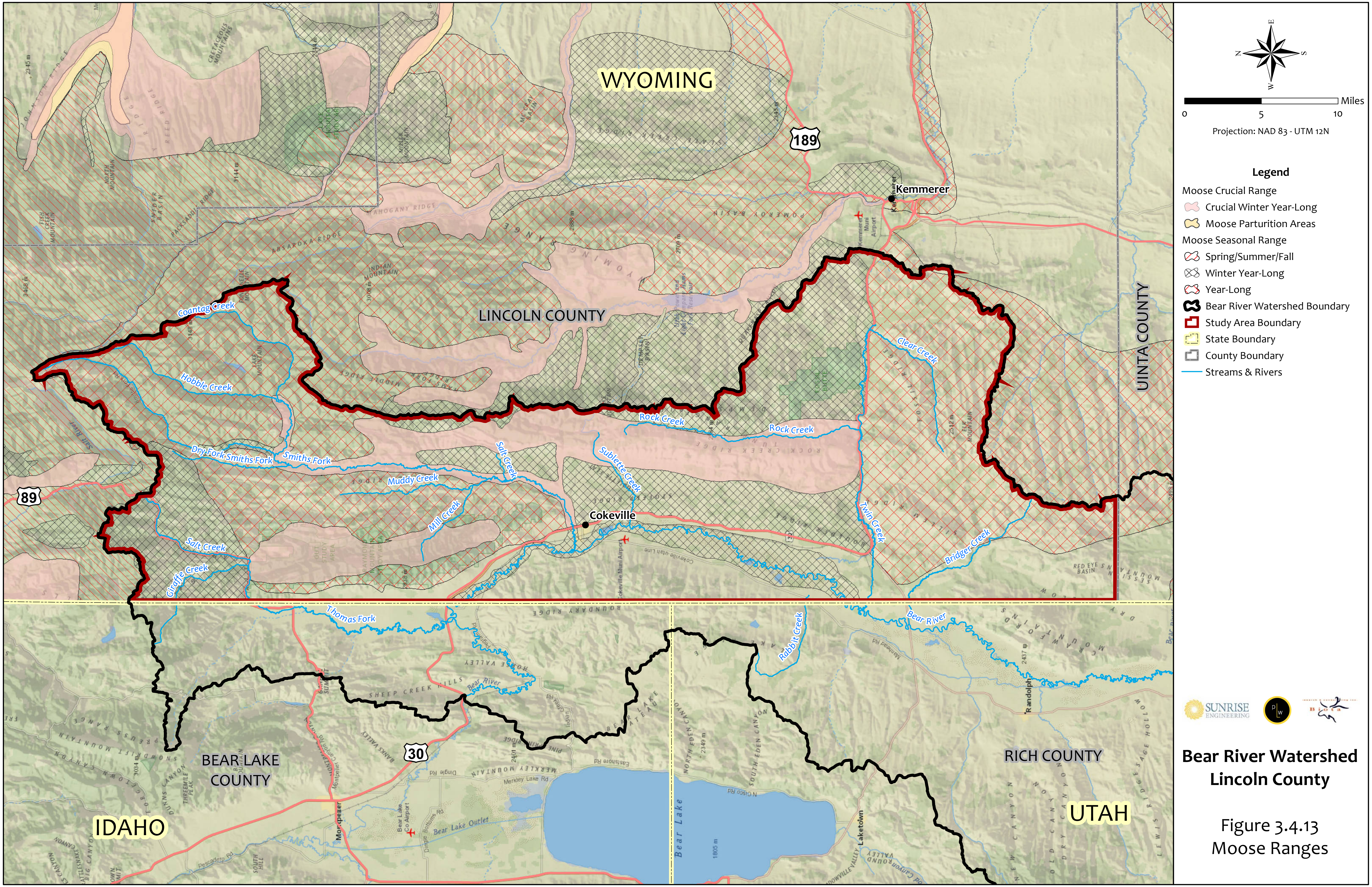
Moose Seasonal Range

- Spring/Summer/Fall
- Winter Year-Long
- Year-Long
- Bear River Watershed Boundary
- State Boundary
- County Boundary
- Study Area Boundary
- Streams & Rivers

SUNRISE ENGINEERING

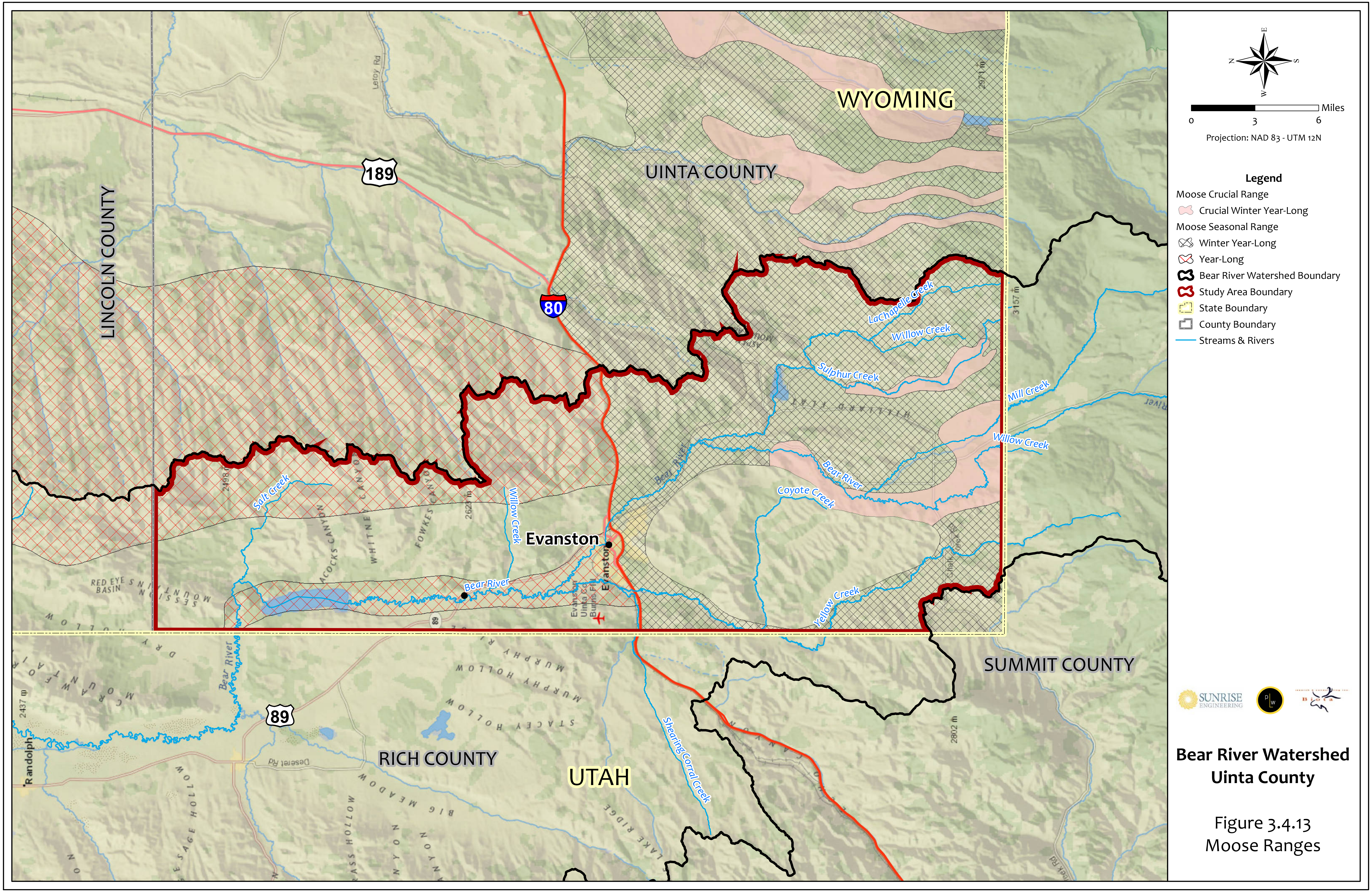
Bear River Watershed

Figure 3.4.13
Moose Ranges



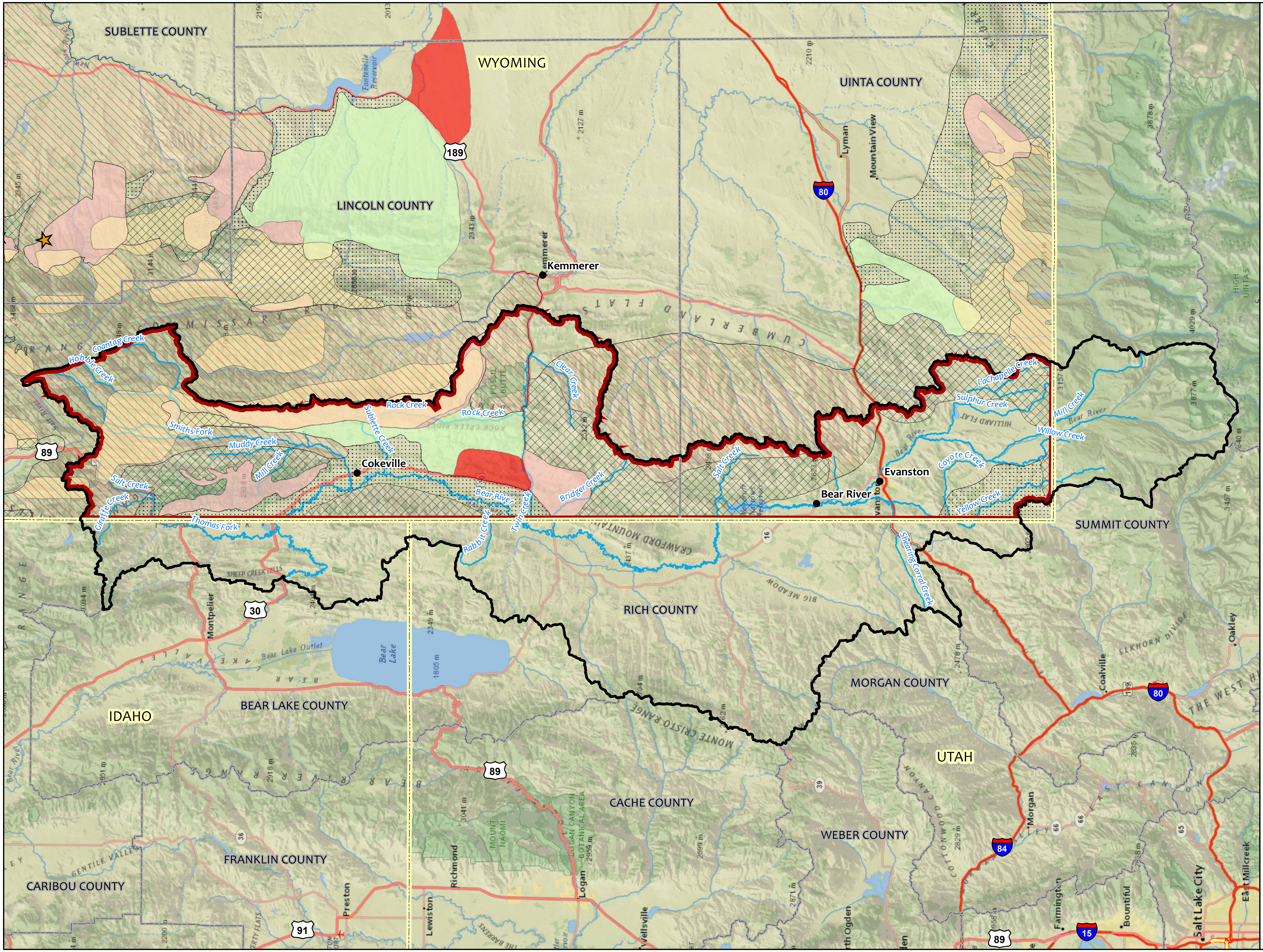
Bear River Watershed Lincoln County

Figure 3.4.13
Moose Ranges



Bear River Watershed Uinta County

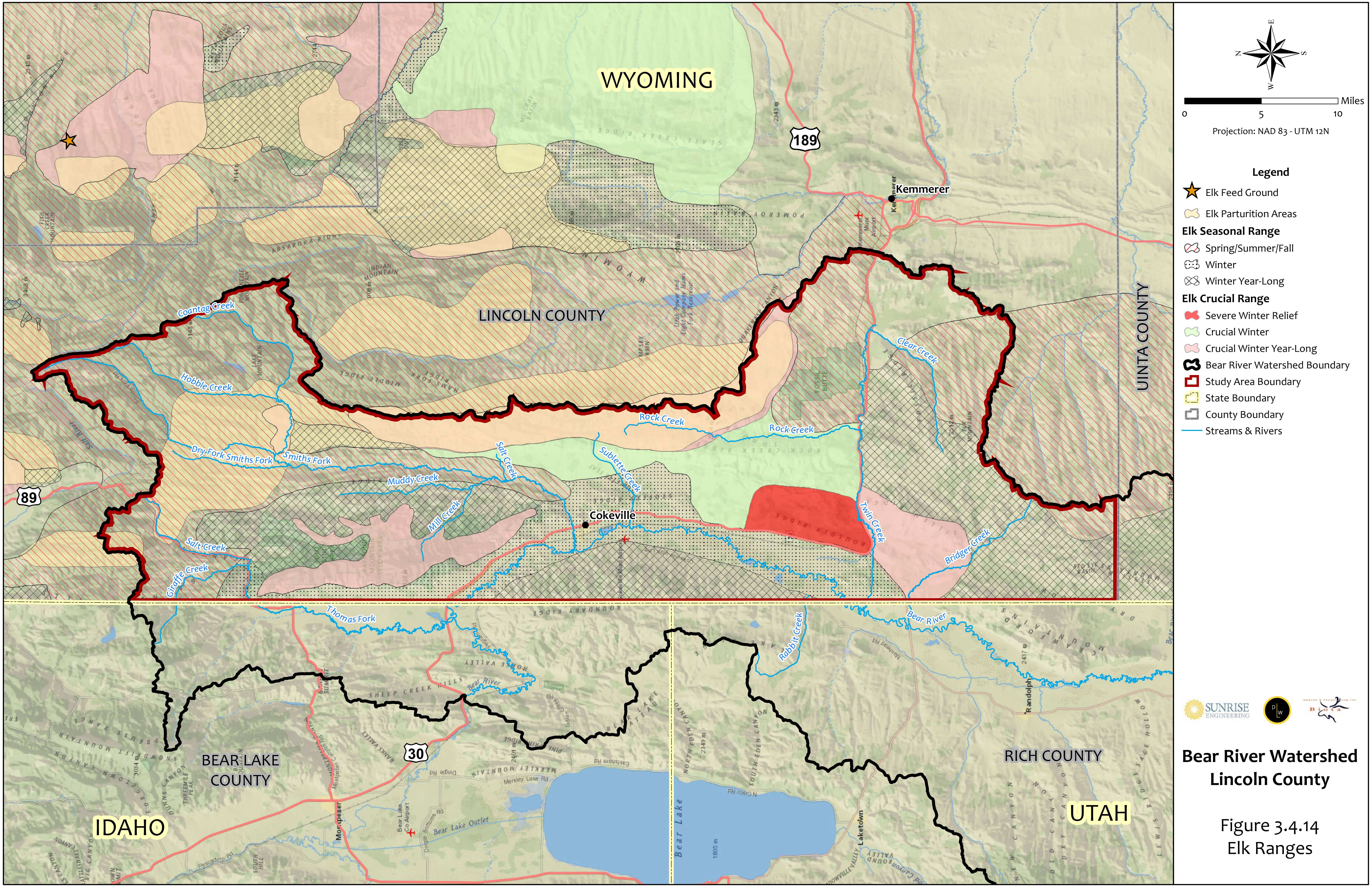
Figure 3.4.13
Moose Ranges



SUNRISE ENGINEERING

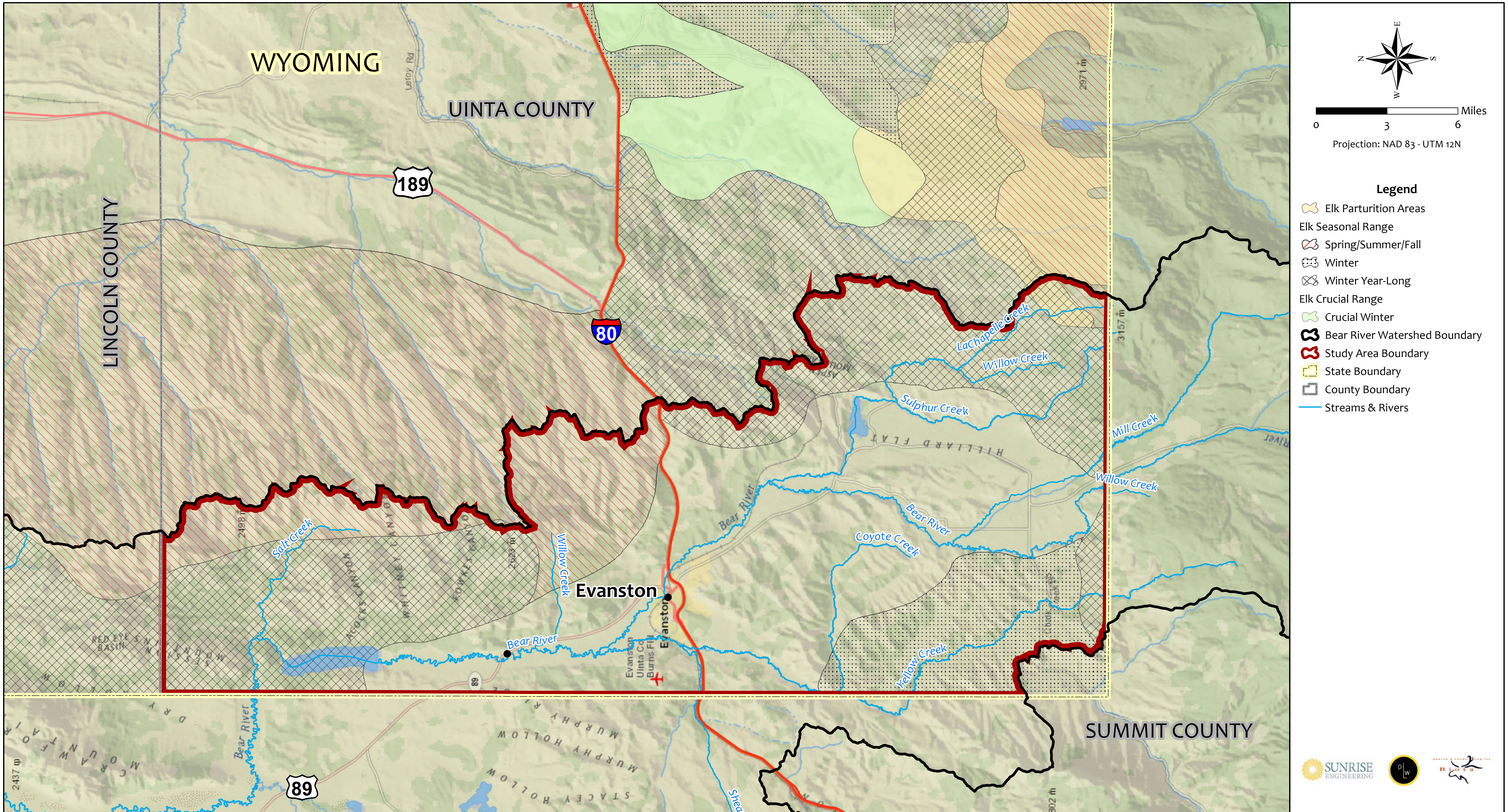
Bear River Watershed

Figure 3.4.14
Elk Ranges



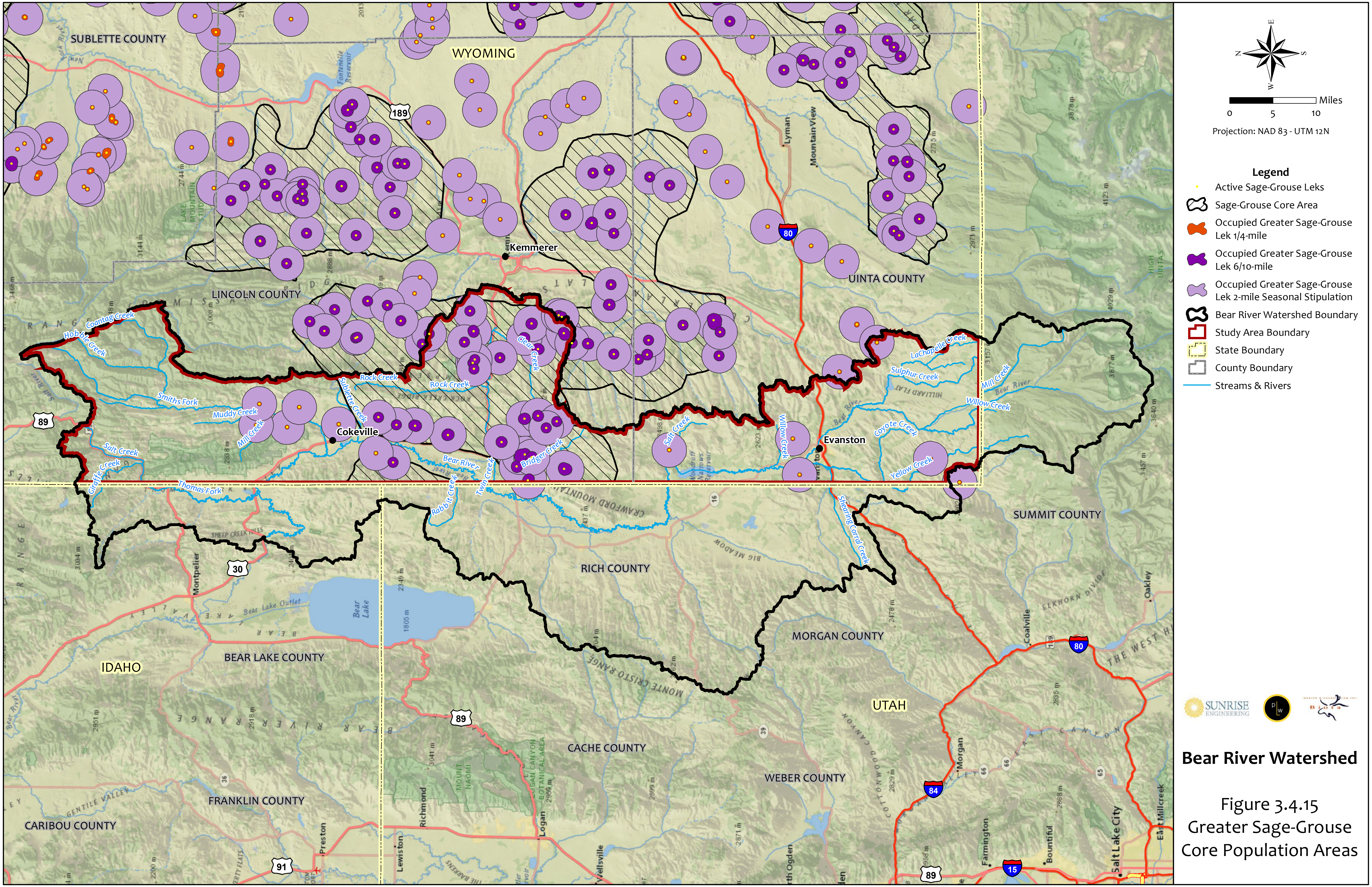
Bear River Watershed Lincoln County

Figure 3.4.14
Elk Ranges



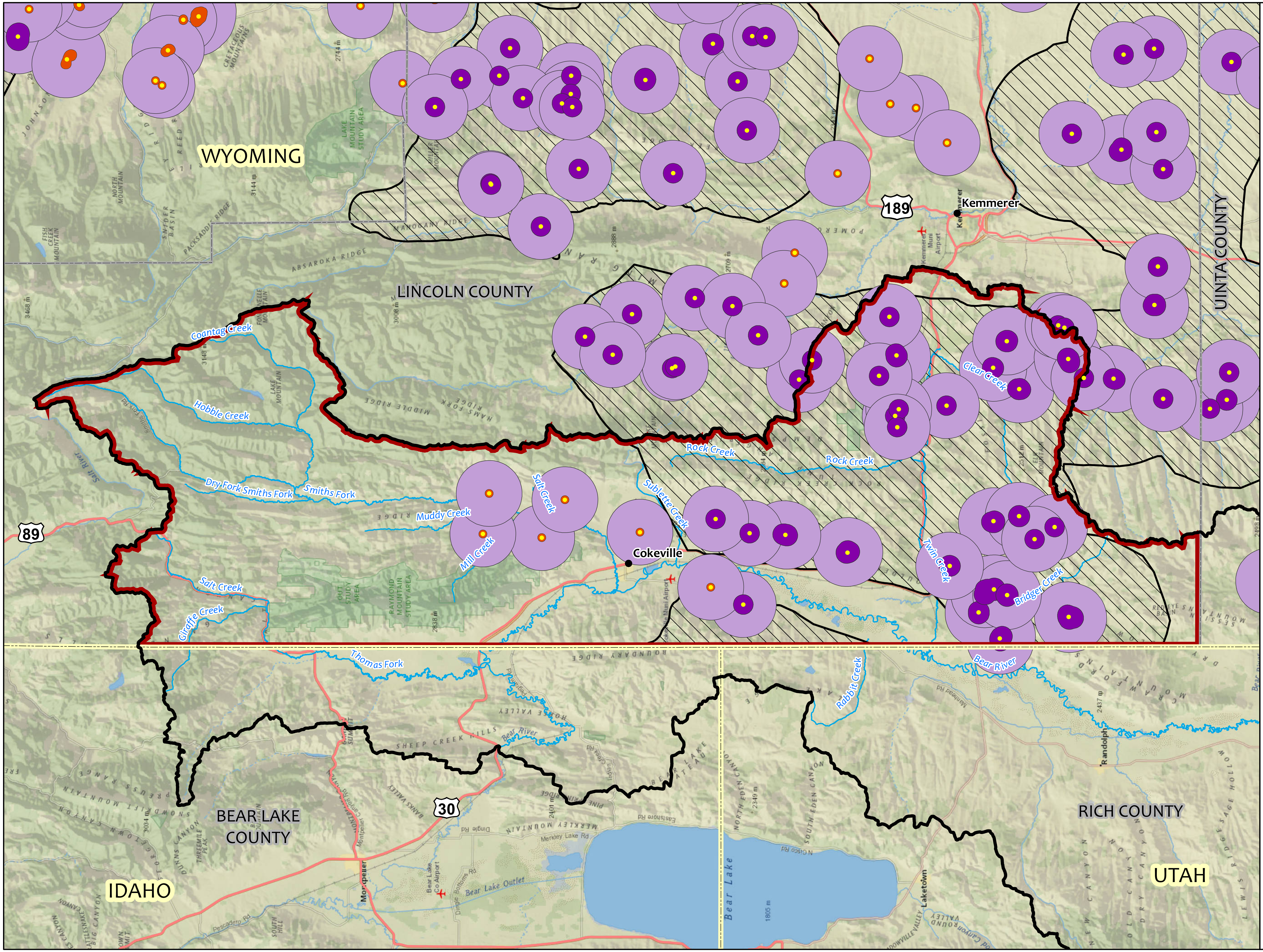
Bear River Watershed
Uinta County

Figure 3.4.14
Elk Ranges



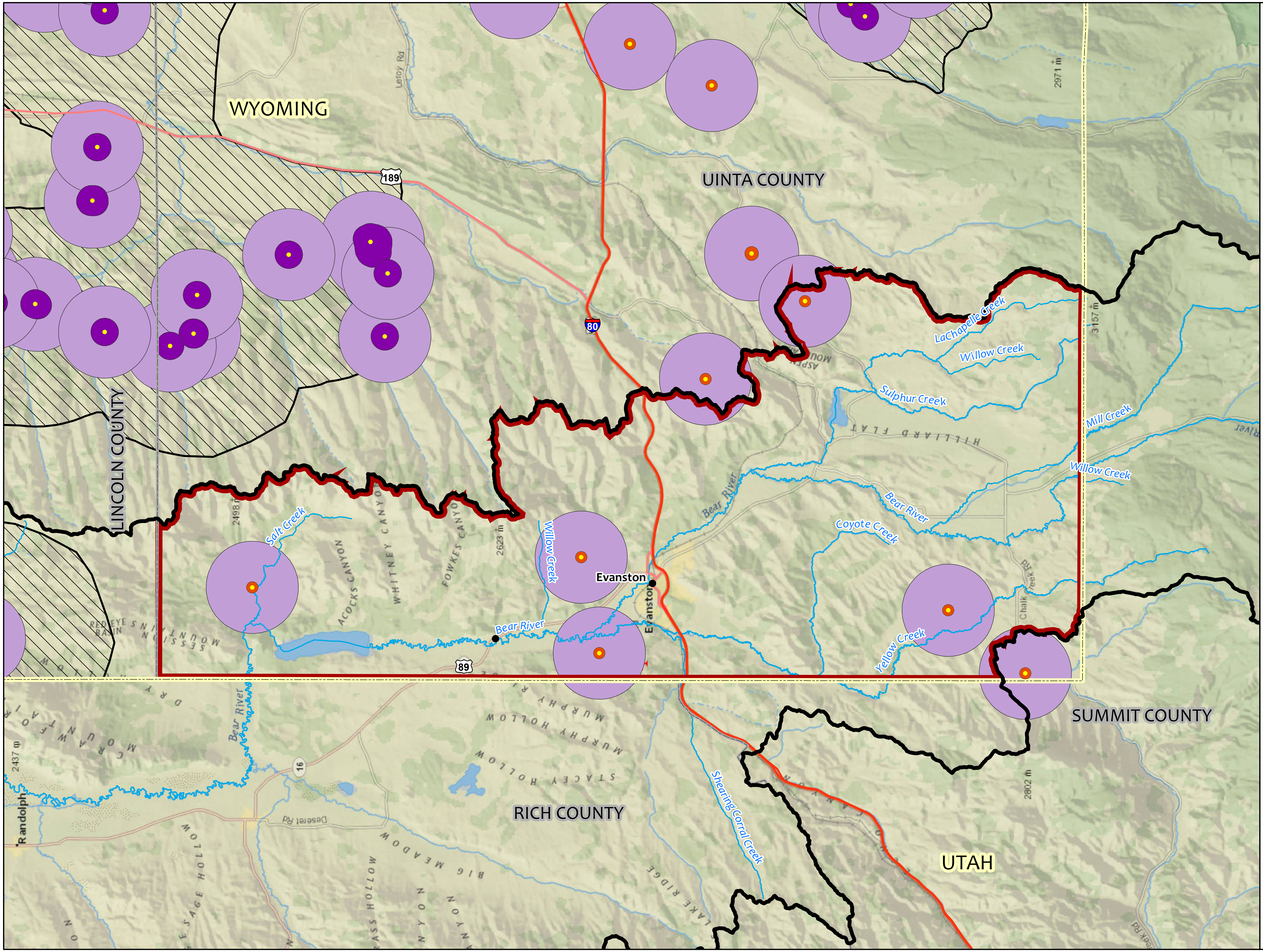
Bear River Watershed

Figure 3.4.15
Greater Sage-Grouse
Core Population Areas



Bear River Watershed Lincoln County

Figure 3.4.15
Greater Sage-Grouse
Core Population Areas



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0 3 6 Miles

Projection: NAD 83 - UTM 12N

Legend

- ● Active Sage-Grouse
- Sage-Grouse Core
- Occupied Greater Sage-Grouse Lek 1/4-mile
- Occupied Greater Sage-Grouse Lek 6/10-mile
- Occupied Greater Sage-Grouse Lek 2-mile Seasonal Stipulation
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams &

SUNRISE ENGINEERING

Bear River Watershed Uinta County

Figure 3.4.15 Greater Sage-Grouse Core Population Areas designated for portions of Lincoln County that overlap high elevation habitats within the northeastern portion of the watershed study area (Fig. 3.4.10.3).

CANDIDATE AND PROPOSED SPECIES

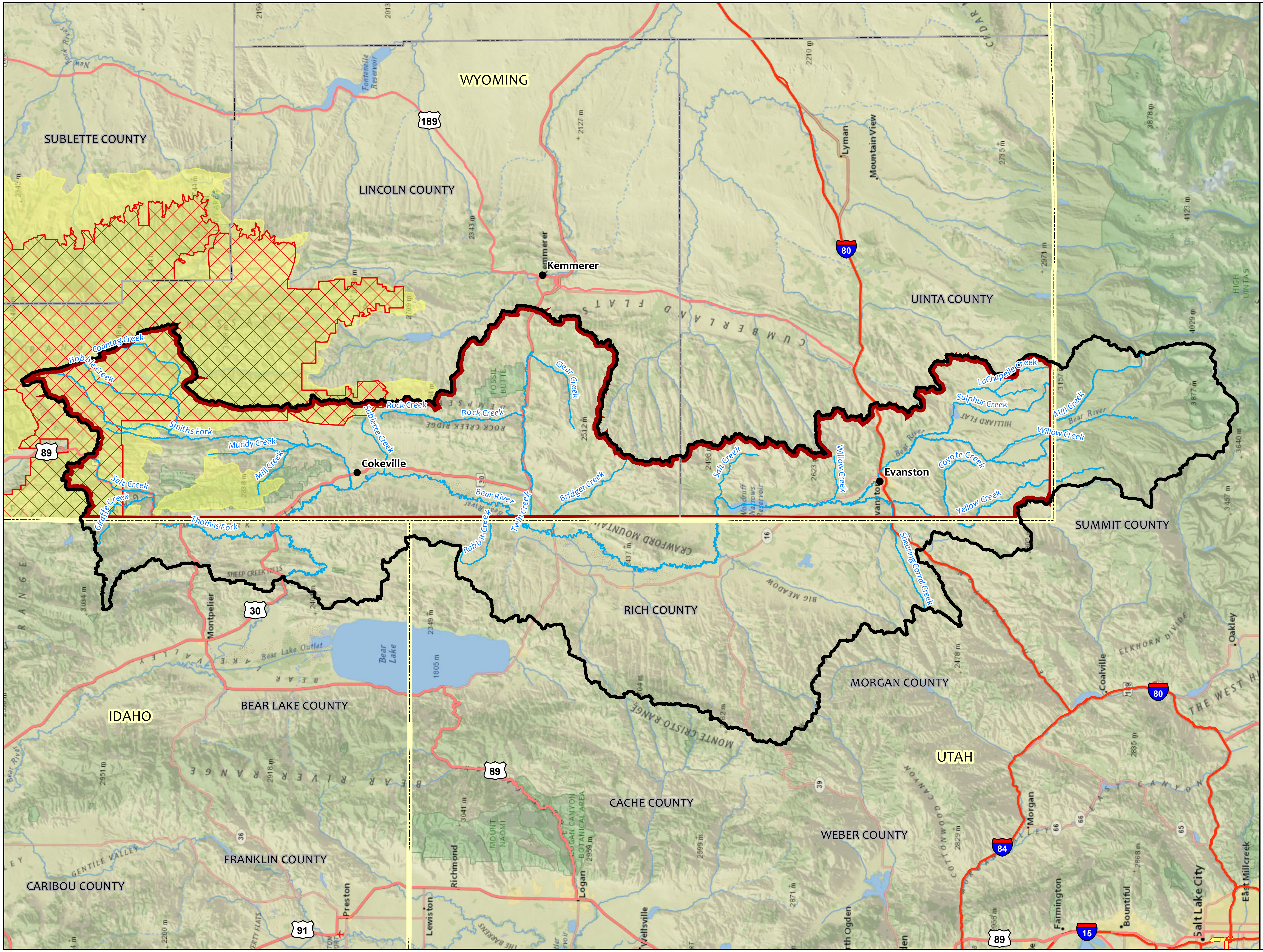
There are currently no animal species designated as candidate species under the ESA occurring within the study area. The North American wolverine was proposed in 2010 for listing as threatened under the Act; however, after carefully considering the best available science, the Service has determined that the effects of climate change are not likely to place the wolverine in danger of extinction now or in the foreseeable future. However, a Federal judge ruled recently (April 4, 2016) that wolverines are, in fact, at peril due to climate change and ordered the USFWS to take immediate steps to protect this species.

3.4.10.4 WGFD Crucial Habitat Areas

The WGFD Strategic Habitat Plan [SHP] (2009, revised 2015) informs the implementation of habitat conservation and enhancement across all departments within WGFD and through coordination with partners. The management of wildlife is inseparable from the habitat that sustains it and WGFD's ability to protect quality wildlife habitat is contingent upon working in partnership with private landowners and public land managers; conservation organizations; local, state, and federal governmental agencies; and the public. Aquatic, terrestrial and combined habitat protection areas were identified for both crucial range protection and enhancement objectives (Fig. 3.4.10). Under the SHP, a fundamental distinction is made between wildlife habitats that are "crucial" for wildlife and those habitats that have been degraded and have potential for "enhancement":

> "*Crucial habitat priority areas are based on significant biological or ecological values. These are areas that need to be protected or managed to maintain viable healthy populations of terrestrial and aquatic wildlife for the present and future. They represent habitat values and identify where those values occur on the landscape. Examples of values include crucial winter range, sage grouse core area seasonal habitats, species of greatest conservation need (SGCN) diversity and uniqueness, quality and condition of vegetative communities, movement corridors, quality of watershed hydrologic function, etc. The department will concentrate habitat protection and management activities in these areas.*"
>
> "*Enhancement Habitat Priority Areas represent those with a realistic potential to address wildlife habitat issues and to improve, enhance, or restore wildlife habitats. These areas offer potential for improving habitat and focusing Department habitat efforts. They may overlap crucial areas or be distinct from them. Enhancement areas are based on habitat issues. Like crucial areas where values are key, issues were identified by regional personnel and used to select enhancement habitat areas. Examples of issues include loss of aspen communities, habitat fragmentation, development, loss of connectivity, water quality effects, water quantity limitations, beetle killed conifer, lack of fish passage, loss of fish to diversions, degraded habitat, etc.*"
>
> *"Combined" areas were created where significant overlap occurred between aquatic and terrestrial areas. Therefore, "combined" crucial and "combined enhancement" areas were created in addition to "aquatic crucial" areas, "aquatic enhancement" areas, "terrestrial crucial" areas and "terrestrial enhancement" areas."*

The watershed study area includes aquatic and terrestrial Habitat Priority Areas such as Crucial Habitat Areas as well as Enhancement Habitat Priority areas (SHP 2015). Narrative excerpts from



Bear River Watershed

Figure 3.4.10.3 Canada Lynx Critical Habitat & Area of Influence the web-based Habitat Priority Area Maps and Narratives, (https://wgfd.wyo.gov/Habitat/Habitat-Priority-Areas/Statewide-Maps), maintained by WGFD, provide rationale for Habitat Area selection, primary species assemblages for focused protection efforts, and Habitat Area conservation solutions or actions.

REFERENCES

U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Montana Fish, Wildlife & Parks, Wyoming Game and Fish Department, Nez Perce Tribe, National Park Service, Blackfeet Nation, Confederated Salish and Kootenai Tribes, Wind River Tribes, Confederated Colville Tribes, Spokane Tribe of Indians, Washington Department of Fish and Wildlife, Oregon Department of Fish and Wildlife, Utah Department of Natural Resources, and USDA Wildlife Services. 2016. Northern Rocky Mountain Wolf Recovery Program 2015 Interagency Annual Report. M.D. Jimenez and S.A. Becker, eds. USFWS, Ecological Services, 585 Shepard Way, Helena, Montana, 59601.

WGFD Stragic Habitat Plan (SHP). 2015. 30pp.

Wyoming Office of the Governor (WOG). 2015. Greater sage-grouse core area protection. State of Wyoming Executive Dept. Executive Order 2015-4. 7pp.

3.4.10.5 FISHERIES

Fisheries within the watershed consist of a mix of 21 native and non-native game species, including 2 subspecies of cutthroat trout, and several species or species of concern. According to the Wyoming Game and Fish Department (WGFD), the reaches of the Bear River and its tributaries are moderately productive cold-water fisheries, with some reaches having limited fisheries potential. Reservoirs and lakes within the watershed provide additional habitat for most nonnative game fish. Although game fish found within the watershed consist primarily of non-native species, 2 native salmonid species are present, these being the Bonneville cutthroat trout and the Mountain Whitefish. Portions of the watershed are classified as key management areas for Bonneville cutthroat trout. Introduced salmonids include rainbow, brook, and brown trout.

Table 3.4.10.4. Fish species present within the Bear River Watershed Study Area. (Information provided by the Wyoming Game and Fish Department.)

Native Game Fish

Bonneville Cutthroat Trout *
Mountain Whitefish*

Native Nongame Fish

Bluehead Sucker*
Longnose Dace
Mottled Sculpin
Mountain Sucker
Northern Leatherside Chub*
Paiute Sculpin
Redside Shiner
Speckled Dace
Utah Chub
Utah Sucker

Nonnative Game Fish

Brook Trout
Brown Trout
Green Sunfish
Largemouth Bass
Rainbow Trout
Smallmouth Bass
Snake River Cutthroat Trout
Walleye
Yellow Perch

Nonnative Nongame Fish

Common Carp

* denotes Species of Greatest Conservation Need

According to the WGFD the population status of Bonneville cutthroat trout (BCT) is vulnerable, greatly restricted in numbers and distribution, but relatively stable. WGFD also says that the abundance of BCT is common within a limited range and that limiting factors are severe and not increasing significantly. BCT habitat availability is limited by land management activities (e.g., livestock grazing, irrigation diversion, energy development, and municipal water diversion), but habitat conditions have not worsened over the past decade (WY-SWAP, 2010). In Wyoming, the BCT are found in the Smiths Fork and Thomas Fork drainages, and main-stem of the Bear River. The BCT was petitioned for listing under the Endangered Species Act (ESA) as a threatened species throughout its range in 1998. In 2008, the U.S. Fish and Wildlife Service determined that listing was not warranted because a range-wide status review indicated that self-sustaining BCT populations are well distributed throughout their historic range and are being restored or protected in all currently occupied watersheds. Several state and federal wildlife and management agencies are coordinating the implementation of conservation measures for BCT within its historic range, the goals of which are to manage for conservation populations of BCT and to eliminate the threats to BCT that warrant listing as a sensitive species or endangered species by state or federal agencies (Lentsch et al., 2000).

Historically, BCT appear to have inhabited all systems with suitable habitat in the Bonneville Basin; however, the last century has seen human land use and stream alterations effectively restrict BCT range through habitat degradation and fragmentation. According to Colyer et al., (2005), BCT conservation efforts should focus on maintenance of migration corridors, stream connectivity, and conservation of seasonally used habitats within privately owned main-stem reaches on the lower Thomas Fork, lower Smiths Fork, and Bear River in order to ensure the long-term persistence of fluvial BCT in the system.

Mountain whitefish are widely distributed throughout their historic range and are abundant in the watershed, and reside in both the Bear River and many of its tributaries.

A number of non-native game species are present within the watershed at varying degrees of abundance. Introduced brook trout, brown trout, and rainbow trout are common throughout the watershed, while introduced non-native Snake River cutthroat trout, largemouth bass, smallmouth bass, green sunfish, and yellow perch are rare. Non-native walleye and smallmouth bass were illegally introduced into Sulphur Creek Reservoir where they are successfully reproducing. Anecdotally, green sunfish have been reported in Quealy Reservoir. Common carp, the only non-native non-game, are abundant in the main-stem Bear River, but population sizes are unknown. Two native non-game species present in the watershed are the bluehead sucker and northern leatherside chub.

WGFD has identified 4 fish species as Species of Greatest Conservation Need in their State Wildlife Action Plan (SWAP).

Species	Abundance	Status
Bluehead Sucker	Extremely Rare	NSS1(Aa)
Northern Leatherside Chub	Unknown	NSSU
Bonneville Cutthroat Trout	Common within a limited range	NSS3(Bb)
Mountain Whitefish	Common	NSS4(Bc)

NSS1(Aa): Native Species Priority 1 Imperiled (extreme)
NSS1(Ba): Native Species Priority 1 Vulnerable (extreme)
NSS1(Bc): Native Species Priority 1 Vulnerable (moderate)
NSS3 (Bb): Native Species Priority II Vunerable (Severe)
NSS4 (Bc): Native Species Species Priority II Vunerable (Moderate)
NSSU: Native Species Status Unknown

The BLM maintains a list of sensitive fish species and the following species are listed as sensitive: Bonneville cutthroat trout, bluehead sucker, and leatherside chub (non-native to watershed).

The majority of the watercourses within the watershed are listed as Class 2AB waters by the Wyoming DEQ Water Quality Division (WDEQ 2001a). Class 2AB waters are defined as those waters known to support game fish populations or spawning and nursery areas at least seasonally, perennial tributaries and adjacent wetlands, and areas in which game fishery and drinking water use is otherwise attainable. Additional protections of Class 2AB waters include "non-game fisheries, fish consumption, aquatic life other than fish, primary contact recreation, wildlife, industry, agriculture and scenic values". Other water quality designations within the watershed include Class 2C, 3B, and Class 4A waters. Class 2C waters include waters shown as having only nongame fish species present. Class 3B waters include tributaries that are not known to support fisheries or drinking water supplies. They typically are intermittent or ephemeral in nature but have the hydrologic conditions necessary to support invertebrate populations, amphibians, and obligate or facultative wetland plant species. Class 4A includes waters outside classes 1, 2, & 3 that are supported by an "approved UAA containing defensible reasons for not protecting aquatic life uses," and, in this case, are applied to irrigation ditches.

WGFD classifies rivers and streams within the Bear River watershed based on the relative productivity of each reach's trout fishery. Five classifications are used to describe the quality of each river reach that has been assessed. (See Figure 3.4.10.4)

Blue Ribbon: Premium trout waters and fisheries of national importance with trout production greater than 600 pounds of trout per mile

Red Ribbon: Very good trout waters and fisheries of statewide importance with trout production of 300 to 600 pounds of trout per mile

Yellow Ribbon: Important trout waters and fisheries of regional importance with trout production of 50 to 300 pounds of trout per mile

Green Ribbon: Low-production water and fisheries of local importance with trout production of less than 50 pounds of trout per mile.

Orange Ribbon: Any cool/warm water fish present.

Brown Ribbon: Reserved in GIS data but not used. (applies Elbow Creek)

Clear: No trout present.

The watershed consists of mostly Green Ribbon stream segments, which is indicative of low fish production; there are no reaches classified as Blue Ribbon. The remaining stream segments consist of one Red Ribbon, five Yellow Ribbon, and five Clear reaches.

Seventeen (17) instream flow filings involving 41.1 miles of watercourses have been made within the watershed.

Watercourse	Reach Distance (miles)	Filing Year
Coal Creek (Howland Creek)	0.8	1995
Raymond Creek	1.6	1995
Smiths Fork River	5.0	1995
North Fork of Smiths Fork River	2.4	1997
Hobble Creek	2.7	1995
Porcupine Creek	1.3	1995
Trespass Creek	1.0	1997
Lander Creek	0.4	1997
Poker Hollow Creek	1.6	1997
Coal Creek	4.2	1996
Huff Creek	3.3	1995
Salt Creek	4.5	1996
Giraffe Creek	2.4	1996
Packstring Creek	1.3	1997
White Creek, Little	2.5	1997
Water Canyon Creek	1.2	1996
Contag Creek	4.9	1996

WGFD continues stocking fish within the watershed, but most stocking involves Bonneville cutthroat trout stocked within the main-stem and Smiths Fork of the Bear River.

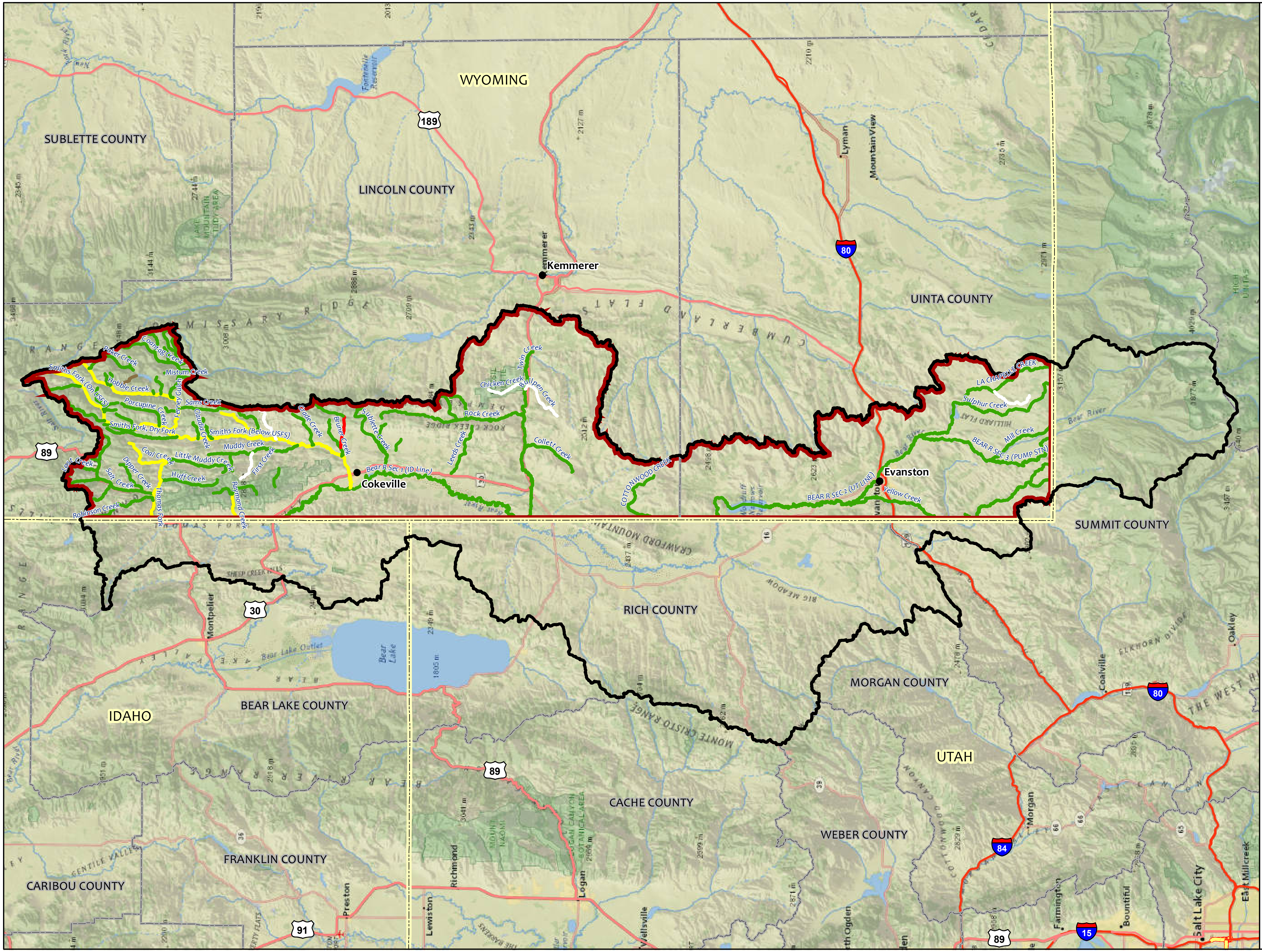
Trout Unlimited (TU) has several ongoing and completed projects in the Bear River watershed study area including the following:

Upper Bear River Reconnect and Flow Restoration Project

This project focused on improving connectivity and flow within irrigation ditches in the area upstream of Evanston, WY. TU plans to screen the Hovarka Canal to eliminate fish entrainment and consolidate the larger Hilliard Canal with the existing Lannon Ditch, roughly 7 miles downstream. The net effect is to restore as much as 35 cfs into the East Fork and Bear River mainstem.

Otter Creek Reconnect and Reintroduction Project

TU eliminated 14 fish passage barriers in this tributary to the Bear River, replacing existing culverts and diversion dams with bottomless arch culverts and instream rock structures. Phase II of the project involves working with the Utah Division of Wildlife Resources to build a



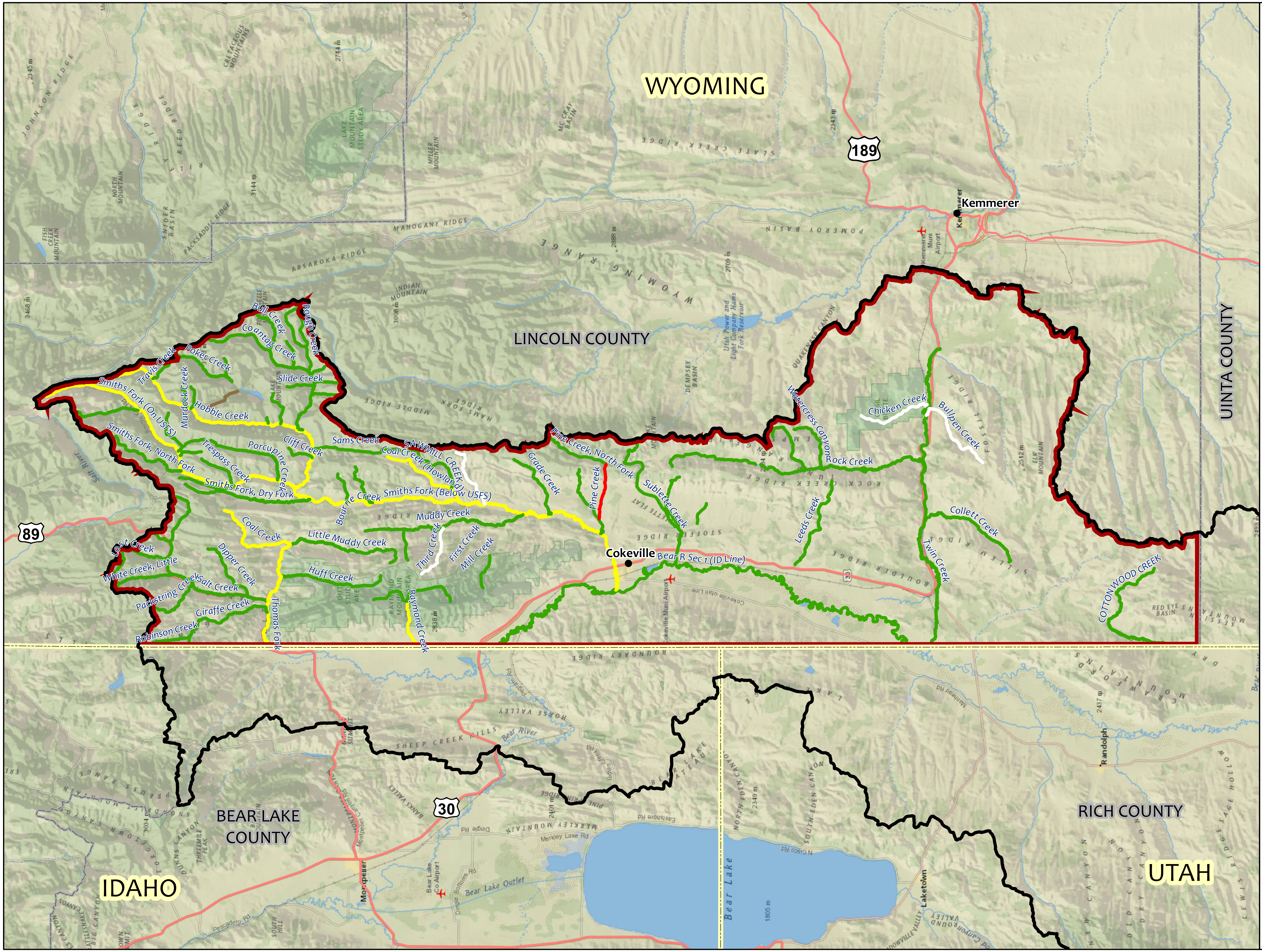
Legend

Trout Stream Classification

- Brown
- Clear
- Green
- Red
- Yellow
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary

Bear River Watershed

Figure 3.4.10.4
WGFD Trout
Stream Class



Miles
0 5 10

Projection: NAD 83 - UTM 12N

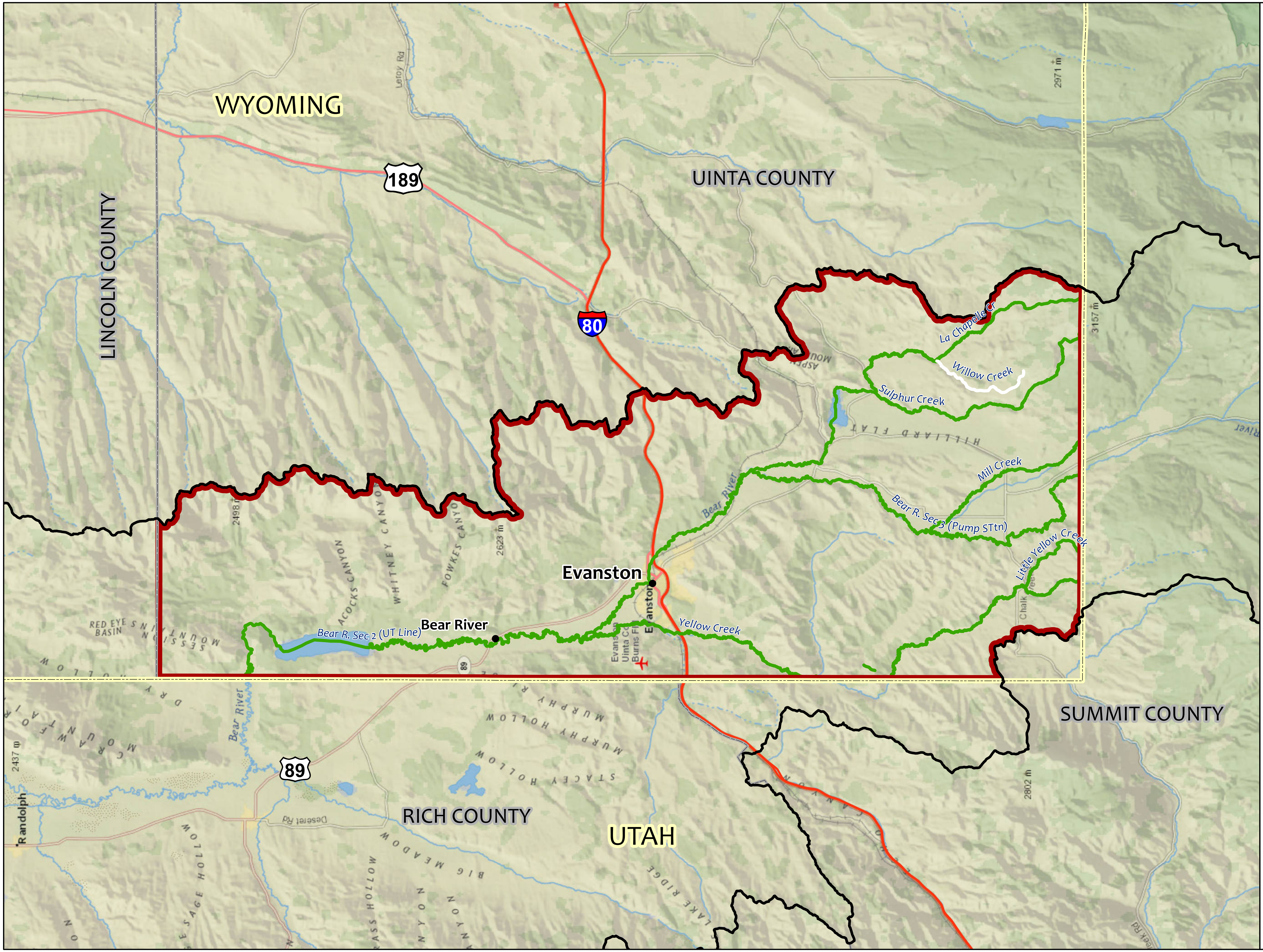
Legend

Trout Stream Classification

- 🟫 Brown
- ⬜ Clear
- 🟩 Green
- 🟥 Red
- 🟨 Yellow
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary

Bear River Watershed
Lincoln County

Figure 3.4.10.4
WGFD Trout
Stream Class



Bear River Watershed
Uinta County

Figure 3.4.10.4
WGFD Trout
Stream Class

barrier to prevent non-native trout from moving upstream and reintroducing an inter-connected population of native Bonneville cutthroat trout, some of which should move downstream to support at risk populations on the Bear River.

2011 Yellow Creek Barrier Assessment and Inventory (Uinta County, WY and Summit County, UT)

TU and The Nature Conservancy, in cooperation with the Utah Division of Wildlife Resources and WGFD, initiated this project to identify and prioritize restoration work on barriers to fish passage within Yellow Creek. The project benefits habitat for the Northern Leatherside Chub.

Coal Creek Fish Passage and Irrigation Improvement (Near Cokeville, Lincoln County WY)

This project improved a water diversion on Coal Creek a tributary of the Smith's Fork, with a fish screen, to improve fish passage and prevent spawning Bonneville cutthroat trout from becoming trapped in irrigation systems.

Grade Creek Project (Lincoln Country, WY)

TU worked with a landowner near Cokeville to reconnect Grade Creek to the Smith's Fork and improve irrigation efficiency by installing a center pivot and fish screen. The project provides spawning habitat and keeps the fish in the creek.

Rock Creek Project (Lincoln Country, WY)

TU partnered with multiple local ranchers to consolidate irrigation canals, improve diversion structures, and install headgates and fish screens to facilitate fish passage and keep fish out of irrigation canals and off the hay fields.

White's Water Diversion (Lincoln Country, WY)

A large rotary drum fish screen was installed to facilitate appropriate fish passage.

Twin Creek (Lincoln Country, WY)

A rotary drum fish screen was installed to facilitate appropriate fish passage.

REFERENCES

Colyer, W. T., R. H. Hilderbrand, and J. L. Kershner. 2005. Movements of fluvial Bonneville cutthroat trout in the Thomas Fork of the Bear River, Idaho-Wyoming. North American J. Fish. Mgmt. 25:954-963.

Lentsch, L. D., C. A. Toline, J. Kershner, J. M. Hudson, and J. Mizzi. 2000. Range-wide conservation agreement and strategy for Bonneville cutthroat trout. Utah Div. Wildl. Resources, Publ. 00-19, Salt Lake City.

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IV. WATERSHED MANAGEMENT AND REHABILITATION PLAN

4.1 INTRODUCTION

A primary objective of the watershed study was to develop a technically sound, practical and economically feasible watershed management plan. The investigative phase of this study focused on an assessment of the watershed characteristics and function, and the identification and evaluation of opportunities to address issues disclosed in Section 3. Opportunities include the following:

- Livestock/Wildlife Upland Watering Opportunities – Potential upland water development projects were identified based on an evaluation of existing water sources, upland grazing conditions, and input from landowners.
- 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.
- Grazing Management Opportunities – Grazing management strategies are presented based on a review of the Ecological Site Descriptions (ESDs), vegetation, and soil conditions within the watershed.
- Irrigation System Improvements - Diversion repairs, fish passage or exclusion, and conveyance efficieicy projects were identified.
- Other Upland Management Opportunities – Additional upland management opportunities were identified.

4.2 UPLAND WILDLIFE AND LIVESTOCK WATER SOURCES

The Bear River Watershed study area supports all or portions of eighty four grazing allotments on BLM (76) and USFS (12) administered land. These allotments are generally adjacent to and often encompass privately held ground and serve as summer and early fall range for the adjacent ranches. The allotment sizes range from a single section up to the sprawling Cumberland and Uinta allotment that has several hundred square miles in the basin. Extensive work has been done within the watershed to provide upland water sources for livestock and wildlife. Natural water features also provide similar services; and are found throughout the watershed (Figure 3.3.4.2a) Figure 3.3.4.2b illustrates the locations of permitted, developed water features. Figure 3.3.4.2c shows wells permitted by the State Engineer. Some of these wells are used for upland watering, many are for irrigation and domestic use. Figure 3.3.4.2d depicts USGS mapped springs. Figure 3.3.4.2e depicts stock pond viability based on an aerial review. Of note are the gaps in coverage such as North Muddy Creek, Mill Creek and other smaller areas.

Many of the allotments have small water improvements constructed by resource agencies or the permit holder. The facilities generally group into one or more of the following categories:

- Wells
- Springs
- Earthen Catchments (Reservoirs)
- Troughs
- Conveyance

In the case of springs there are both developed and undeveloped springs. The undeveloped springs in many cases could be improved and protected with development and troughs. In addition there are some natural features such as ponds and pits that also serve to water livestock.

4.2.1 NEW WATERING OPPORTUNITIES

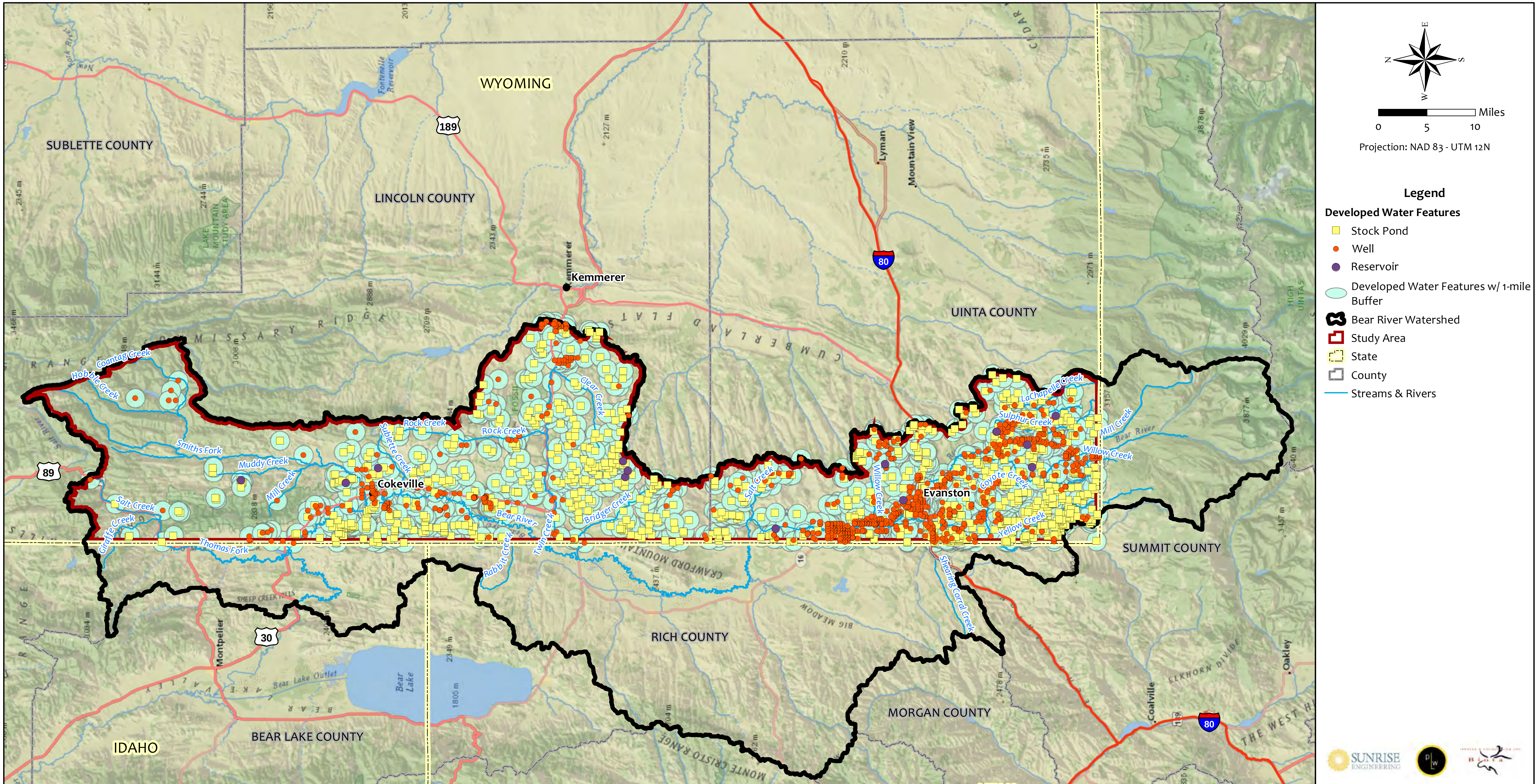
Considerable work has been performed within the watershed to provide upland water sources for both livestock and wildlife. Abundant natural water features also provide similar services, especially in the northern and southern portions of the watershed.

Opportunities to develop additional water sources exist. Potential water sources that would provide at least seasonal water on underutilized rangelands include development of springs, and enlargement and/or rehabilitation of existing permitted stock reservoirs and wells. Development of springs that flow in excess of 2 gallons per minute and redevelopment of stock wells provide the greatest potential for new or expanded water sources. New or rehabilitated stock reservoirs could also provide upland water sources where wells or springs are not available, but these activities will likely require more work and are inherently more expensive to design, permit, and construct. The following is a partial list of possible upland water development projects.

- Stock ponds
- Storage reservoirs
- Spring developments
- Existing wells with conventional windmills, wind turbines and combined solar/wind systems
- New wells with conventional windmills, wind turbines and combined solar/wind systems
- Guzzlers/raintraps
- Pipeline/tank systems

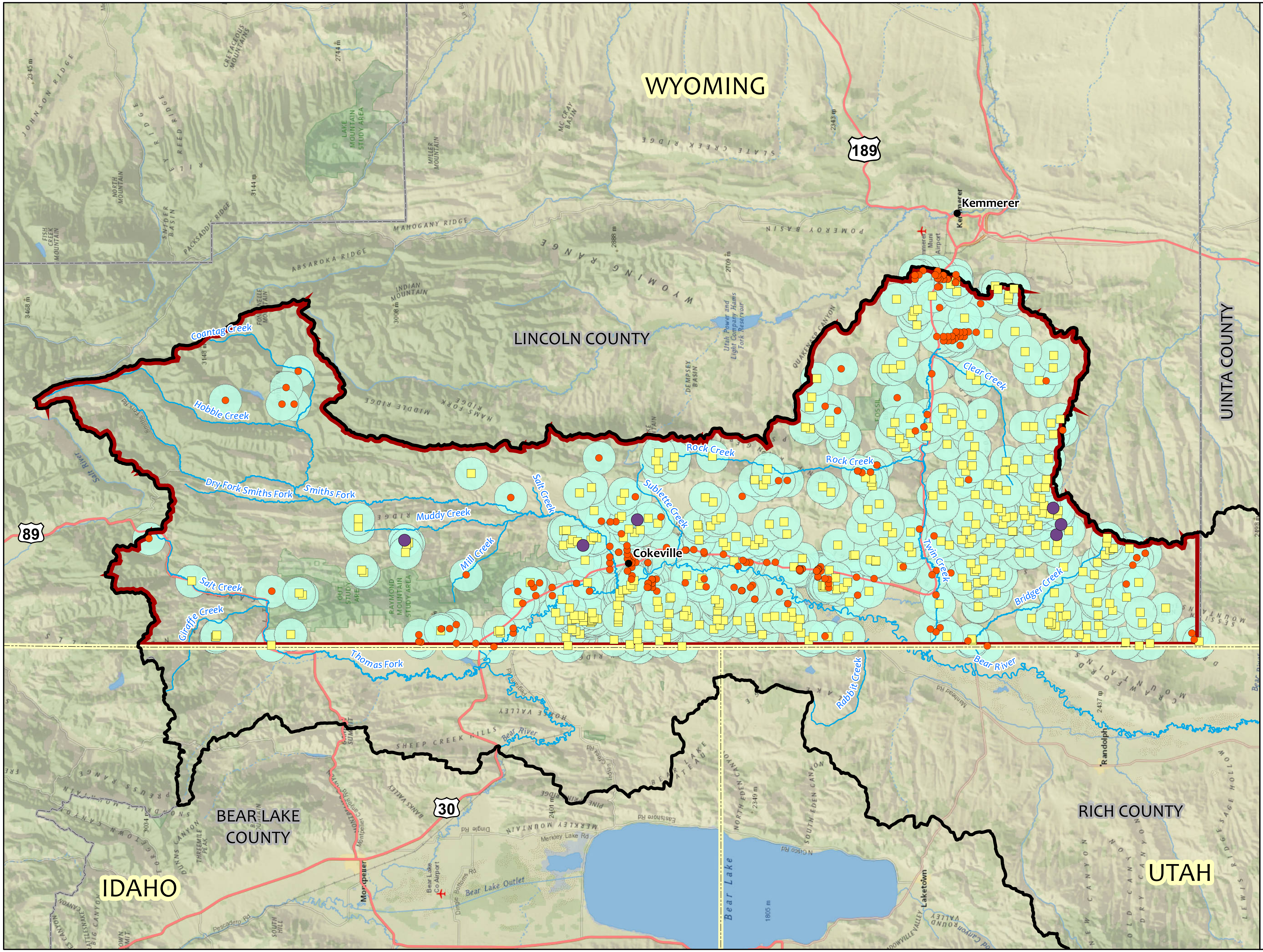
The topography throughout a substantial portion of the watershed, particularly the lower elevations within all but the extreme southern and northern portions, make existing water sources (both water development and natural) capable of providing water to livestock and wildlife within a one-mile radius. This same one-mile buffer has been used in a variety of previously prepared WWDC-funded watershed studies, and for the purposes of this Level I study, this radius was assumed to be reasonable for the Bear River Watershed. However, the effective radius around a given water source could be smaller depending on factors such as topography, water quality, fences, roads, and grazing allotment boundaries.

To this end, one-mile buffers were drawn around documented water sources described in Section 3 and are presented in Figures 4.2.1.1 for water development features, Figure 4.2.1.2 for natural water features. Figure 4.2.1.3 depicts only one-mile buffers around all natural and water development features. Water source buffers depicted in these figures, however, may not represent a complete list of all water development and natural water sources within the watershed. In



Bear River Watershed

Figure 4.2.1.1
Developed Water
Features with
1-Mile Buffer



Projection: NAD 83 - UTM 12N

Legend

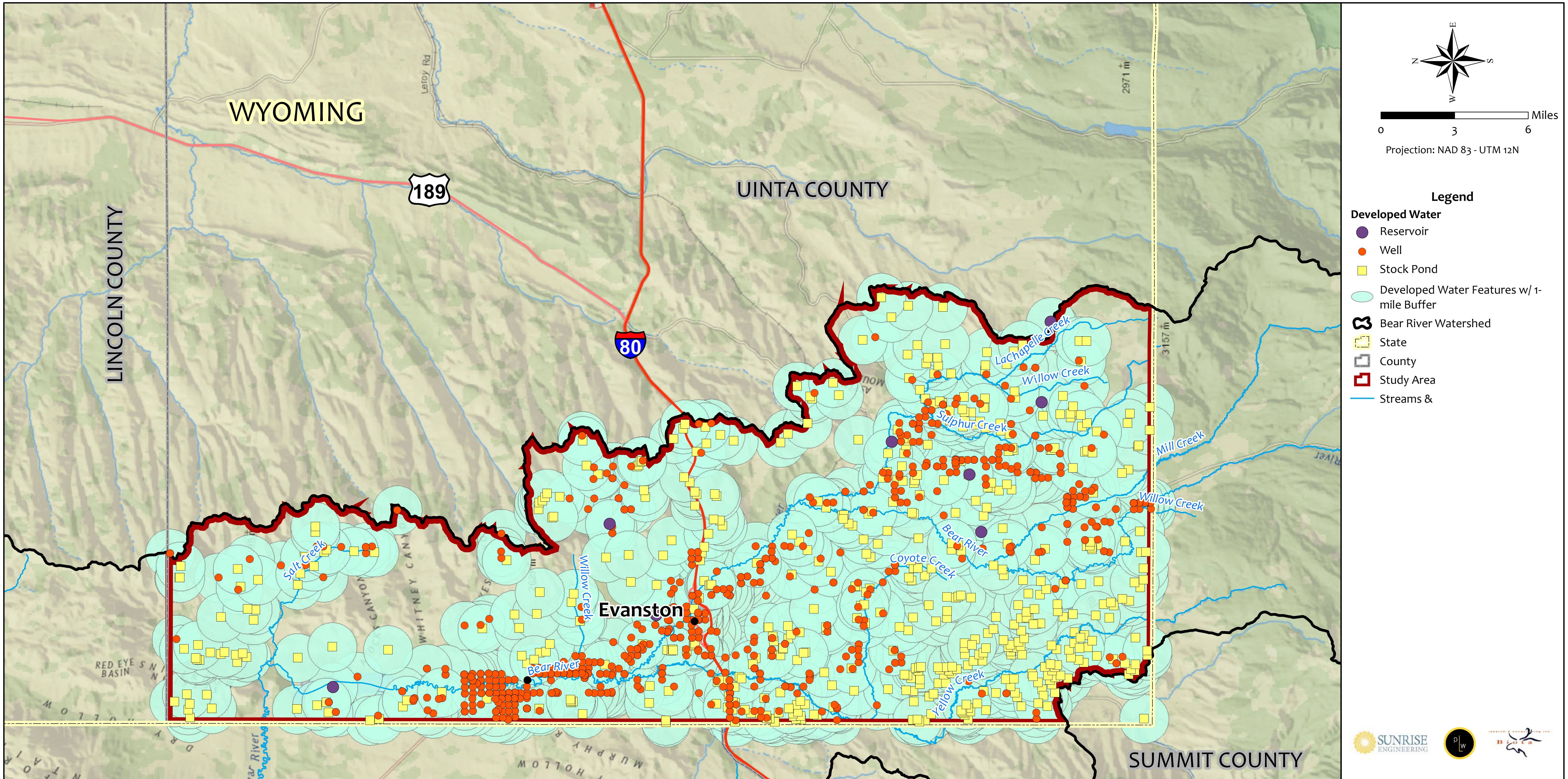
Developed Water Features

- ● Reservoir
- ● Well
- ■ Stock Pond
- ● Developed Water Features w/ 1-mile Buffer
- Bear River Watershed Boundary
- ☐ Study Area Boundary
- ☐ State Boundary
- ☐ County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

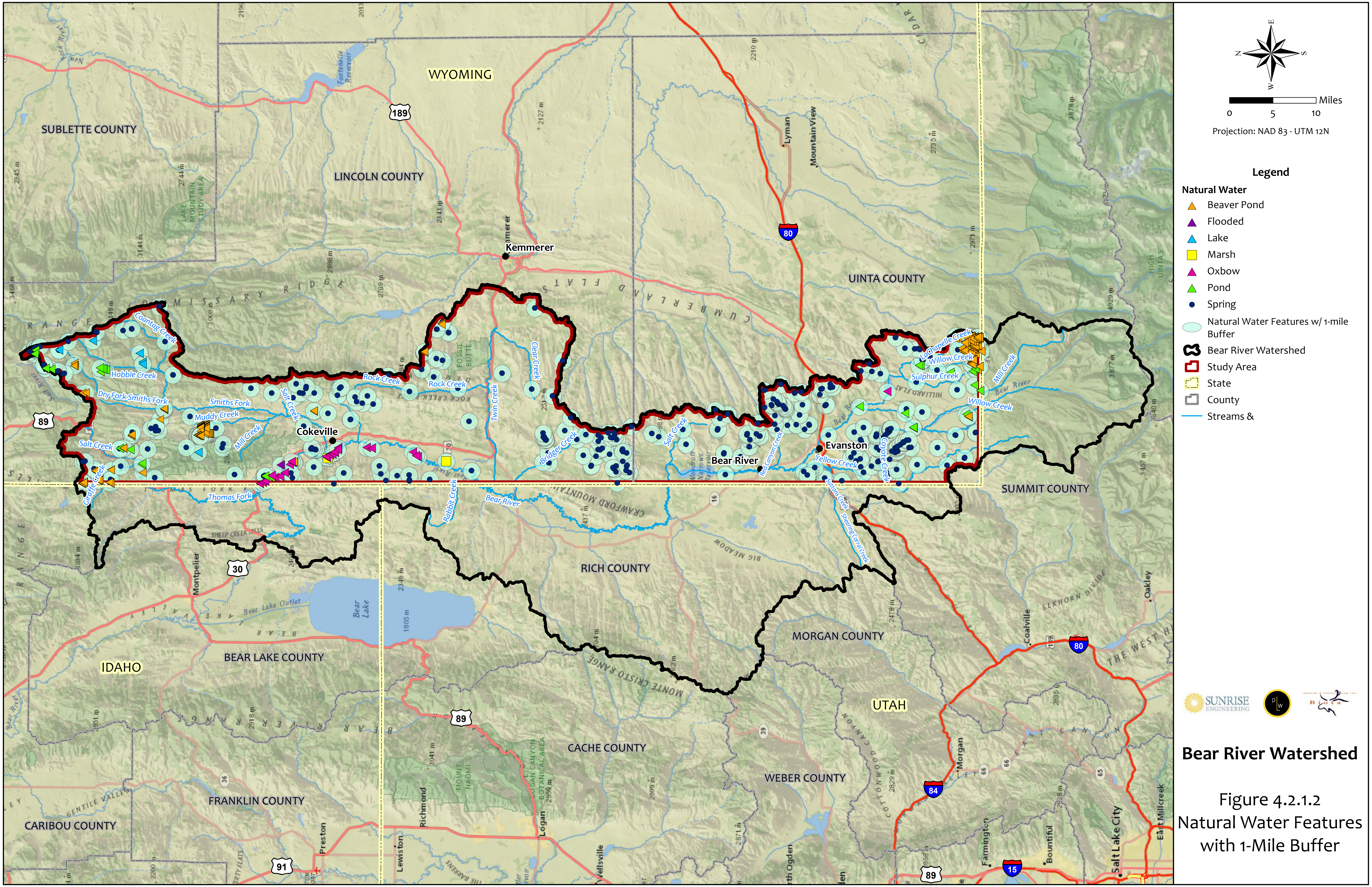
Bear River Watershed
Lincoln County

Figure 4.2.1.1
Developed Water
Features with
1-Mile Buffer



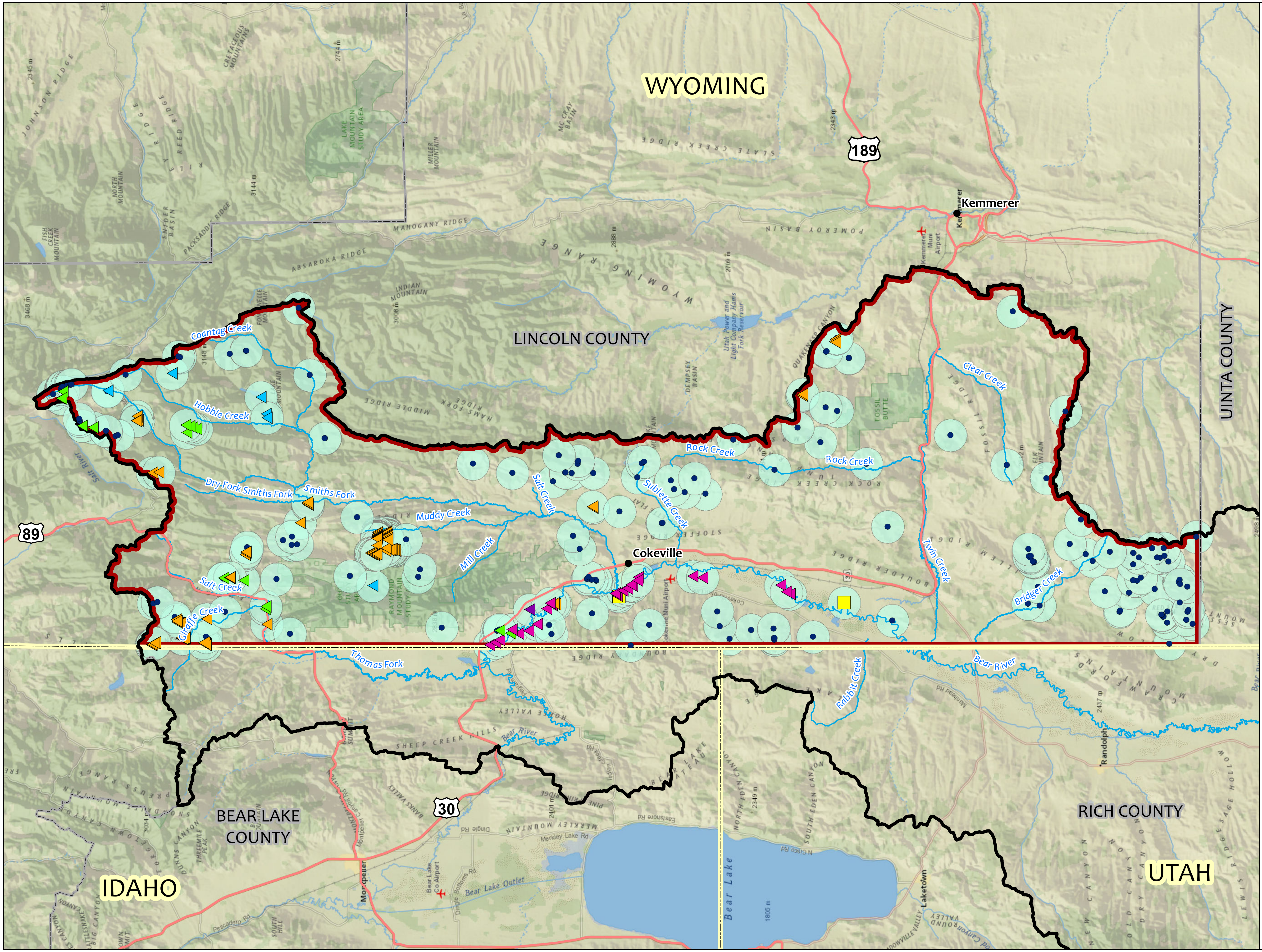
Bear River Watershed
Uinta County

Figure 4.2.1.1
Developed Water
Features with
1-Mile Buffer



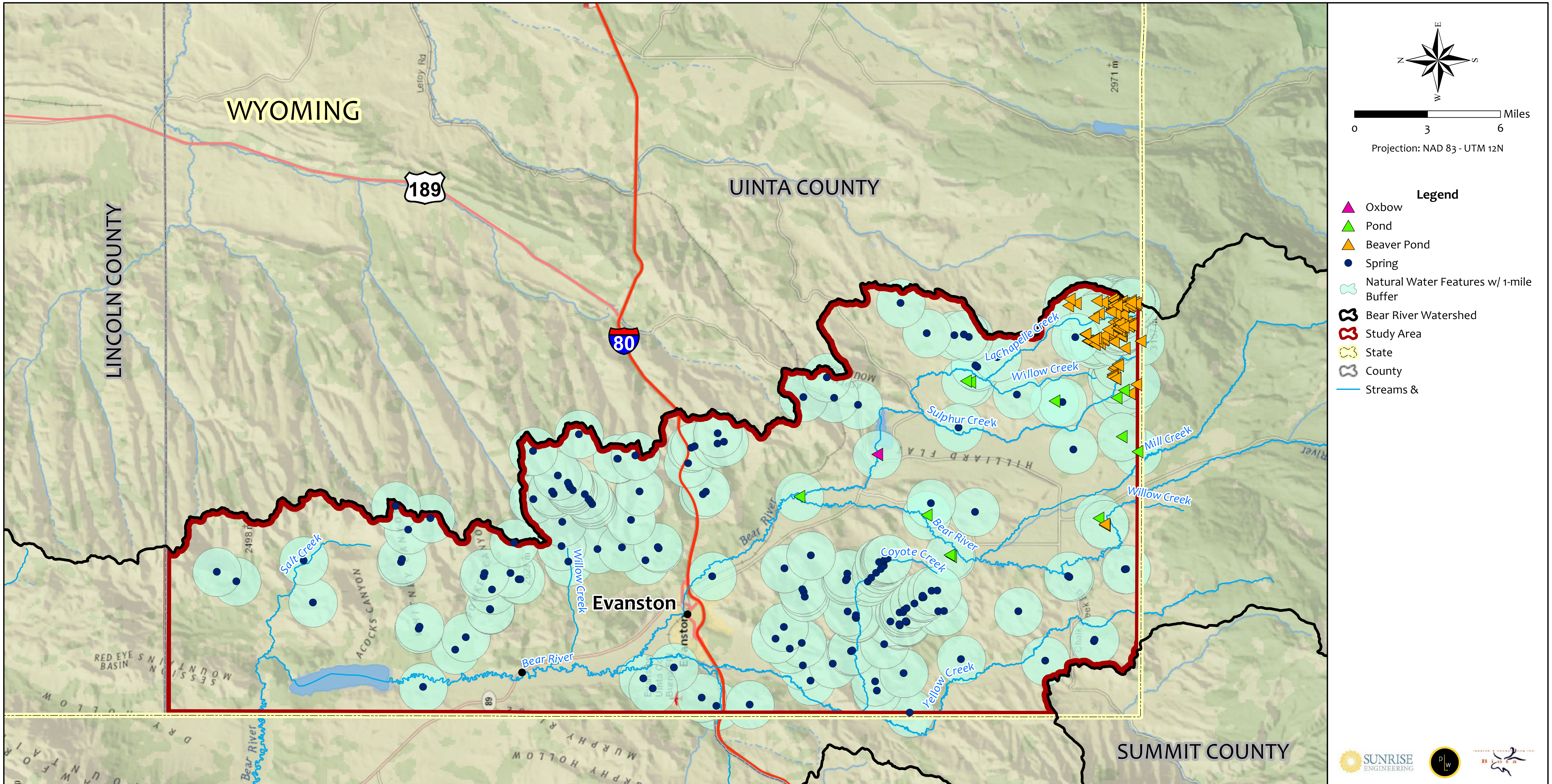
Bear River Watershed

Figure 4.2.1.2
Natural Water Features
with 1-Mile Buffer



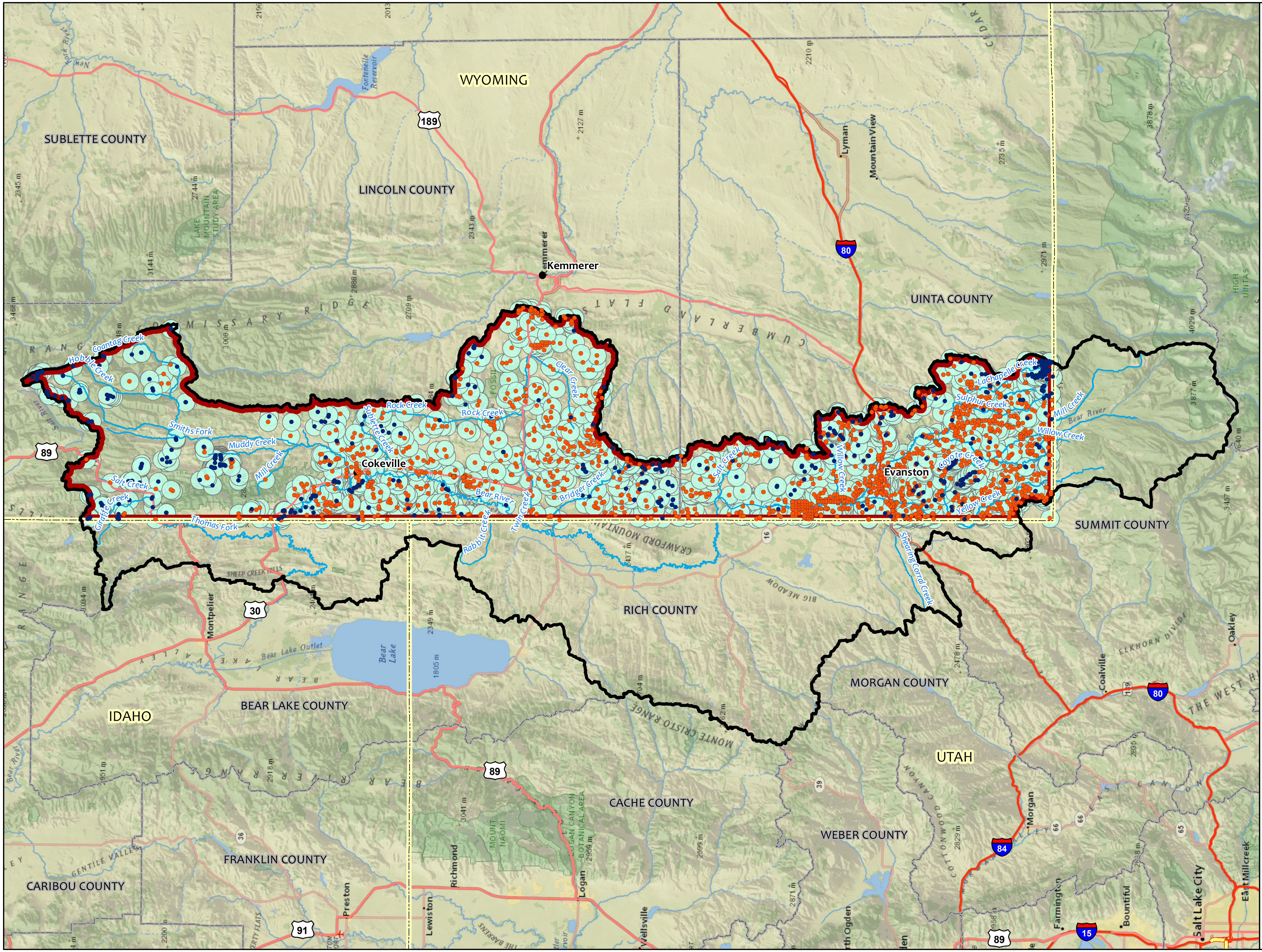
Bear River Watershed
Lincoln County

Figure 4.2.1.2
Natural Water Features
with 1-Mile Buffer



Bear River Watershed
Uinta County

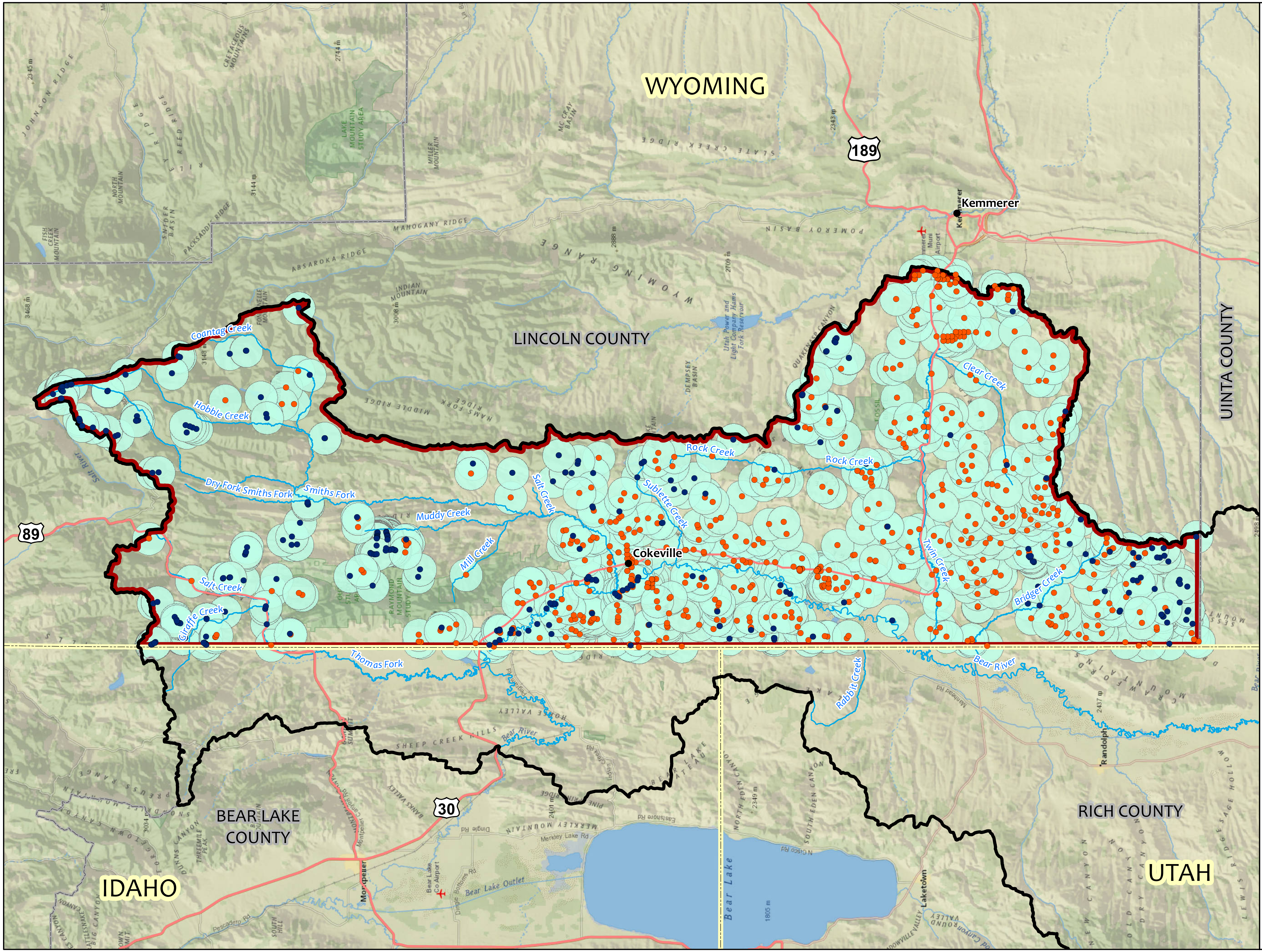
Figure 4.2.1.2
Natural Water Features
with 1-Mile Buffer



SUNRISE ENGINEERING

Bear River Watershed

Figure 4.2.1.3
Natural & Developed Water Features with 1-Mile Buffer



N
E
S
W

0 5 10 Miles

Projection: NAD 83 - UTM 12N

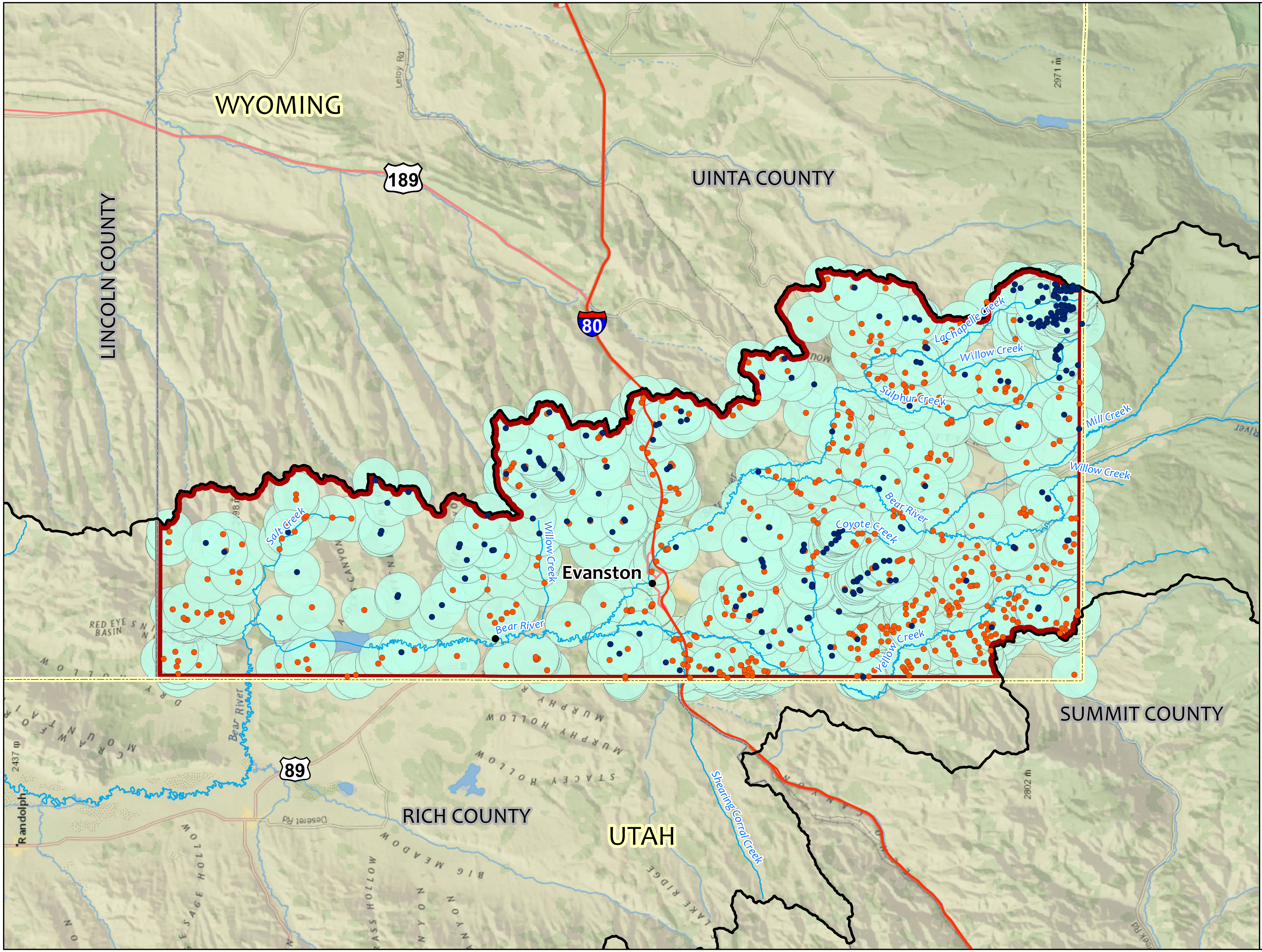
Legend

- ● Natural Water Feature
- ● Developed Water Feature
- Natural & Developed Water Features w/ 1-mile Buffer
- Bear River Watershed Boundary
- Study Area Boundary
- State Boundary
- County Boundary
- Streams & Rivers

SUNRISE ENGINEERING

Bear River Watershed
Lincoln County

Figure 4.2.1.3
Natural & Developed
Water Features with
1-Mile Buffer



Bear River Watershed
Uinta County

Figure 4.2.1.3
Natural & Developed
Water Features with
1-Mile Buffer

addition, water co-produced during recent gas production can sometimes provide a source for upland wildlife/livestock usage depending upon its water quality. Because one objective of this study was to evaluate alternative water sources for wildlife and livestock other than perennial and intermittent streams, these streams were not buffered in Figures 4.2.1.2 and 4.2.1.3.

An examination of these figures shows that much of the land in the watershed, including grazing lands, appear to be within one mile of a water source. However, the more mountainous area in the northern portion of Lincoln County has fewer water sources (both natural and developed) than the remaining portion of the watershed. Although it is possible that some undetected upland water features exist in this area, these figures suggest that most of the grazed portion of the watershed has upland water sources.

The 1-mile buffer is based on a relatively gentle slope that can be traversed by cattle with little difficulty. The varied and steep topography in many parts of the basin limits the effective radius a given water source may service. In addition, seasonal variability and equipment breakdowns eliminate many sources, thereby increasing travel distances and limiting the practical ability to graze certain areas. The completeness of the buffer coverage must consider the loss of certain sites through much of the year.

Each of these sites plays a critical role in the grazing management plan. Not only in terms of water being available, but also in the ability of the operator to control when this water is, or is not, available.

Future planning and design of additional upland wildlife/livestock water sources should include onsite consultation with landowners or land managers (if federal lands are involved), allotment permittees, the Natural Resource Conservation Service, and the Lincoln and Unita County Conservation Districts to verify location of the planned improvements in relation to existing sources. Additional upland water development may be desirable in areas appearing well watered because topography, physical barriers and other limiting factors were not considered during the analysis. Various types of upland water development projects identified during this study are tabulated and detailed in the individual county supplements which accompany this study.

4.2.2 UPLAND WILDLIFE/LIVESTOCK WATER DEVELOPMENT PROJECTS

One of the tasks of this Level I study was to meet, on a voluntary basis, with various landowners and permit holders to tabulate and discuss their recommendations regarding upland water development.

A list of interested landowners and allotment permittees was generated based upon input obtained at project meetings and from input obtained through project team member activities and interviews conducted during the completion of the project. Individual meetings with the landowners were scheduled and completed to gain their input on the water needs of their respective geographical areas of interest. Based upon the results of these interviews, and the information presented above pertaining to existing water supplies and areas in need of upland water development, numerous conceptual water development projects were identified. Table 4.2.1 summarizes the results of the upland water landowner consultations.

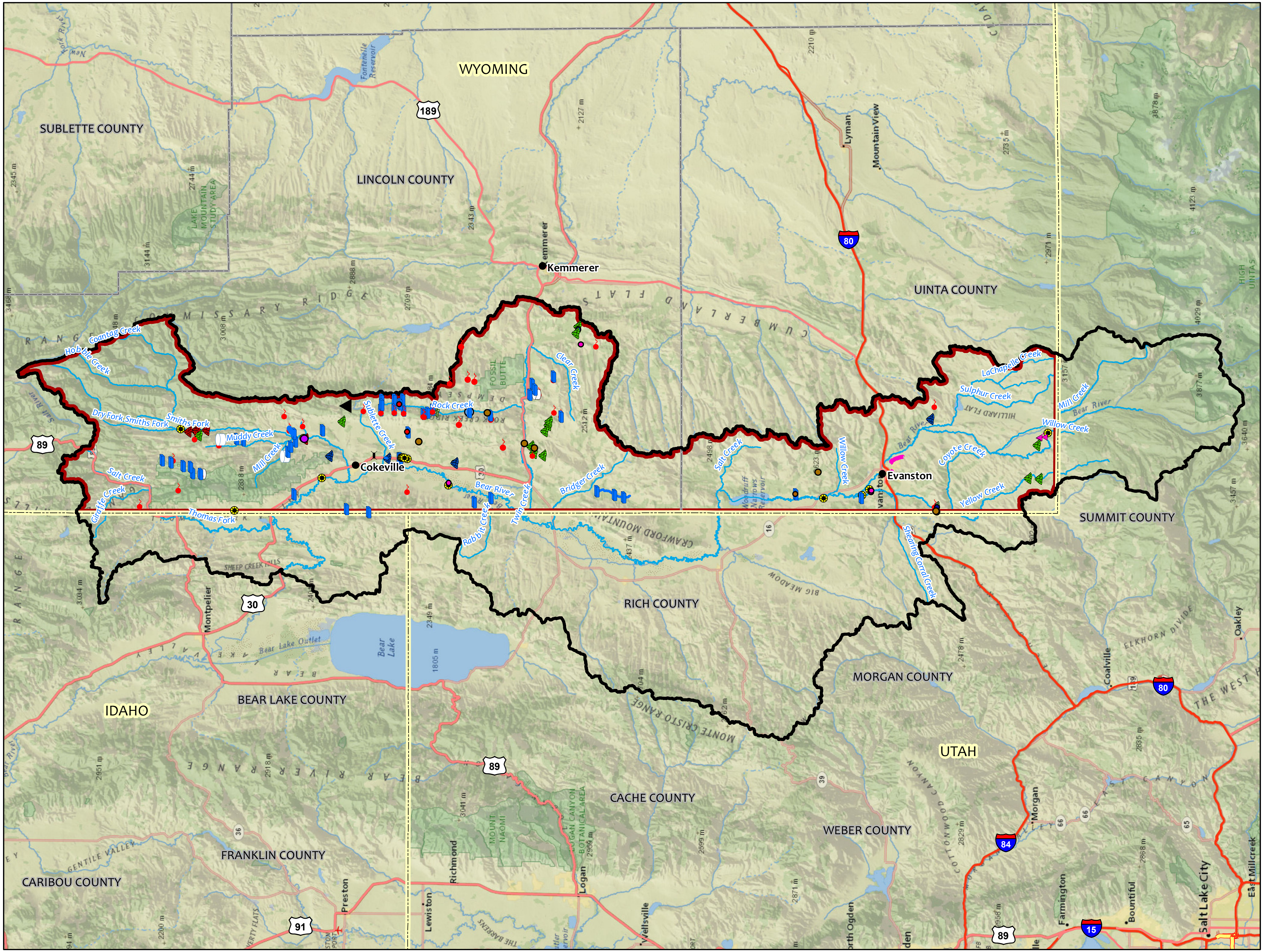
Table 4.2.1 Upland Water Projects

			Major Project Components						
General Location	Owner or Operator	Number of Projects	Spring Development	Water Well or Pump in Sump	Surface Catchment	Tank	Trough	Small Dia. Pipeline	Estimated Total Project Costs
Lincoln County	Boehme	6	3	2		2	10	3	$ 644,298
	Benion	1		1			1		$ 88,676
	BLM	11	12	4			26	3	$ 937,060
	Clark	1		1			1		$ 100,902
	Carter	2	1				2	1	$ 58,950
	Cornia	1		1			1	1	$ 48,456
	Circle B	5	6	1			8	2	$ 225,237
	Etchevery	1	1						$ 19,553
	Nate	1					1		$ 2,878
	Roberts	1					2	1	$ 35,658
	Thornock	2		2			2		$ 168,435
	Julian	16	6	2	9		4	1	$ 343,276
	Willis	3		1			5	4	$ 198,916
	Pierce	1					3	1	$ 190,375
	Total for Lincoln County	**52**	29	15	9	2	66	17	**$ 3,063,000**
Uinta County	Cornielison	1	1				1		$ 15,430
	Brieninger	1		1			1		$ 51,424
	BLM	1		1					$ 96,121
	Hayduk	1					1	1	$ 52,995
	Hansen/YC Ranch	1	1						$ 12,430
	Loham	1			1				$ 134,368
	Total for Uinta County	**6**	2	2	1	0	3	1	**$ 363,000**

The projects are identified geographically using decimal degree locations on the individual project cost estimates. Figure 4.2.2.1 illustrates the distribution of the potential upland water projects. Note several of the proposed projects are new installations and serve to fill in gaps while others are rehabilitation of existing projects. The county supplments contain additional maps of greater detail for the sites shown on Figure 4.2.2.1. Also found in the supplements are detailed cost estimates for each of the individual projects.

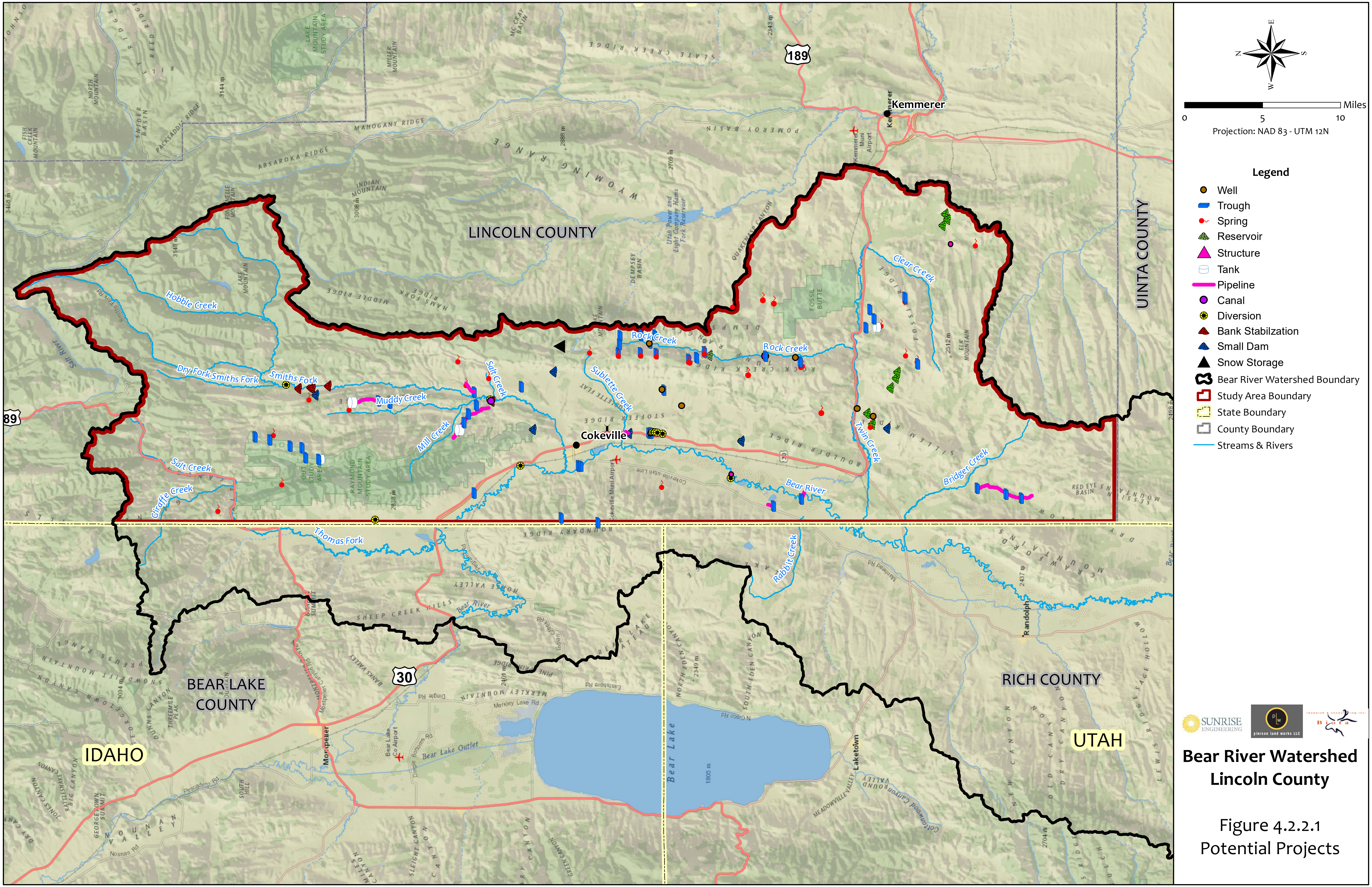
The sites visited during this study were selected for review precisely because they could be improved. The watershed also contains numerous upland sites that are operating smoothly as intended.

The condition of the facilities reviewed varies from good working order to inoperable. Even when in good condition, there may be need for improvements, better reliability and ease of operation using modern technology. Further improvements and repairs are intended to provide higher quality and quantities of water that will reduce travel distances and allow better control over animal distribution.



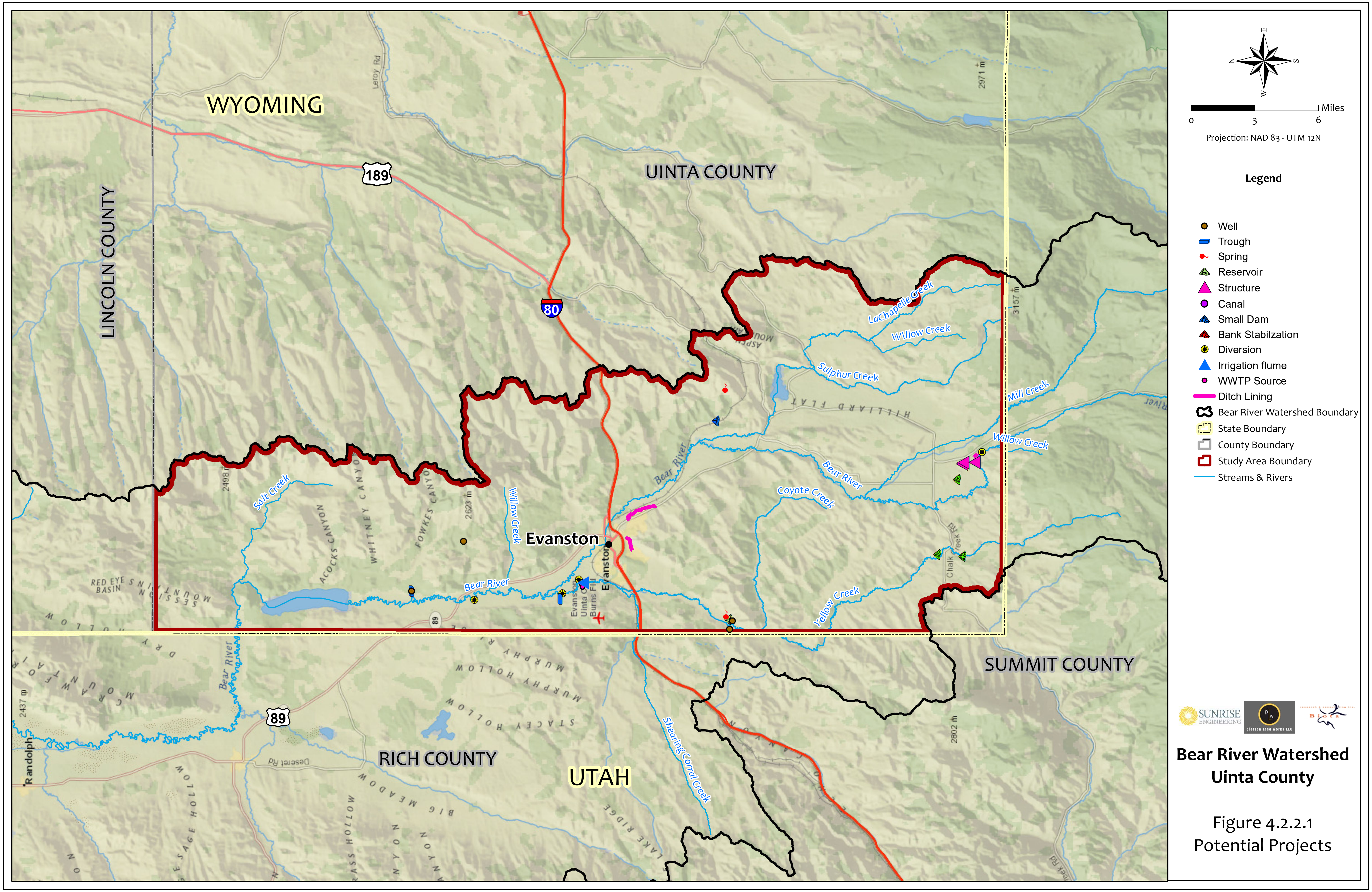
Bear River Watershed

Figure 4.2.2.1
Potential Projects



Bear River Watershed
Lincoln County

Figure 4.2.2.1
Potential Projects



Bear River Watershed
Uinta County

Figure 4.2.2.1
Potential Projects

Several themes or goals common among most of the permit holders are listed below.

Reliability:

Some of the facilities are developed to less than their potential. Consequently, the water becomes scarce sooner than it might otherwise. Springs and earthen catchments identified for improvement are examples of structures that, because of wear and tear, no longer meet their full potential, or were never originally constructed to meet their full potential. In other cases, outdated equipment and corrosion reduce the effective use of the water that is available.

Distribution of sites:

The distance to water limits the use of some areas and also causes lengthy travel distances to water. Additional reliable sources will allow better distribution of animals and reduce travel damage occurring along the current trails. Several of the proposed pipeline projects will also allow a single source to serve multiple troughs and allow isolation of certain troughs to move cattle while still using the same source. This distribution and control will facilitate more even use of natural forage, reduce over grazing and promote regeneration.

Maintenance labor and equipment costs:

Wells and tanks tend to require regular maintenance to insure operation. Spring boxes and catch basins also require maintenance but that effort tends to be at longer intervals of time. Reducing project components and operator effort should be a goal of any design. For instance, if a tank can be allowed to overflow when full, it eliminates the need to shut off a solar source pump and simplifies communication between the tank and pump and the pump controls. Every installation will have unique requirements that determine the level of control.

Plugged troughdrains or overflows are a common issue. During field contacts several operators pointed out that trough overflow lines should be at least three inches to reduce plugging by grass.

Placement of source pumps and storage tanks should be as near to existing roads as possible to provide easy access for construction and maintenance. Trough locations on the other hand are driven by the desired animal distribution and movement patterns.

Permit Risk:

Each of the allotments is at risk of being lost in the future for reasons beyond the control of the current permittee. Threats include a variety of groups with stated and unstated goals. Groups range from those with common goals of improving habitat for wildlife and the public to others with stated opposition to use of public land for grazing, development or resource extraction. Philosophies of future policy makers at the Federal level may at some point be influenced by or support those opposed to use of public lands. Consequently, the permittee may be reluctant to invest significant dollars on a project to repair or improve upland water sources. However, projects to improve watershed health and functionality could arguably help secure future use of allotments.

Wildlife:

Upland stock watering sites provide critical water to Wyoming wildlife. Big game, upland birds, song birds and predators rely on the stock water maintained by the permit holder.

It should be noted that additional opportunities for upland water development and range improvement may exist and should not be assumed to be invalid because they are not included in this report. The projects presented in this report were developed based upon input received from the interested landowners and do not represent a comprehensive list of watershed needs.

The general objective of this effort was to provide 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 county supplements project designs are presented at the conceptual level. It must be kept in mind that these designs are conceptual only and if implemented, detailed design would be required. Figure 4.2.2.1 displays the general location of livestock/wildlife water opportunity projects included in this report. Table 4.2.1 sumarizes cost estimates for the potential projects.

Each of the upland water development projects may involve coordination as appropriate with the NRCS, LCCD, and/or UCCD and the USFS or BLM (if federal lands are involved) in order for construction to occur. Written agreements will be required which define the maintenance responsibility and ownership liability associated with each project.

The BLM and State administer most of the public land on which the proposed upland water projects are located. The maintenance of existing projects generally falls on the permittee. In the case of the BLM, some funds are available to help with major BLM directed maintenance tasks such as relocation of a well or installation of power source. Typically, maintenance activities do not require National Environmental Policy Act (NEPA) review. New projects instigated by the permittee are the permittee’s responsibility. The NEPA must be followed for all projects. The BLM can help with some NEPA tasks and ultimately issues the Decision, however, BLM scheduling may not meet the project goals. Use of a third party to prepare the NEPA documents is an alternative to expedite the process.

4.3 STREAM CHANNEL CONDITION AND STABILITY

The morphologic condition of major stream channels in the basin was assessed during the geomorphic classification and associated results analysis. The Level I classification was completed primarily using remote sensing techniques, and the results should accordingly be viewed as general. Additional assessment of fluvial conditions should be completed in order to precisely identify dominant system processes and inform stabilization efforts at the local scale. The watershed level classification does describe channel conditions throughout the basin, and can be used to inform stakeholders regarding general channel conditions and management strategies.

4.3.1 STREAM CHANNEL STABILITY ASSESSMENT

The classification of valley types provides context for the assessment of channel morphology and stability. This process is feasible because valley types describe boundary conditions, which dictate equilibrium channel conditions. For example, a braided D-type channel located on an active alluvial fan (valley type IIIa) is a typical condition representative of a system that is naturally storing excess sediment. However, a braided D-type channel located in an alluvial valley (valley type VIII) is typical of an unstable system that is not in equilibrium. Typical equilibrium and disequilibrium channel forms are identified by valley type in Table 4.3.1-1 (Rosgen 2012).

Table 4.3.1-1. Typical equilibrium and disequilibrium channel forms associated with various valley types.

Valley Type	Typical Equilibrium Channel Form	Typical Disequilibrium Channel Form
I	A, G	-
II	B	F, G
IIIa	D	A, F, G
IIIb	B	F, G
IV	C, F	-
V	C, D	F, G
VI	A, B, C, F, G	-
VII	A, G	-
VIIIa	B, C, E	A, D, F, G
VIIIb	B, C, E	A, D, F, G
VIIIc	C, E	A, D, F, G
IX	C, D	F, G
X	C, Da, E	F, G

The stability of stream channels in the Bear River watershed study area can be interpreted in the context of setting, or valley type delineations. The project GIS enables review of geomorphic channel form in the context of valley type at georeferenced locations within the study area. Presented information can be used to interpret whether or not a typical equilibrium channel form exists at any given location within the study area based upon valley type. An impaired system that has lost equilibrium with hydrologic, sediment, and/or boundary conditions will undergo an evolutionary trajectory in an attempt to regain equilibrium conditions. An example would be a stable C-type channel that was altered through loss of riparian vegetation. The channel could be expected to widen and become a braided D-type channel due to loss of bank stability. The channel would likely cut through historic meanders and straighten in alignment. The increased slope of the straightened channel would then enable down-cutting and the formation of a G-type channel with excessive hydraulic forces. Additional bank erosion would ensue, and ultimately a high width/depth ratio entrenched F-type channel would result. The F-type channel would lose competence to down-cut through existing substrate, but would continue to erode banks and recruit sediment. Excessive sediment inputs would result in the formation of a constrained inset floodplain, and ultimately the regaining of equilibrium conditions through the creation of a C-type channel at the lowered elevation. This evolutionary scenario is depicted as example 3 in Figure 4.3.1.2, which depicts typical observed channel evolutionary sequences (NRCS 2007).

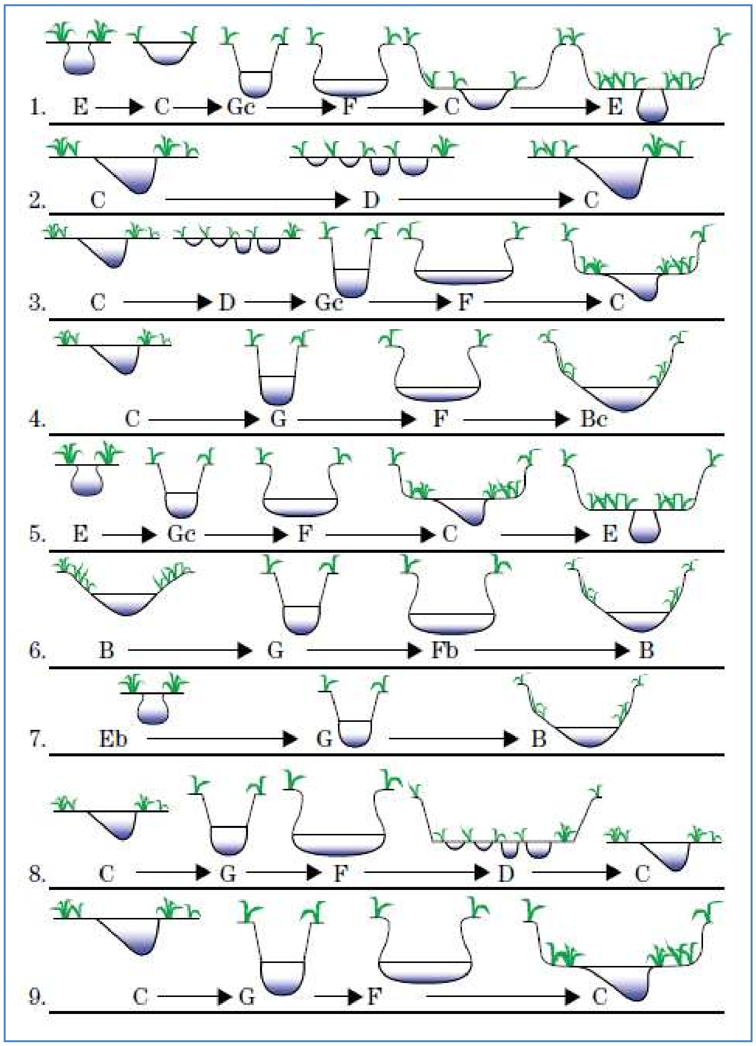


Figure 4.3.1.2 Example evolutionary trajectories in channel form due to initial loss of equilibrium conditions.

Reaches of stream channel that are in disequilibrium based upon interpretation of geomorphic classification in the context of valley type delineation are presented in Figure 4.3.1.2. Identified reaches have morphology indicative of impaired channel function, and are either vertically or laterally unstable. Morphologic areas of concern include nick points, headcuts, channel impingements, and areas of instability identified during the geomorphic classification. Disequilibrium channel reaches and morphological areas of concern are also depicted in Figure 3.4.5.1.4 Geomophic Stream Classifications.

4.3.2 STREAM CHANNEL RESTORATION STRATEGIES

Extensive restoration and enhancement strategies have been developed and reviewed in the fluvial geomorphologic literature. Stream reaches identified as being in disequilibrium during the geomorphic classification represent precise locations where future channel improvement efforts could be pursued. Implementation of restoration efforts would involve the reconstruction of a specific channel form that would be in morphologic equilibrium with hydrologic and sediment inputs. Such efforts require a comprehensive survey, modeling, and design work at the reach scale, and should be conducted by practitioners with extensive experience in river restoration science. A less comprehensive approach to river restoration is to implement isolated treatments to improve and stabilize impaired conditions. However, such treatments should be designed in the context of existing channel form, the likely scenario of channel evolution, and the potential future equilibrium channel morphology. Numerous treatment strategies exist to stabilize stream channels, but all treatment types are not universally appropriate for application within all channel forms. Tables 4.3.2.1 and 4.3.2.2 describe the relative appropriateness of instream treatments based upon morphologic channel type (Rosgen 1996).

Tables 4.3.2.1. Applicability of instream restoration and stabilization treatments by Rosgen channel type.

Channel Type	Gravel Traps, V shaped	Gravel Traps, Log	Cross Vane	W-Weir	Root Wad Bank Stabilization	J-Hook, Hybrid Vanes	Toe Wood
B1	Excellent	Excellent	Good	Good	n/a	n/a	n/a
B2	Good	Good	n/a	n/a	n/a	n/a	n/a
B3	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
B4	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
B5	Poor	Poor	Good	Excellent	Excellent	Good	Excellent
B6	Poor	Poor	Good	Good	Excellent	Excellent	Excellent
C1	Good	Good	Good	Good	Excellent	Good	Excellent
C2	Excellent	Excellent	n/a	n/a	Excellent	Good	Excellent
C3	n/a	n/a	Excellent	Excellent	Excellent	Excellent	Excellent
C4	Poor	Poor	Excellent	Good	Excellent	Excellent	Excellent
C5	Poor	Poor	Good	Fair	Excellent	Good	Excellent
C6	Poor	Poor	Good	Good	Excellent	Good	Excellent
D3	Poor	Poor	Poor	Poor	Fair	Fair	Good
D4	n/a	Poor	Poor	Poor	Fair	Fair	Good
D5	Poor	Poor	Poor	Poor	Fair	Fair	Good
D6	Poor	Poor	Poor	Poor	Fair	Fair	Good
E3	Fair	Fair	Good	n/a	Good	Good	Fair
E4	n/a	n/a	Good	n/a	Good	Good	Fair
E5	Poor	Poor	Good	n/a	Good	Good	Fair
E6	Poor	Poor	Good	n/a	Good	Good	Fair
F1	Poor	Poor	n/a	n/a	n/a	n/a	n/a
F2	Fair	Fair	n/a	n/a	n/a	n/a	n/a
F3	Fair	Fair	Good	Fair	Good	Good	Fair
F4	n/a	n/a	Good	Fair	Good	Good	Fair
F5	Poor	Poor	Good	Fair	Good	Good	Fair
F6	Poor	Poor	Good	Fair	Good	Good	Fair
G1	n/a	n/a	n/a	n/a	n/a	n/a	n/a
G2	n/a	n/a	n/a	n/a	n/a	n/a	n/a
G3	Poor	Poor	Good	Poor	Good	Fair	Poor
G4	Poor	Poor	Good	Poor	Good	Fair	Poor
G5	Poor	Poor	Good	Poor	Good	Fair	Poor
G6	Poor	Poor	Good	Poor	Good	Fair	Poor

Tables 4.3.2.2. Applicability of instream restoration and stabilization treatments by Rosgen channel type.

Channel Type	Low Stage Check Dam	Medium Stage Check Dam	Boulder Placement	Single Wing Deflector	Double Wing Deflector	Channel Constrictor	Bank Cover
B1	Poor	Poor	Poor	Poor	Poor	Poor	Excellent
B2	Excellent	Excellent	n/a	Excellent	Excellent	Excellent	Excellent
B3	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent
B4	Excellent	Good	Excellent	Excellent	Excellent	Excellent	Excellent
B5	Good	Fair	Fair	Good	Good	Good	Excellent
B6	Good	Fair	Fair	Good	Good	Good	Excellent
C1	Poor	Poor	Poor	Poor	Poor	Poor	Excellent
C2	Good	Fair	n/a	Good	Good	Good	Good
C3	Good	Fair	Good	Good	Good	Good	Good
C4	Fair	Poor	Poor	Fair	Fair	Fair	Good
C5	Fair	Poor	Poor	Poor	Poor	Poor	Fair
C6	Fair	Poor	Poor	Poor	Poor	Fair	Good
D3	Poor	Poor	Poor	Fair	Fair	Fair	Poor
D4	Poor	Poor	Poor	Fair	Fair	Fair	Poor
D5	Poor	Poor	Poor	Fair	Fair	Fair	Poor
D6	Poor	Poor	Poor	Fair	Fair	Fair	Poor
E3	n/a	Poor	Poor	Poor	Fair	n/a	n/a
E4	n/a	Poor	Poor	Poor	Fair	n/a	n/a
E5	n/a	Poor	Poor	Poor	Fair	n/a	n/a
E6	n/a	Poor	Poor	Poor	Fair	n/a	n/a
F1	Poor	Poor	Poor	Fair	Poor	Poor	Fair
F2	Fair	Poor	n/a	Fair	Fair	Fair	Fair
F3	Fair	Poor	Fair	Good	Good	Fair	Fair
F4	Fair	Poor	Poor	Good	Fair	Fair	Fair
F5	Fair	Poor	Poor	Fair	Fair	Fair	Fair
F6	Fair	Poor	Fair	Fair	Fair	Fair	Fair
G1	n/a	n/a	Poor	n/a	n/a	n/a	Poor
G2	n/a	n/a	n/a	n/a	n/a	n/a	Poor
G3	Fair	Poor	Poor	Poor	Fair	n/a	Poor
G4	Fair	Poor	Poor	Poor	Fair	n/a	Poor
G5	Fair	Poor	Poor	Poor	Fair	n/a	Poor
G6	Fair	Poor	Poor	Poor	Fair	n/a	Poor

The following photos, 4.3.2.1 to 4.3.2.5, illustrate several restoration strategies having application in the Bear River Watershed.

Photo 4.3.2.1 Instream treatment example: W-weir.

Photo 4.3.2.2 Instream treatment example: rock cross vanes.

Photo 4.3.2.3 Instream treatment example: rock J-hook vane.

Photo 4.3.2.4 Instream treatment example: root wad revetment and bank cover.

Photo 4.3.2.5 Instream treatment example: root wad revetment and rock barb.

4.4 GRAZING MANAGEMENT OPPORTUNITIES

4.4.1 ECOLOGICAL STATE AND TRANSITION MODELS

State-and-transition models illustrate the plant communities that typically occur on ecological sites and expected transitions between these communities (states) due to ecological disturbances or changes in management practices. These models are management focused models that provide a framework for organizing current understanding of potential ecosystem dynamics and aid in understanding the response of rangeland ecosystems to natural (e.g., climatic events or fire) and/or management-induced (e.g., farming, grazing, or burning) disturbances. State-and-transition models are included in the ESDs for each ecological site.

State-and-transition model diagrams illustrate the “phases” (common plant communities) and “states” (aggregations of those plant communities) that can occur on the site. The plant communities shown in these models may not represent every possibility, but are probably the most prevalent and recurring plant communities. Differences between phases and states depend primarily upon observations of a range of disturbance histories in areas where the ESD is represented. These situations include grazing gradients to water sources, fence-line contrasts, patches with differing dates of fire, herbicide treatment, tillage, etc.

The major successional pathways within states, (“community pathways”) are indicated by arrows between phases. “Transitions” are indicated by arrows between states. The drivers of these changes are indicated in codes that area defined in the legend below the diagram and by reading the detailed narratives that follow the diagram.

The Historic Climax Plant Community (HCPC) for a state-and-transition model is typically determined by expert study of rangeland relic areas, or areas protected from excessive disturbance, as well as trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts. In areas where the HCPC is difficult to determine, a Reference State that illustrates the common plant communities that probably existed just prior to European settlement is used in place of the HCPC.

State-and-transition models for the 3 most prominent ecological sites within the mapped portions of the study area are provided below along with a description from the respective ESD report.

Mountain Loam (Mountain Big Sagebrush)

The most abundant ecological site in the watershed is Mountain Loam (Mountain Big Sagebrush). It is impossible to determine in any quantitative detail the HCPC for this ecological site because of the lack of direct historical documentation preceding all human influence. The Reference State is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans.

State 1: Mountain Big Sagebrush-Steppe

The description of the Reference State (State 1 on Figure 4.4.1.1) was determined by NRCS Soil Survey Type Site Location information and familiarity with rangeland relict areas where they exist. The least modified plant community would have been co-dominated by mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*) and a mixture of herbaceous species. Dominant grasses would have included bluebunch wheatgrass (*Pseudoroegneria spicata*), and basin wildrye (*Leymus cinereus*), and forbs would have included sticky purple geranium (*Geranium viscosissimum*), shortstem buckwheat (*Eriogonum brevicaule*), and lupines (*Lupinus caudatus ssp. caudatus* and *L. argenteus*), among others.

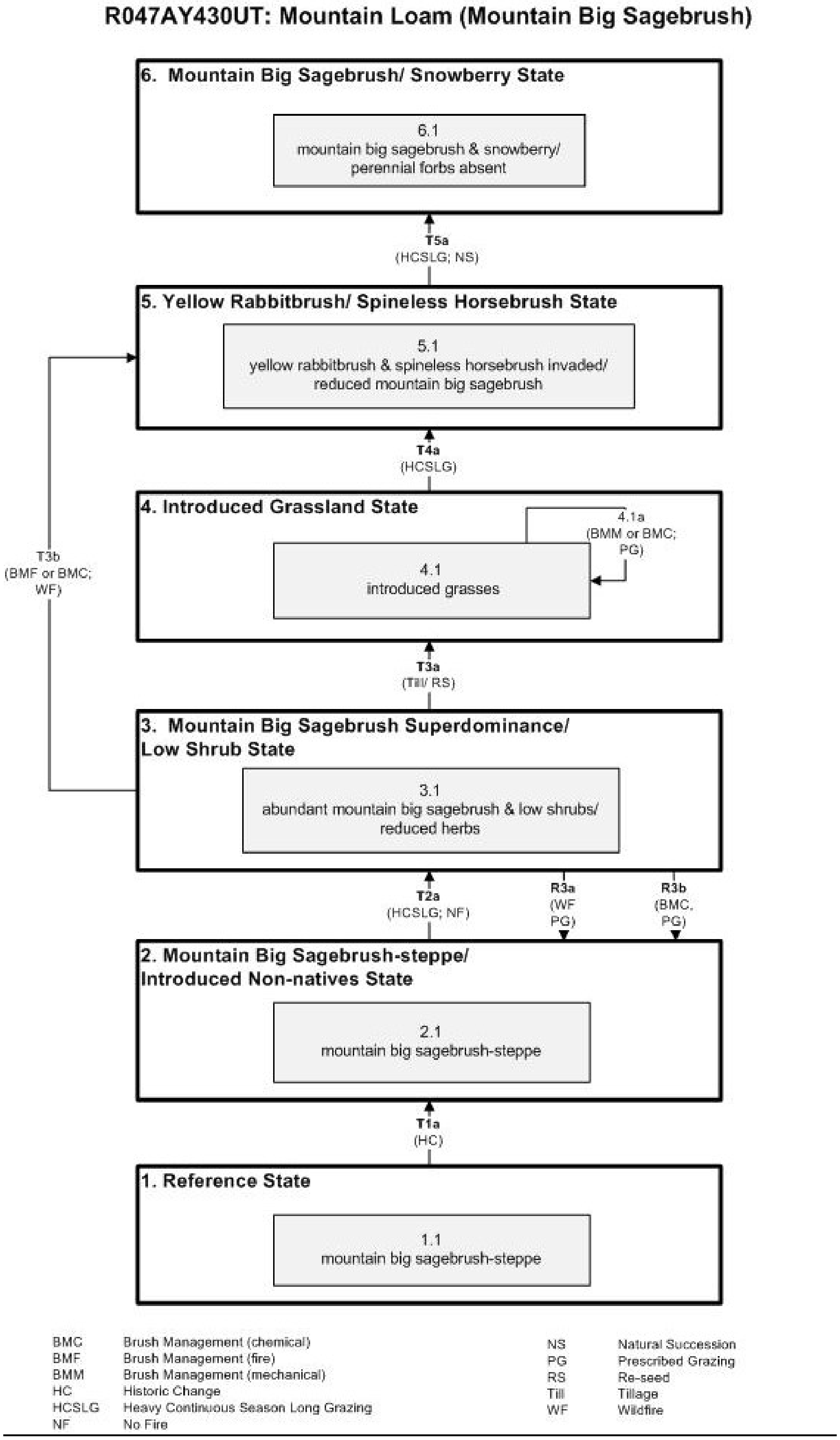


Figure 4.4.1.1. State-and-transition model diagram for the Mountain Loam (Mountain Big Sagebrush) site.

Community Phase 1.1 (Mountain big sagebrush-steppe): This plant community would have been characterized by a co-dominance of mountain big sagebrush with a rich and productive herbaceous understory.

Transition T1a [from State 1 (Reference State) to State 2 (Mountain Big Sagebrush-Steppe/ Introduced Non-natives State)]:The simultaneous introduction of exotic species, both plants and animals, possible extinctions of native flora and fauna, and climate change has caused State 1 to transition to State 2. Reversal of such historic changes (i.e., a return pathway) back to State 1 is not practical because of the naturalization of exotic species of both flora and fauna, possible extinction of native species, and climate change. There may have also been accelerated soil erosion.

State 2: Mountain Big Sagebrush-Steppe/Non-natives

State 2 is identical to State 1 in form and function, with the exception of the presence of non-native plants and animals, possible extinctions of native species, and a different climate. State 2 is a description of the ecological site shortly following Euro-American settlement. This state can be regarded as the current potential. This is a shrub-steppe community where there is a co-dominance between mountain big sagebrush (and other minor shrubs) and a rather diverse mixture of herbaceous species. Dominant grasses are bluebunch wheatgrass and basin wildrye, and forbs include sticky purple geranium, shortstem buckwheat, and lupine species, among others. A small component of non-natives will also be present. The resiliency of this state is maintained by a healthy, productive, and diverse plant community that can provide native seed sources and promotes soil stability, water infiltration, and soil moisture retention. Wildfire may also play a role in maintaining the balance between shrubs and herbs. The resiliency of this state will also be maintained by appropriate stocking rates and season of use. Conversely, heavy continuous season-long livestock grazing and accelerated soil erosion will negatively impact the resiliency of this State.

Community Phase 2.1 (Mountain big sagebrush-steppe): This plant community is characterized by co-dominance of mountain big sagebrush and a rich and productive understory.

Transition T2a [from State 2 (Mountain Big Sagebrush-steppe/Introduced Non-natives State) to State 3 (Mountain Big Sagebrush Super-dominance/Low Shrub State)]: Lack of fire and continued heavy livestock grazing during the growing season of grasses will cause a transition into the Mountain Big Sagebrush Super-dominance/Low Shrub State. The approach to this transition is indicated by a loss of perennial grass understory, an increase in the shrub component relative to grasses, and the bare soil exposure between shrubs and/or other evidence of accelerated soil erosion. The transition is triggered by sustained, heavy season-long grazing.

State 3: Mountain Big Sagebrush Superdominance/Low Shrub

In the absence of fire, and with continued impacts from heavy livestock grazing, the native grasses will markedly decrease, allowing the shrubs, mainly mountain big sagebrush, to become super-dominant and take over the site. Some low shrubs such yellow rabbitbrush (*Chrysothamnus viscidiflorus ssp. viscidiflorus*), broom snakeweed (*Gutierrezia sarothrae*), and spineless horsebrush (*Tetradymia canescens*) may also increase. The stability of this state is maintained by the lack of a healthy, productive and diverse herb component capable of providing native seed source, soil stabilization, and soil moisture retention. The abundance of sagebrush seed source and lack of fire will also serve to maintain this state. Appropriate livestock grazing (i.e., correct stocking rate, timing, etc.) will help maintain the resiliency of this state, but continuous heavy livestock grazing will negatively impact the resiliency of the state.

Community Phase 3.1 (abundant mountain big sagebrush & low shrubs/reduced herbs): This plant community is characterized by a dramatic increase in mountain big sagebrush with low shrubs replacing some of the perennial herbaceous component in the understory.

Transition T3a [from State 3 (Mountain Big Sagebrush Super-dominance/Low Shrub State) to State 4 (Introduced Grassland State)]: This transition occurs when a decision is made to increase forage production by tilling and re-seeding with intermediate wheatgrass (*Thinopyrum intermedium*), smooth brome (*Bromus inermis*), or orchardgrass (*Dactylis glomerata*).

Transition T3b [from State 3 (Mountain Big Sagebrush Super-dominance/ Low Shrub State) to State 5 (Yellow Rabbitbrush/ Spineless Horsebrush State)]: Wildfire or brush management, either by mechanical means or prescribed fire, will temporarily remove the mountain big sagebrush. However, an increase in yellow rabbitbrush or other root-sprouting shrubs such as spineless horsebrush will follow the removal of sagebrush in most circumstances. The herbaceous component may also increase after fire or brush beating.

Restoration Pathway R3a [from State 3 (Mountain Big Sagebrush Super-dominance/Low Shrub State) to State 2 (Mountain Big Sagebrush-steppe/Introduced Non-natives State): Wildfire combined with prescribed grazing during only part of the non-growing season of the grasses and forbs will remove much of the dense sagebrush and allow the native perennial herbaceous species to re-establish.

Restoration Pathway R3b [from State 3 (Mountain Big Sagebrush Super-dominance/Low Shrub State) to State 2 (Mountain Big Sagebrush-steppe/Introduced Non-natives State): Application of 2, 4-D™ combined with prescribed grazing during the non-growing season of the grasses and forbs will also remove much of the dense sagebrush and allow the native perennial herbaceous species to re-establish.

State 4: Introduced Grassland

State 4 is characterized by the dominance of seeded grasses such as intermediate wheatgrass, smooth brome, or orchardgrass. This state occurs when a decision is made to increase forage production by tilling and re-seeding introduced grasses. Periodic brush management is required to maintain the grass-dominance of this state. This resiliency of this state can be maintained by moderate grazing, high intensity short duration use. Conversely, continued heavy use will result in accelerated soil erosion and negatively impact the resiliency.

Community Phase 4.1 (introduced grasses): This plant community is dominated by seeded species such as intermediate wheatgrass, smooth brome, or orchardgrass. Because of the depletion of native grass seed reserves, it is common for introduced grasses that have not been seeded in these areas, such as bulbous bluegrass (*Poa bulbosa*), to establish.

Community Pathway 4.1a: Periodic shrub control or brush management will be necessary to maintain grass dominance by either chemical or mechanical means, provided any livestock grazing is less than ¾ of the current annual growth.

Transition T4a [from State 4 (Introduced Grassland State) to State 5 (Yellow Rabbitbrush/ Spineless Horsebrush State): Heavy, continuous, season-long grazing will reduce the herbaceous component, allowing the fast-growing unpalatable shrubs to re-establish. The approach to this transition is indicated by a diminishment of grass vigor and an increase in shrub seedlings. This transition is triggered by excessive or improperly timed grazing of grasses.

State 5: Yellow Rabbitbrush/Spineless Horsebrush

The shrub component of State 5 is characterized by an increased amount of root-sprouting shrubs such as yellow rabbitbrush and spineless horsebrush, and a reduction in mountain big sagebrush as a result of sagebrush removal by pyric (fire) or chemical means. The stability of this state is maintained by the lack of sagebrush and the lack of a productive herbaceous component capable of providing native seed source. Proper livestock grazing (i.e., correct stocking rates and timing, etc.) will help maintain the resiliency of this community, but heavy season long livestock grazing will negatively impact its resiliency.

Community Phase 5.1 (yellow rabbitbrush & spineless horsebrush invaded/reduced mountain big sagebrush): The shrub component of this phase is characterized by an increased amount of root-sprouting shrubs such as yellow rabbitbrush and spineless horsebrush, and a reduction in mountain big sagebrush as a result of sagebrush removal by pyric (fire) or chemical means.

Transition T5a [from State 5 (Yellow rabbitbrush/Spineless horsebrush State) to State 6 (Mountain Big Sagebrush/Snowberry Super-dominance State): Shrubs, mainly mountain big sagebrush and mountain snowberry (*Symphoricarpos oreophilus*), will come to dominate the community through natural succession as the length of time increases since the last shrub-killing disturbance. The approach to this transition is indicated by the presence of only older yellow rabbitbrush and spineless horsebrush, and the presence of sagebrush and snowberry seedlings. The trigger causing this transition is heavy, season-long grazing combined with natural succession.

State 6: Mountain Big Sagebrush/Snowberry

State 6 is characterized by the dominance of mountain big sagebrush and snowberry and is the result of natural succession combined with continuous, heavy, season-long grazing. The shrub dominance is maintained by abundant shrub seed source and the lack of herb seed source. The stability of this state is also partially maintained by the fact that the longer-lived shrubs serve to protect the soil and provide abundant litter. Heavy, season-long livestock grazing will negatively impact the resiliency of this state. Earlier sheep grazing may have reduced the forb component to the extent that introduced grasses become established in the plant community in their place.

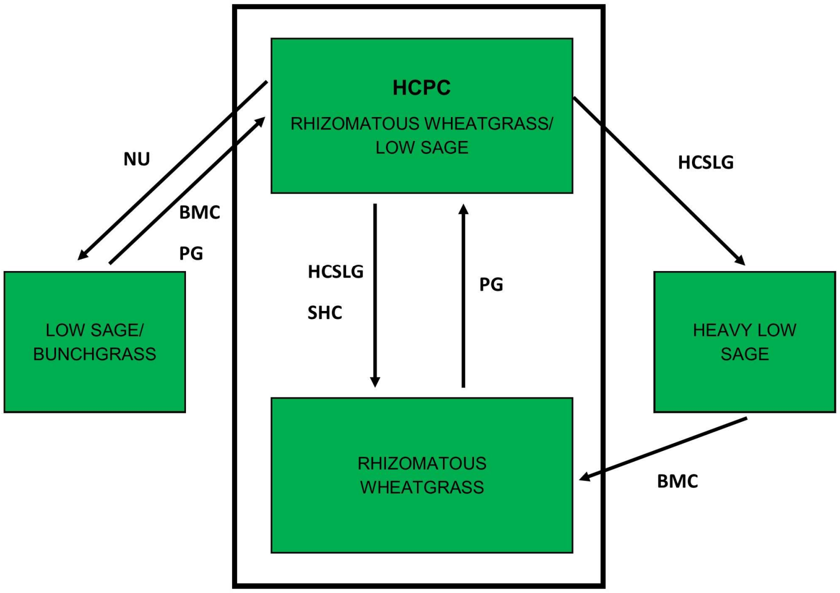
Community Phase 6.1 (mountain big sagebrush & snowberry/perennial forbs absent): This state is characterized by the dominance of mountain big sagebrush and snowberry that is the result of natural succession combined with continuous heavy season long grazing. Earlier sheep grazing may have reduced the forb component such that introduced grasses become established in the plant community.

Dense Clay 10”-14” Precipitation Zone (Foothills and Basins West)

The HCPC for this site has been determined by study of rangeland relic areas, or areas protected from excessive disturbance. Trends in plant communities going from heavily grazed areas to lightly grazed areas, seasonal use pastures, and historical accounts have also been used.

State 1: Rhizomatous Wheatgrass/Low Sagebrush (HCPC)

The interpretive plant community (Figure 4.4.1.2) for this site is the Historic Climax Plant Community. This state evolved with grazing by large herbivores and is suited for grazing by domestic livestock. Potential vegetation is estimated at 70% grasses or grass-like plants, 10% forbs and 20% woody plants. The major grasses include rhizomatous wheatgrasses, bottlebrush squirreltail, and mutton bluegrass. Other grasses and grass-like plants may include prairie junegrass, Indian ricegrass, plains reedgrass, and Canby and Sandberg bluegrass. Low sagebrush is the major woody plant. Other woody plants that may occur include early sagebrush, green rabbitbrush, and winterfat. A typical plant composition for this state consists of rhizomatous wheatgrass 30-40%, bottlebrush squirreltail 5-15%, mutton bluegrass 5-10%, other grasses and grass-like plants 10-20%, perennial forbs 5-15%, low sagebrush 10-20%, and 5-10% other woody species. Ground cover, by ocular estimate, varies from 55-60%. The total annual production (air-dry weight) of this state is about 750 pounds per acre, but it can range from about 450 lbs./acre in unfavorable years to about 1000 lbs./acre in above average years. This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).



BMC - Brush Management (chemical)
HCSLG - Heavy Continuous Season-long Grazing
NU - Nonuse
PG - Prescribed Grazing
SHC - Severe Hoof Compaction

Figure 4.4.1.2. State-and-transition model diagram for the Dense Clay (Foothills and Mountains West) site.

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

- Nonuse will convert this plant community to the Low Sagebush/Bunchgrass State.
- Heavy Continuous Season-long Grazing and/or Severe Hoof Compaction will convert this plant community to the Rhizomatous Wheatgrass State.
- Heavy Continuous Season-long Grazing will convert this plant community to the Heavy Low Sagebrush State.

State 2: Low Sagebrush/Bunchgrass

This state is the result of protection from grazing. Low sagebrush dominates with annual production often exceeding 20%, and herbaceous forage production is decreased. The understory of grass includes rhizomatous wheatgrass, Indian ricegrass, bottlebrush squirreltail, and mutton bluegrass. The total annual production (air-dry weight) of this state is about 650 pounds per acre, but it can range from about 400 lbs/acre in unfavorable years to about 900 lbs/acre in above average years. The site is not protected from erosion due to excessive amounts of bare ground. The biotic integrity of this plant community is not intact, due to the invasion of greasewood, cheatgrass, and excessive bare ground. The state is stable. The biotic integrity of this plant community is usually intact, however forage value will decrease and wildlife values will shift toward different species. The watershed is functioning. Chemical brush management followed by 1 to 2 years deferment as part of a prescribed grazing plan will result in a plant community very similar to the HCPC (Rhizomatous Wheatgrass/Low Sagebrush State).

State 3: Rhizomatous Wheatgrass

This state is the result of brush management and/or improper grazing techniques involving severe hoof compaction of heavy clay soils. Shrubs have been removed, and rhizomatous wheatgrass is the dominant and sometimes the only species present. There is a substantial amount of bare ground. Phlox is a common forb on this site. The total annual production (air-dry weight) of this state is about 500 pounds per acre, but it can range from about 300 lbs/acre in unfavorable years to about 700 lbs/acre in above average years. The soil is not protected and erosion will increase if management is not changed. The biotic integrity may be reduced due to low vegetative production and plant diversity. The watershed is functioning at risk. Prescribed Grazing will result in a plant community very similar to the HCPC (Rhizomatous Wheatgrass/Low Sagebrush State).

State 4: Heavy Low Sagebrush

This state is the result of improper grazing. Low sagebrush dominates with annual production often exceeding 30-60%. There is mostly bare ground between sagebrush plants with an understory of grass and forbs limited to the protected areas under shrubs. The major grasses include Sandberg bluegrass and rhizomatous wheatgrass. The total annual production (air-dry weight) of this state is about 300 pounds per acre, but it can range from about 100 lbs/acre in unfavorable years to about 400 lbs/acre in above average years. Soil erosion is accelerated because of increased bare ground. The biotic community has been compromised, but is relatively stable. The watershed is functioning, but is at risk of further degradation. Water flow patterns and pedestals are obvious. Infiltration is reduced and runoff is increased. Chemical Brush Management will convert this plant community to the Rhizomatous Wheatgrass State.

Mountain Shallow Loam (Mountain Big Sagebrush)

As with the Mountain Loam site, it is impossible to determine in any quantitative detail the HCPC for the Mountain Shallow Loam site because of a lack of direct historical documentation preceding all human influence. The Reference State is a description of this ecological site just prior to Euro-American settlement but long after the arrival of Native Americans.

State 1: Scattered Lower Stature Mountain Big Sagebrush/Patchy Native Perennial Grasses and Forbs

The Reference State (State 1 on Figure 4.4.1.3) would have been dominated by a scattering of lower-statured mountain big sagebrush (*Artemisia tridentata ssp. vaseyana*) and a mixture of relatively patchy herbaceous species. Antelope bitterbrush (*Purshia tridentata*) and mountain snowberry (*Symphoricarpos oreophilus*) would have been present but less common shrub associates. Dominant grasses would have included bluebunch wheatgrass (*Pseudoroegneria spicata*), muttongrass (*Poa fendleriana*), and Columbia needlegrass (*Achnatherum nelsonii*), and forbs would have included tapertip hawksbeard (*Crepis acuminata*), arrowleaf balsamroot (*Balsamorhiza sagittata*), sticky purple geranium (*Geranium viscosissimum*), and shortstem buckwheat (*Eriogonum brevicaule*), among others.

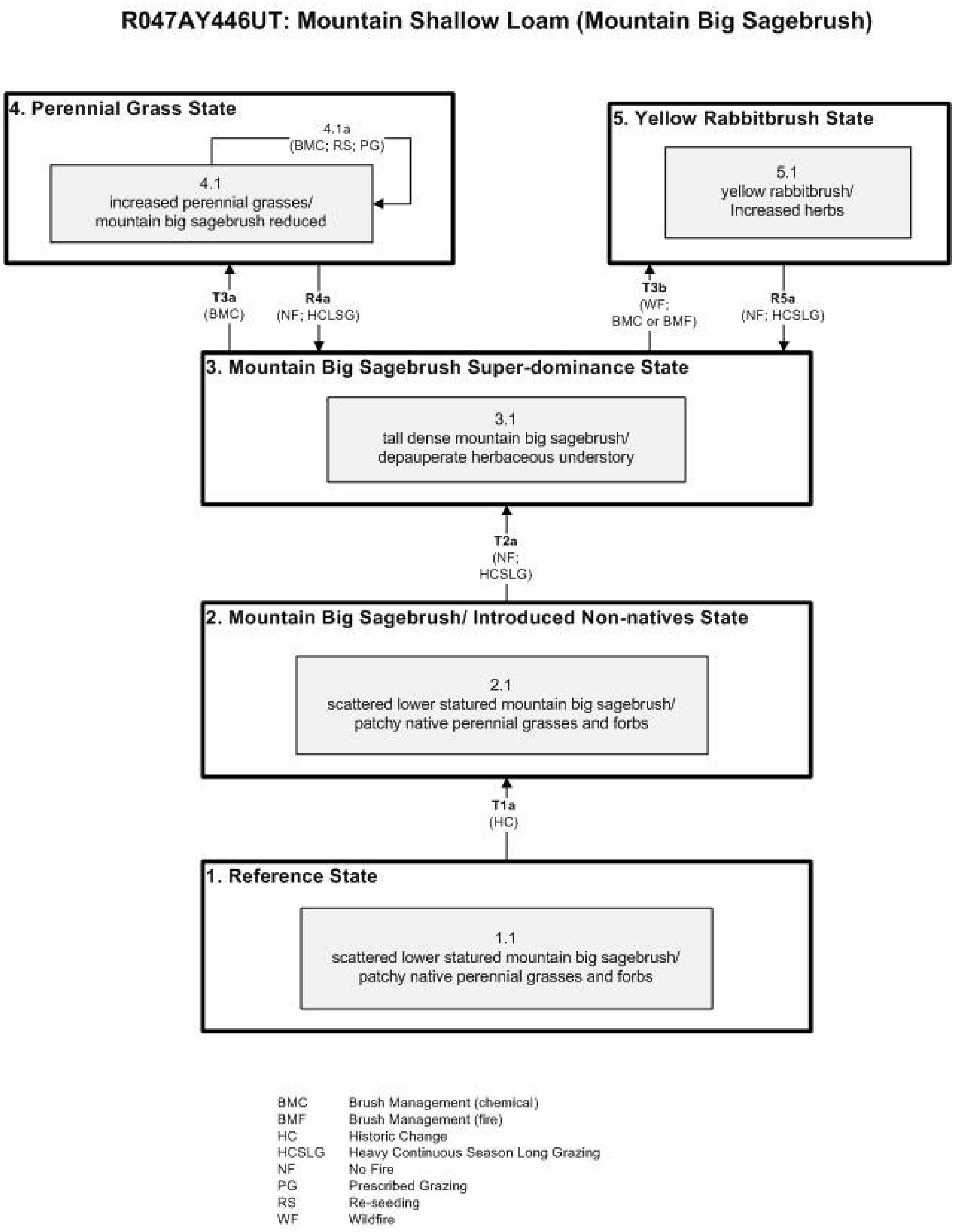


Figure 4.4.1.3. A graphical depiction of the state and transition model for the Mountain Shallow Loam (Mountain Big Sagebrush) site.

Community Phase 1.1 (scattered lower statured mountain big sagebrush/ patchy native perennial grasses and forbs): This plant community would have been characterized by a scattering of lower-statured mountain big sagebrush and a relatively patchy herbaceous understory.

Transition T1a [from State 1 (Reference State) to State 2 (Mountain Big Sagebrush/ Introduced Non-natives State)]: The simultaneous introduction of exotic species, both plants and animals, possible extinctions of native flora and fauna, and climate change has caused State 1 to transition to State 2. Reversal of such historic changes (i.e., a return pathway) back to State 1 is not practical.

State 2: Mountain Big Sagebrush-Steppe/Introduced Non-natives

State 2 is identical to State 1 in form and function, with the exception of the presence of non-native plants and animals, possible extinctions of native species, and a different climate. State 2 is a description of the ecological site shortly following Euro-American settlement. This state can be regarded as the current potential. This state is characterized by somewhat scattered mountain big sagebrush, antelope bitterbrush, and other minor shrubs with a mixture of herbaceous species. Dominant grasses are western wheatgrass (*Pascopyrum smithii*), with bluebunch wheatgrass, muttongrass, and Columbia needlegrass being slightly diminished from the Reference State. Forbs include tapertip hawksbeard, arrowleaf balsamroot, and sticky purple geranium, among others. A small component of non-natives will also be present. The resiliency of this state is maintained by a healthy, productive, and diverse plant community that can provide native seed sources and promotes soil stability, water infiltration, and soil moisture retention. Wildfire may also play a role in maintaining the balance between shrubs and herbs. The resiliency of this state will be maintained by a reduction in livestock numbers and season of use. Conversely, heavy continuous season long livestock and/or big game grazing will negatively impact the resiliency of this State.

Community Phase 2.1 (scattered lower statured mountain big sagebrush/ patchy native perennial grasses and forbs): This plant community is characterized by a scattering of lower-statured mountain big sagebrush and a relatively patchy herbaceous understory.

Transition T2a: [from State 2 (Mountain Big Sagebrush/ Introduced Non-natives State) to State 3 (Mountain Big Sagebrush Super-dominance State)]: Lack of fire and continued heavy livestock grazing during the growing season of grasses can cause a transition into Mountain Big Sagebrush Super-dominance State. The approach to this transition is indicated by a loss of the perennial grass understory, an increase in the shrub component relative to the grasses, and an increase in bare soil exposed between the perennials. This transition is triggered by sustained heavy grazing in the growing season by livestock and big game use in winter.

State 3: Mountain Big Sagebrush Superdominance

In the absence of fire, but with continued heavy impacts from livestock grazing, the native herbaceous understory will markedly decrease, allowing the shrubs, mainly mountain big sagebrush, to become super-dominant and take over the site. The stability of this state is maintained by the abundance of seed source for sagebrush and other shrubs, and the lack of seed source for native perennial herbs, and possibly by soil erosion. The resiliency of this state can be maintained by reductions in animal numbers and seasons of use as long as soils are largely intact. Conversely, heavy, season-long grazing by livestock and big game will negatively impact the resiliency of this state.

Community Phase 3.1 (tall dense mountain big sagebrush/depauperate herbaceous understory): This plant community is characterized by having tall, dense mountain big sagebrush with a dramatically reduced perennial herbaceous understory.

Transition T3a [from State 3 (Mountain Big Sagebrush Super-dominance State) to State 4 (Native Perennial Grass State)]: With the application of 2, 4-D or spike, it may be possible to reduce the shrub layer and allow the perennial grasses to re-establish.

Transition T3b [from State 3 (Mountain Big Sagebrush Super-dominance State) to State 5 (Yellow Rabbitbrush State)]: Wildfire or brush management, either by mechanical means or prescribed fire, will temporarily remove the mountain big sagebrush. However, an increase in yellow rabbitbrush (*Chrysothamnus viscidiflorus*) will follow the removal of sagebrush in most circumstances. The herbaceous component may also increase after fire or brush beating. The approach to this transition is indicated by the loss of desirable perennial species and a build-up of fuel loads. This transition is triggered by wildfire or brush removal by mechanical or pyric (fire) means.

State 4: Perennial Grass
Perennial grasses will temporarily dominate the site if chemicals (e.g. 2, 4-D, spike) are used to reduce the shrub component. This grass-dominated plant community can be sustained by re-application of chemical, re-seeding when necessary, and moderating the grazing by livestock during the growing season. Fire control combined with continuous heavy season long grazing will allow the site to eventually return to State 3.

Community Phase 4.1 (Increased perennial grasses/mountain big sagebrush reduced): This plant community is dominated by perennial grasses, which increase following the chemical reduction of mountain big sagebrush.

Community Pathway 4.1a: Periodic shrub control will be necessary to maintain grass dominance by re-application of chemicals, provided any livestock grazing is sustainable as shown by monitoring.

Restoration Pathway R4a [from State 4 (Native Perennial Grass State) to State 3 (Mountain Big Sagebrush Super-dominance State)]: Fire control and heavy grazing will allow sagebrush to eventually re-establish, allowing the plant community to return to State 3.

State 5: Yellow Rabbitbrush
Yellow rabbitbrush and some herbaceous species such as bluebunch wheatgrass, muttongrass, western wheatgrass and squirreltail (*Elymus elymoides*) will increase following fire, whether prescribed or wild, and/or chemical removal of mountain big sagebrush. This state will be maintained by the recurrence of wildfire at short intervals, assuming that soils are largely intact. Fire control combined with continuous heavy season-long grazing will allow the site to eventually return to State 3.

Community Phase 5.1 (Yellow rabbitbrush/ Increased herbs): This plant community is dominated by yellow rabbitbrush and a suite of hearty herbaceous-disturbance followers such as squirreltail, prairie Junegrass (*Koeleria macrantha*), Nevada/Sandberg bluegrass (*Poa secunda*), hawksbeard (*Crepis spp.*), blue flax (*Linum perenne*), and common yarrow (*Achillea millefolium*).

Restoration Pathway R5a [from State 5 (Yellow rabbitbrush State) to State 3 (Mountain Big Sagebrush Super-dominance State)]: Fire control and heavy grazing will allow sagebrush to eventually re-establish, allowing the plant community to return to State 3.

4.4.2 RANGE AND GRAZING MANAGEMENT CONSIDERATIONS

In the sagebrush grasslands of the arid west, livestock use is often concentrated around watering areas and lush palatable vegetation (i.e., riparian zones). Implementing certain Best Management Practices (BMPs) can help to disperse livestock, graze underutilized areas, and reduce pressure on riparian zones. Environmental conditions and constraints vary amongst allotments, but the following BMPs can be implemented in concert with the ESD state and transition models to improve range health:

1. Upland (i.e., off-site) livestock watering systems;
2. Strategic salting and/or herding;
3. Riparian fences to exclude livestock from, or manage livestock use of, riparian areas;
4. Pasture fences or cross-fences to facilitate rotational grazing systems;
5. Prescribed fire; and
6. Chemical brush control.

Many of these management practices are mutually beneficial for livestock, range condition, and wildlife. It is important to consider the impacts of any range improvement project on wildlife and wildlife habitat, especially in sensitive habitats. Some range improvement projects can unintentionally have adverse effects on wildlife habitat. For example, the installation of certain types of fence can increase the chance of certain species of wildlife becoming entangled. Adding a smooth top wire or rail to the fence will help to mitigate these impacts. Another example of a wildlife friendly range improvement project involves the addition of escape ramps to stock watering tanks.

There are many different types and applications of upland water developments for livestock, and the particular design that is selected depends on needs, local conditions, and available funding. Upland livestock watering systems identified during this study include spring developments, wells, pumps, tanks, diversions, and gravity feed systems.

Strategic salting and active herding can be used to direct livestock to the most underutilized areas in a pasture of allotment. The most desirable areas are often grazed so heavily that individual plants do not have time to replenish nutrients and energy reserves between grazing episodes. Strategic salting and active herding can reduce grazing pressure on the areas that have the most concentrated use, and allow root system reserves to be replenished in these areas.

4.5 OTHER UPLAND MANAGEMENT OPPORTUNITIES

4.5.1 PRESCRIBED FIRE

The native vegetation communities of the entire watershed study area evolved as dynamic landscapes influenced by wildfire of varying degrees of intensity. Active fire suppression and historic land management including intensive livestock grazing have impacted stand diversity and productivity in forested, shrub steppe, and grassland-dominated community types. Dense, often monotypic stands of vegetation with depleted understory diversity and herbaceous productivity have resulted. Large stand replacing fires historically were an important source of landscape heterogeneity, introducing a mosaic of unburned patches interspersed through burned or partially burned areas. Unburned, mature even-aged, forested communities have also proven to be more susceptible to epidemics of mountain pine beetle, bark beetle and budworm infestations.

Historically, wildland fires were an important source of landscape heterogeneity, introducing a mosaic of unburned patches interspersed through burned or partially burned areas. These fires reset natural succession; provided patches of young, resilient, early seral species; and opened up the canopy to allow for the regeneration of a diverse understory. Where fire suppression has been the presiding management option, wildland fires tend to burn uncharacteristically hot when they do occur. These uncharacteristically hot fires turn normal forests into sparsely vegetated areas. These burned areas lack sufficient seed sources and the cool moist microclimates necessary for the reestablishment and growth of native plant species. The primary forest communities within the watershed (Douglas-fir, lodgepole pine, whitebark pine, limber pine, subalpine fir/Engelmann spruce and aspen) are all underrepresented by the youngest age classes (<5" diameter at breast height); representing a lack of regeneration in these important forest communities. Prescribed fire can address habitat improvement criteria to maintain healthy ecosystems, while reducing hazardous fuels to mitigate potential for future severe wildland fires.

Prescribed burns in the shrub steppe vegetation community are also recommended where sagebrush canopy cover exceeds 25 percent, in more than 30-45 percent of the sagebrush community. Under these conditions, soil water retention is reduced and growth of important understory species, such as forbs and perennial bunchgrasses, is suppressed. The use of prescribed burns as a management technique in sagebrush-dominated communities must be applied very carefully. Such areas are susceptible to conversion to non-native annual species such as cheatgrass, which limit the habitat value for sagebrush obligate species that require shrub cover. Prescribed burns in sagebrush-dominated shrublands should be applied on a small scale, and designed to allow gradual reestablishment of sagebrush from peripheral stands or direct seeding. Early spring and late fall burns are preferable; hot season fires tend to eradicate native perennial grasses and forbs, and encourage invasive species. Fire, applied appropriately can reduce cheatgrass invasion, however, evaluation of potential prescribed burn size and severity is integral to preserving extant sagebrush habitats, and implementation of natural or mechanical firebreaks may be necessary to avoid excessive impacts to important sagebrush habitat.

If used properly, prescribed fire can:

- increase production of desirable forage,
- decrease bare soil,
- decrease runoff,
- improve infiltration,
- and increase and extend groundwater discharges.

These desirable results of properly used fire benefit both wildlife and livestock while improving aquatic habitat and the riparian environment.

Disadvantages of prescribed fire include:

- temporary increases in rates of soil erosion,
- temporary decrease in water quality,
- increases in soil temperature extremes,
- initial loss of vegetative productivity,
- reduction in soil moisture level,
- a minimum of one growing season rest (BLM Rangeland Mechanical Treatment Guide).

4.5.2 MECHANICAL TREATMENT

In circumstances where passive management practices will not achieve long-term habitat goals and prescribed fire is not warranted, upland vegetation may benefit from mechanical treatments. Such treatments have proven successful in facilitating rapid landscape alterations that allow for restoration to a desired plant community composition or age-structure within an accelerated time frame. Mechanical treatments are generally specific to a community type.

Upland shrub-steppe communities dominated by sagebrush may benefit from localized mechanical treatments including mowing, roto-beating, chaining, disking, roller harrowing, railing, and blading.

A mowing project of 300-400 acres was recently conducted within USFS allotments near Daniel Wyoming, within the Green River watershed. The objectives of this project were:

- Remove decadent and dead sagebrush.
- Increase age class diversity of sagebrush in a mosaic pattern.
- Increase the vigor and production of the existing perennial grass and forb species.
- Maintain or increase herbaceous diversity.
- Improve wildlife habitat for mule deer, antelope, elk and sage-grouse.

Similar projects within the Bear River watershed would have similar benefits.

An important consideration in the planning process was to maintain a sufficient mature shrub component which would enhance natural regeneration of forbs, perennial grasses, and native shrubs.

Regional aspen declines have been tied directly to replacement by seral stage conifers, fire suppression, and excessive herbivory. Disturbance through fire or other means reduces competition from conifers and creates conditions conducive for reproduction and recruitment of early seral stages of aspen.

Mechanical treatments in aspen that can be used independently or in conjunction with prescribed fire include: thinning of mature aspen, removal of conifers, and aspen root separation, or severing of lateral roots near the soil surface with bulldozer-mounted ripper attachment, to stimulate regeneration.

In some areas, successful regeneration of aspen cannot be accomplished without clone or stand protection with fencing.

Pastureland, rangeland, grazed forest, and native pastures where slopes are less than 30 percent, may benefit from pitting, contour furrowing, and chiseling (ripping of subsoil). These mechanical treatments for grazing lands are designed to fracture compacted soil layers, and improve soil permeability. Additional benefits include reduction in runoff, increased infiltration rates, increased plant vigor, and consequently increased plant productivity and yields. Site-specific considerations and specifications for these applications can be obtained from the NRCS.

4.5.3 CHEMICAL TREATMENT

Herbicide treatment is another management tool used to enhance habitat in shrub steppe systems. Tebuthiuron (Spike 20P) is a popular broad spectrum, non-selective herbicide that has been used to thin decadent sagebrush and encourage understory growth. At rates recommended for thinning sagebrush, Spike 20P has little or no adverse effect on grasses, forbs, or desirable wildlife brush species such as bitterbrush, winterfat or serviceberry (Baxter 1998). As with mechanical treatments, herbicide treatments can be used to address specific management goals with predictable effects on community structure.

4.5.4 INVASIVE SPECIES TREATMENT

State Weed and Pest administrative areas coincide with county boundaries in Wyoming. Portions of two county Weed and Pest Districts are within the Bear River Watershed study area; Lincoln County has about 66%, while Uinta County has about 34%. Weed and pest districts focus on education outreach, as well as active identification and treatment of noxious weeds to maintain low levels of invasive and noxious weeds in the region. The district weed and pest offices are responsible for noxious weed control on Federal, State and County road right-of-ways, as well as collaborative weed control with state and federal agencies and through cost share agreements with private landowners and oil and gas production companies. Cost share opportunities are available through the local Weed and Pest Districts; other information for broader funding and cooperative invasive species management is available from the Wyoming Weed and Pest Council (http://www.wyoweed.org). The Weed and Pest districts have established guidelines for assuming some or all of the cost of weed prevention and detection on private property, including weed control consultation, reduced price herbicides, and spray equipment.

Forested lands within the Bridger-Teton National Forest have not been identified as high-risk weed management areas; however, an inventory of noxious weeds does indicate an increase in acres infested and in the number of noxious weed species present. Recent or prolonged surface disturbing activities are the greatest contributors to the spread of noxious weeds. Early detection and early treatment is critical in economical treatment of noxious weeds. The Forest Service National Strategic Framework for Invasive Species Management (2013) prioritizes and guides prevention, detection, and control of invasive plants, insects, pathogens, wildlife and fish (http://www.fs.fed.us/foresthealth/publications/Framework_for_Invasive_Species_FS-1017.pdf).

The most cost effective way to manage weeds is through early detection and small-scale infestation control. Wyoming State laws require that landowners control noxious weeds on their own property, and integrate weed control Best Management Practices. Methods to identify invasive/noxious plants of concern within the project area are outlined here:

1. Map areas where invasive/noxious plants of concern already exist, and weed free areas.
2. Implement strategies to assist in prevention of the spread of noxious weeds or invasive plants.
3. Prioritize and aggressively treat invasive/noxious plants in identified areas of concern.
4. Employ appropriate site preparation techniques and timely reseeding, with approved seed mixes, of any disturbed areas to prevent establishment and encroachment of invasive/noxious plants.
5. Maintain cumulative records for invasive/noxious plants treatment.
6. Educate public on invasive weeds and how to control them.

7. Encourage use of wash stations or vehicle cleaning for vehicles or equipment that have a high potential to spread weeds.
8. Encourage enforcement of travel plans on public lands.

Noxious weed management and control can be cost and labor intensive, especially when invasive species become well established. Local Weed and Pest Districts have cost-share programs that assist landowners in treating weeds on private land. There are two Weed and Pest Districts within the study area; Lincoln County and Uinta County.

The Lincoln County Weed and Pest District does have a cost share program that assists in the control of noxious weeds within the county. They will pay 50% of the cost for herbicide used in treating most noxious weeds, and will pay 100% of the cost for herbicides used to treat leafy spurge and perennial pepperweed. The county generally does not furnish labor, but may assist on private lands under special circumstances.

Lincoln County does rent sprayers for 4-wheelers and side-by-side utility vehicles to individuals to treat weeds on their property.

The portion of the study area within Lincoln County is included in the Highlands Cooperative Weed Management Area (Highlands CWMA). It is likely that the Highlands would help with treating weeds in Lincoln County. The Highlands CWMA can be contacted through the Lincoln County Weed and Pest District. In the past the Highlands has sponsored weed days to treat perennial pepperweed in the Bear River drainage.

The Uinta County Weed and Pest District also has a cost share program to treat noxious weed within that county. Their program is based on a 4-tiered priority system:

Priority #1 weeds- weed patches must be less than 5 acres in size- Uinta County pays 60% on chemicals, plus 50-100% on labor to treat: leafy spurge, knapweed, dyers woad, and yellow toadflax.

Priority #2 weeds- weed patches must be less than 5 acres in size- Uinta County pays 60% on chemicals plus 50% on labor to treat: Scotch thistle, Purple loostrife, St. Johns wort, skeleton leaf bursage, common burdock, and salt cedar.

Priority #3 weeds- Large infestations of weeds- Uinta County pays 60% on chemicals but contributes no labor to treat: common tansy, hoarycress, hounds tongue, field bindweed, perennial pepperweed, plumless thistle, and Russian olive.

Priority #4 weeds- Large infestations of weeds- Uinta County pays 60% on chemicals but contributes no labor to treat: Canada thistle, perennial sow thistle, quack grass, musk thistle, and black henbane.

Uinta County Weed and Pest Department will also loan equipment to individuals for the treatment of noxious weeds. This equipment includes: pull behind sprayers, 4-wheeler sprayers, slip in truck sprayers, and back-pack sprayers.

The Bear River Divide Cooperative Weed Management Area (CWMA) does include that portion of the study area within Uinta County. It is likely assistance would be available from the Bear River Divide CWMA, for treating weeds located in Uinta County. This CWMA can be contacted through Uinta County Weed and Pest Department.

REFERENCES

Baxter, G. 1998. Thinning dense sagebrush stands with Spike 20P. Rangelands 20(3) 14-16, June 1998.

Beck, J.L., J.W. Connelly, and K.P. Reese. 2009. Recovery of Greater Sage-Grouse Habitat Features in Wyoming Big Sagebrush following Prescribed Fire. *Restoration Ecology* 17 (2009) 393-403, doi: 10.1111/j.1526-100X.2008.00380.x.

V. IRRIGATION SYSTEM INVENTORY AND REHABILITATION

5.1.1 AGRICULTURAL WATER USE

Agricultural water use in the Bear River Basin consists primarily of irrigation and to a lesser degree stock watering. Although a few irrigation wells exist in the Bear River Basin, the predominant source of irrigation supply is surface water. Historically, a network of canals and ditches were constructed by producers to convey water from the natural tributaries and main stem Bear River to the meadows and cultivated lands. Flood irrigation remains the principal method of applying water to the fields. In recent years, through the NRCS Environmental Quality Incentives Program (EQIP), center pivot irrigation systems have emerged as an alternative to flood irrigation. Center pivot irrigation is being utilized in the Lincoln County area(s) of the Basin with a few sites in the Uinta County portion of the basin.

5.1.1.1 IRRIGATION SYSTEM INVENTORY

Approximately 233 irrigation diversions to ditches or pipline intakes exist in the Bear River Watershed atudy area. In addition, another 109 diversions to various individuals and enterprises were tabulated, some of which are cancelled permits. The priority dates range from 1891 to 2018. Table 5.1.1.1 sumarizes a irrigation/surface water rights tabulation found in Appendix J containing the conveyance name along with the appropriator, permit number, priority date, diversion rate, acreage and source creek. Table 5.1.1.1 below outlines the status of the SEO e-Permit Search for Division 4, Districts 2 & 4 (Bear River Drainage)

Table 5.1.1.1 Water Rights Filings based on e-Permit Search

Water Right Status Count From SEO e-Permit			
WaterRight Status	Lincoln County	Uinta County	Total
Fully Adjudicated	27	189	216
Complete	14	10	24
Incomplete	3	1	4
Unadjudicated	1	4	5
Cancelled	21	54	74
Expired	1	1	2
Abandoned	0	1	1
No Status Given	6	10	16

During the course of this study the public meetings discussed in Section II were used to identify potential landowners/managers with projects. Several landowners/managers at these meetings later proposed projects. In addition, the conservation districts were able to gain several referrals by word of mouth. Meetings were held with these landowners and concept projects were produced. Section 5.1.1.2 sumarizes the potential projects identified during this study. Each county supplement to this study contains conceptual designs and cost estimates for the various projects.

5.1.1.2 POTENTIAL IRRIGATION IMPROVEMENT PROJECTS

Much of the project need within the Bear River waterhed study area is associated with aging headgate structures, headgates being stranded as the main channel drops in elevation or moves laterally, and diversion revetments that are difficult to maintain. One of the projects also included piping of a ditch section. Figure 4.2.2.1 illustrates the distribution of potential project throughout the watershed.

The following Table 5.1.1.2 summarizes the project types and cost. More detailed evaluations and detailed cost estimates for each project are found in each county supplement.

Table 5.1.1.2 Potential Irrigation Projects

			Major Project Components						
General Location	Owner or Operator	Number of Projects	Ditch Improvements	Headgate	Diversion	Reservoir Storage	Bank Stabilization	Other	Estimated Total Project Costs
	Buckley	3	1			2			$ 659,003
	Carter	1	1						$ 158,674
	Clark	1		5					$ 10,808
	Circle B	1				1			$ 359,644
	Cornia	1				1			$ 545,881
	Dayton-Crane	3		1			1	1	$ 962,299
	Esterholt	1	1	1					$ 50,736
	Etchevery	3		1		2	1	1	$ 793,132
	Evan Pope	3			1			2	$ 448,819
	Nate	1		1	1				$ 184,843
	Thornock	1				1			$ 3,655,132
	Tiechert	1	1			1			$ 641,284
	Julian	1	1			1			$ 119,339
	Total for Lincoln County	**21**	5	9	2	9	2	4	**$ 8,590,000**
Uinta County	Cornielison	1				1			$ 1,452,791
	Hayduk	4		2				3	$ 74,920
	Town of Bear River	1			1				$ 193,166
	Robinson	1						1	$ 11,848
	Simmons	4	1	1	1	1		1	$ 241,725
	Hansen/YC Ranch	6				1	1	3	$ 459,690
	Evanston City Ditch	2	1						$ 5,095,109
	Total for Uinta County	**19**	2	3	2	3	1	8	**$ 7,530,000**

5.1.1.3 EXCHANGES

Not specific to any particular landowner or the small water project program, several concepts related to downstream exchanges could potentially improve irrigation reliability.

1. Acquire/lease land or water below the Cook Canal for exchanges. The Cook Canal has an early (1883) Wyoming water right for 43+/- cfs. It primarily irrigates Idaho lands owned by the Hawks' family. The canal has priority over most other Wyoming water upstream and is usually the last ditch to be shut off. The land could be purchased for less than a storage reservoir could be constructed. Other options include a long term land lease or even an annual payment not to irrigate after July 1st. There would be no permitting issues with WYG&F, BLM, COE, USFWS, etc. Exhibit 5.1.1.3 shows the canal diversion point (right side) and it's irrigated acreage (irregular blue along south side of river).

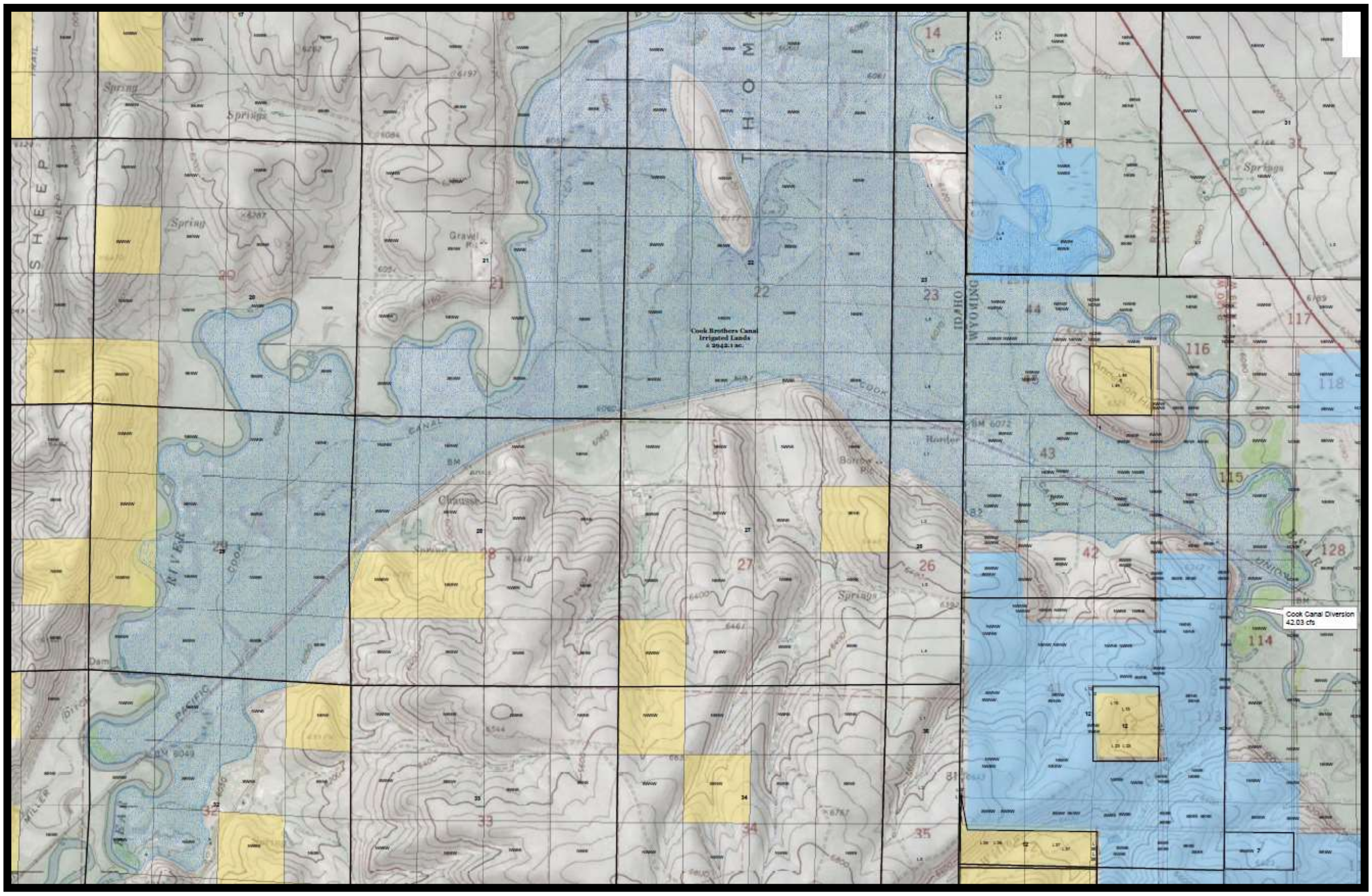


Exhibit 5.1.1.3 Lands Irrigated by the Cook Bros Diversion

2. Construct two small dams on the Bear River (See Exhibit 5.1.1.4) for storage and exchanges. The Bear River officially ends at Pixley Dam. From that point below to the Smiths Fork, no river technically exists. Both dams would be entirely on private property and would not inundate land. The upper site could be filled from the Mau or Covey canals and release water from the Bear River. Each of the two dams would be comparable in size to the BQ or Pixley Dams (approximately 120' in width). There would be some permitting

issues but of a reduced scope. A new irrigation district would own the two dams. The USFWS has been very supportive and offered financial assistance through Partners for Fish & Wildlife. Based on the cost of other structures that were constructed by NRCS and Trout Unlimited the cost of each dam would be around one million dollars. Each dam would hold approximately 200-400 acre-feet. This storage along with the storage from the Pixley Dam could approach or exceed 1000 acre-feet. These projects would allow for fish passage as an added advantage.

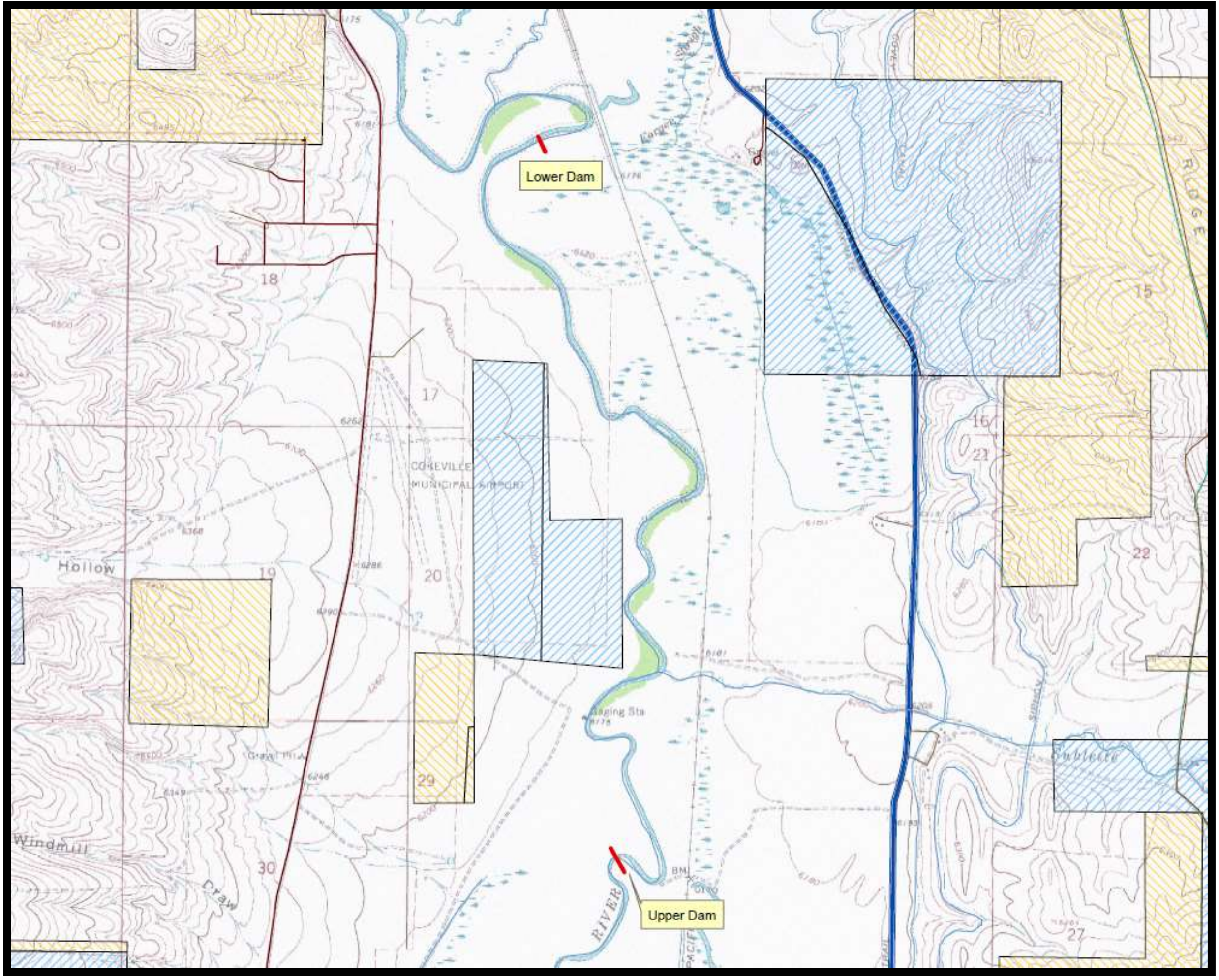


Figure 5.1.1.4 Potential Dam Sites

3. If a storage reservoir ever becomes a reality, a winter snowpack augmentation seeding project should be analyzed as a potential next step. Previous studies by Utah Power & Light in the Thomas Fork and Smiths Fork from 1955-1970, 1980-1982, plus 1989 and 1990 showed a 11% or higher increase in precipitation. (Level II Weather Modification Feasibility Study for the Salt River and Wyoming Ranges, Wyoming) Studies currently being conducted in the Wind River Range and the Medicine-Bow show very similar results. Idaho Power has been cloud seeding in the Salt River Range for several years with shown improvements. Idaho Power have their costs down to around $40K per unit.

These exchange concepts are believed to offer a lower cost per acre-foot alternative to a larger reservoir project.

5.1.2 IRRIGATED ACREAGE

Irrigated acreage has been reported a number of different ways in studies completed for the Bear River Basin. The area of interest for this study, the Bear River Basin in Wyoming, includes lands within WYSEO Division 4, Districts 2 and 4 shown in Figure 5.1.2a.

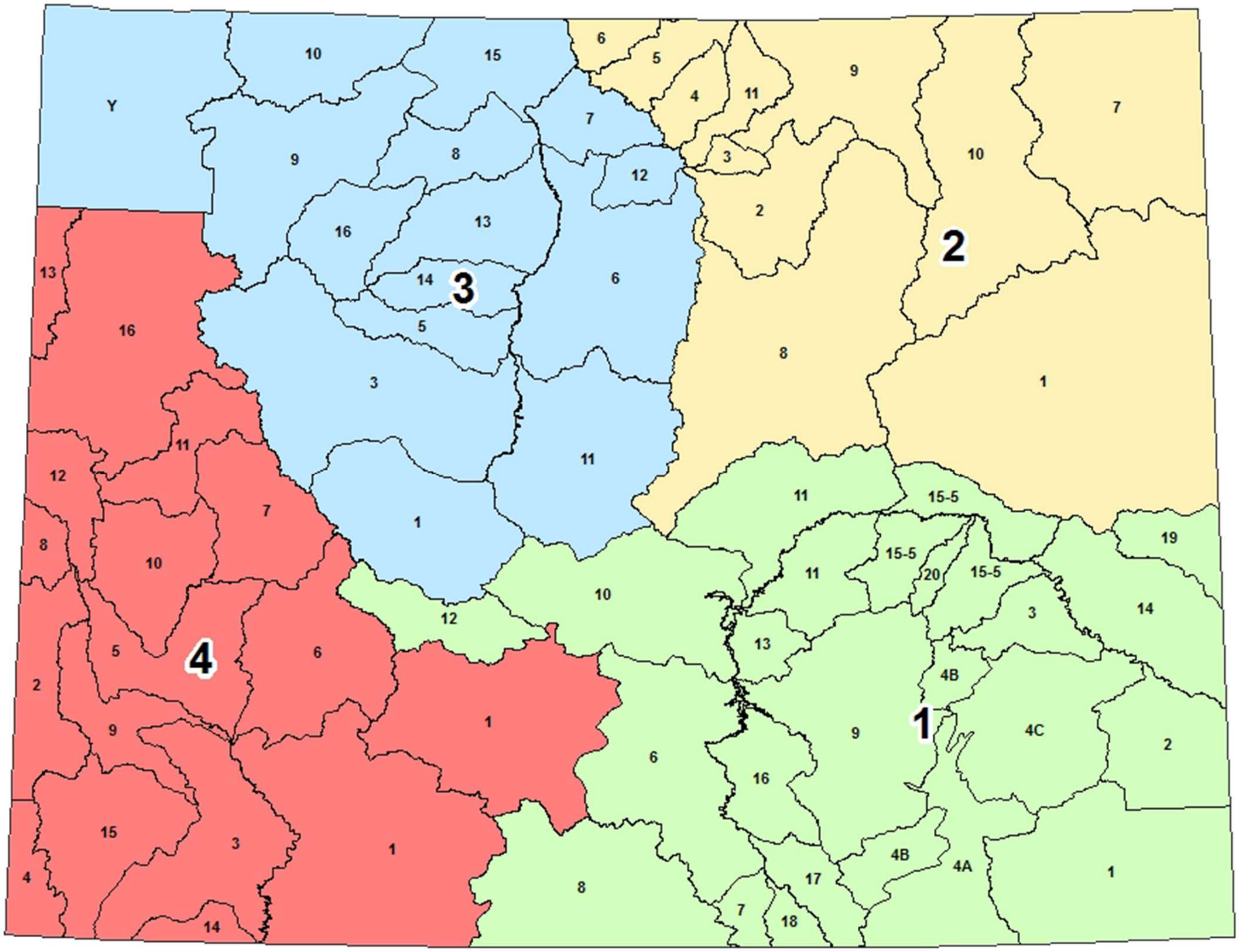


Figure 5.1.2a SEO Water Divisions (map provided by SEO)

The most recently reported irrigated acreages for the Bear River Basin was included in the 2011 Bear River Basin Plan Update completed by the WWDO. The totals in Table 5.1.2 were taken from the 2011 basin plan update and also match the 2001 original basin plan.

TABLE 5.1.2 - IRRIGATED ACREAGE BY COMPACT DIVISION

LOCATION	IRRIGATED ACREAGE
Upper Division	40,400
Central Division	23,500
Total	63,900

The Bear River Basin Plan Update reported irrigated acreage using the Central and Upper Divsions as defined by the Bear River Compact. In the Compact, Pixley Dam is identified as the dividing line between the Central and Upper Division. Pixley Dam is located about 7.2 miles downstream of where the Bear River crosses from Utah back into Lincoln County, Wyoming. This watershed study will tabulate irrigated acreages based on the boundary between Lincoln and Uinta County Conservation Districts. Consequently, some acreage that has been attributed to the Upper Division by the Compact actually falls in Lincoln County and will be included with the Lincoln County totals and deducted from the Upper Division. Exhibit 5.1.2b illustrates the acreage in question.

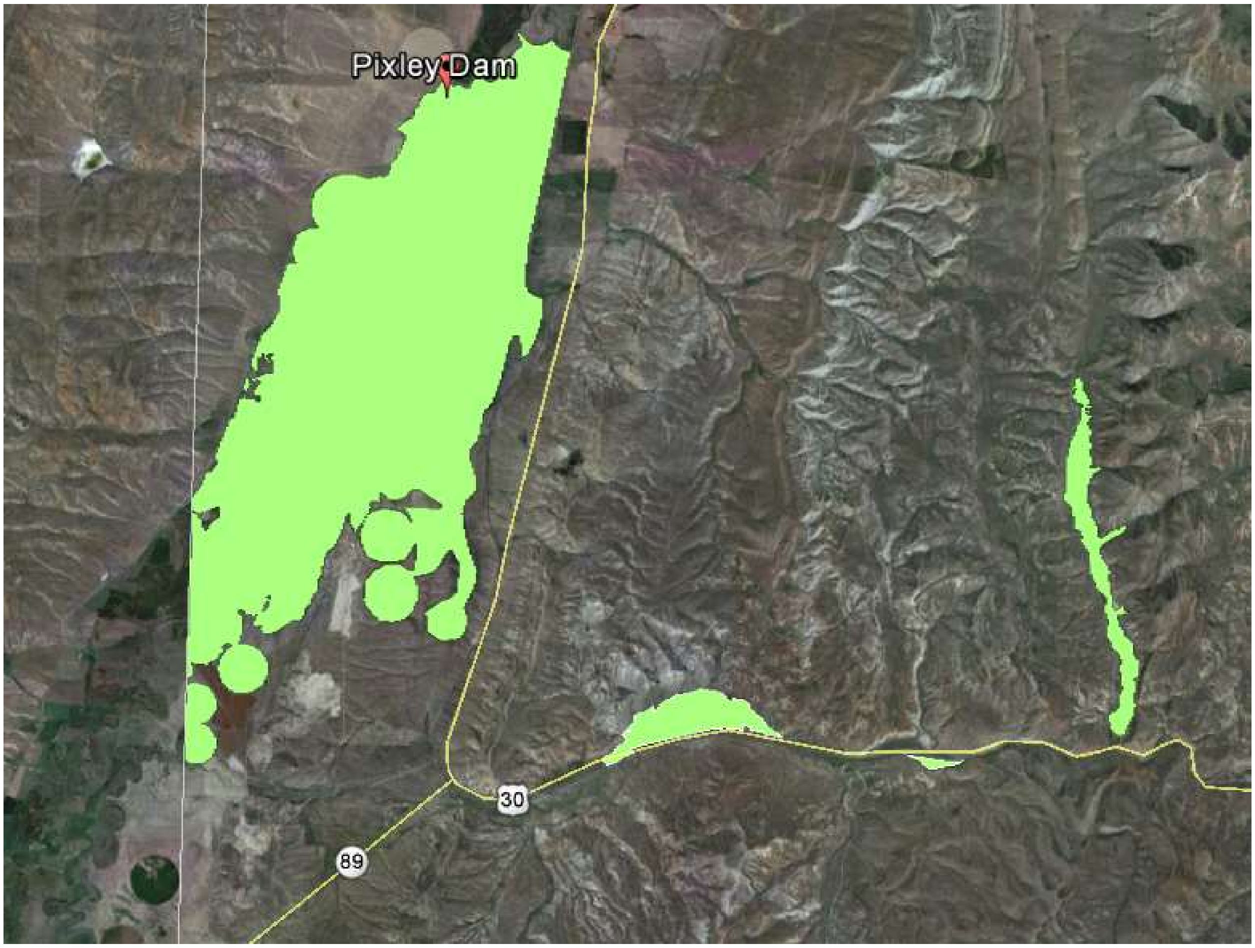


Figure 5.1.2b Acreage in Lincoln County that falls in the Upper Division of the Bear River Compact

The total acreage between Pixley and the state line is estimated at 9,000 acres. Converting Table 5.1.2 acreages into a total by county results in the following total irrigated acreage (Table 5.1.2c).

TABLE 5.1.2c - IRRIGATED ACREAGE BY COUNTY

LOCATION	IRRIGATED ACREAGE
Lincoln County	32,500
Uinta County	31,400
Total	63,900

GIS data from 2007 regarding total irrigated acreage places the total irrigated acres at 63,300, with Lincoln County at 31,968 and Uinta County at 31,330. Given the new center pivots in Lincoln County it is understandable that the acreage in 2011 is slightly higher as shown on Table 5.1.2c.

5.1.3 AGRICULTURAL CROPS

Grass hay and alfalfa are the primary crops in the Upper Bear River Basin. In the Cokeville region additional crops include malting barley, feed barley, hay barley, oat seed, oat hay, and saifoin. At present, no know tabulations of acreage planted in specific crop varieties by County, SEO District, or watershed is maintained. Crop rotation changes ratios on a constant basis.

5.1.4 IRRIGATION DIVERSIONS

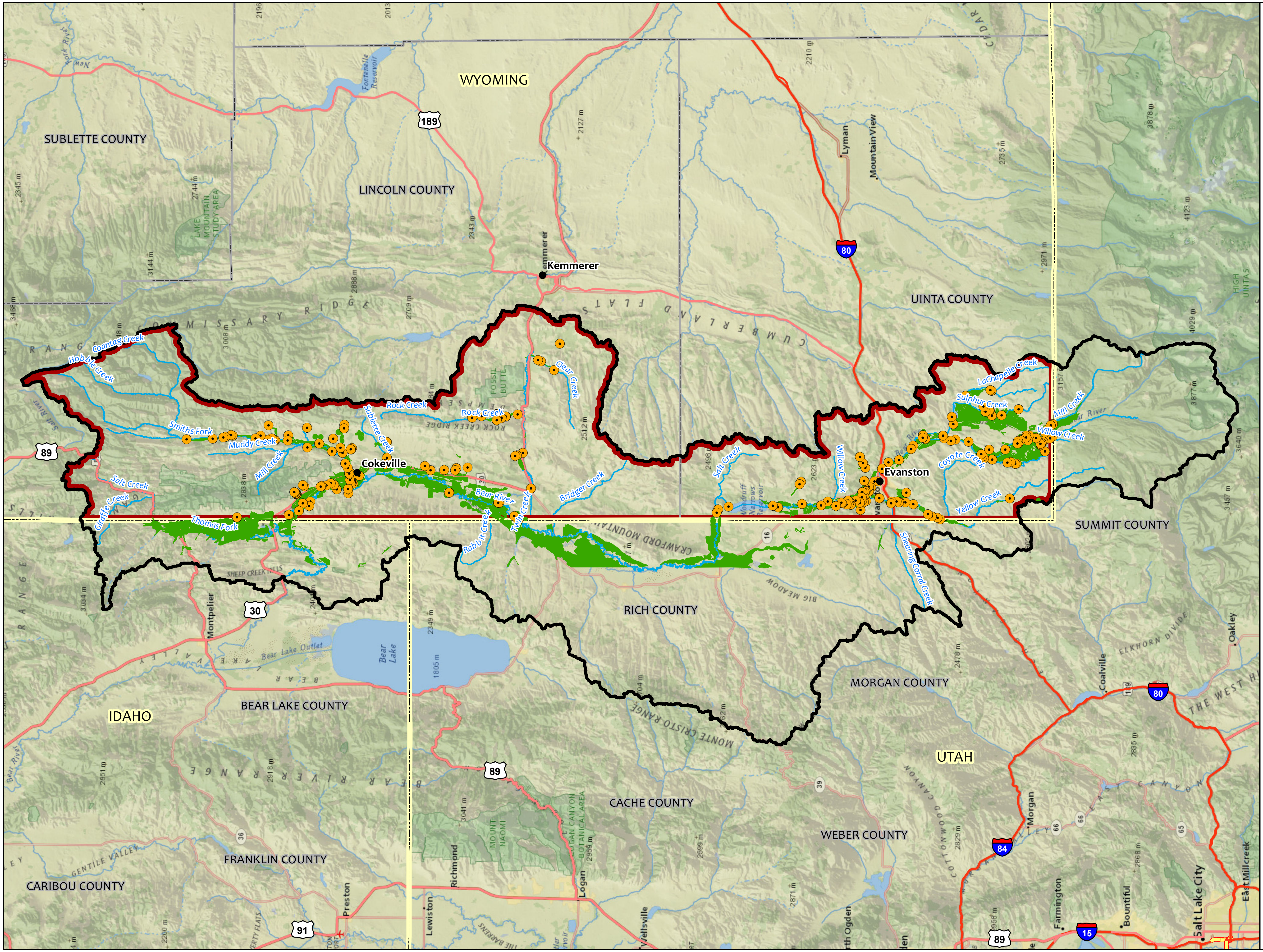
Based on 2012 WYSEO Hydrographer Annual Reports there are 233 active surface water diversions in Districts 2 and 4 (SEO Division 4) of the Bear River Basin. A breakdown of the location by County of the 233 active diversions is illustrated in Table 5.1.4.1.

Table 5.1.4.1 Irrigation Diversion by County Bear River Basin

County	Number of Diversions	Major Diversions	Minor Diversions
Lincoln	110	72	38
Uinta	123	66	57
Total	233	138	95

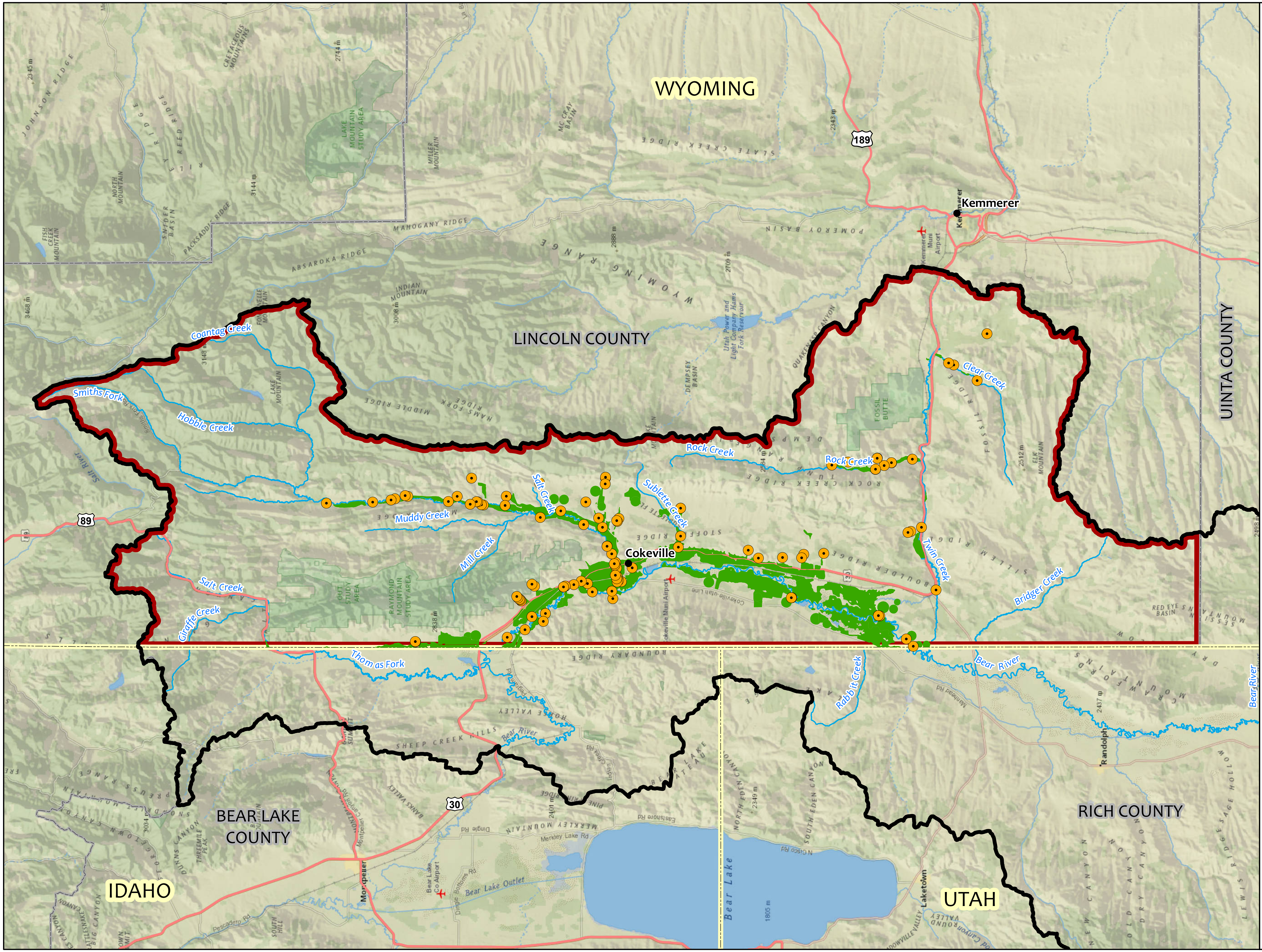
Tables 5.1.4.2a & b illustrate Average Annual Diversions within Lincoln and Uinta Counties derived from compilations completed by the WYSEO for 2012, 2013, & 2014. Based on records to date from the SEO, these diversions are the ones with continuous recorders at this time (May 2015). Tables 5.1.4.2c & d contain spot measurements in terms of cfs for those diversions that do not have recorders.

Figure 5.1.4 identifies irrigated acreage and points of diversion for the study area. Appendix I contains single line diagrams for the main basin river reaches showing the relative order of diversions along the stream.



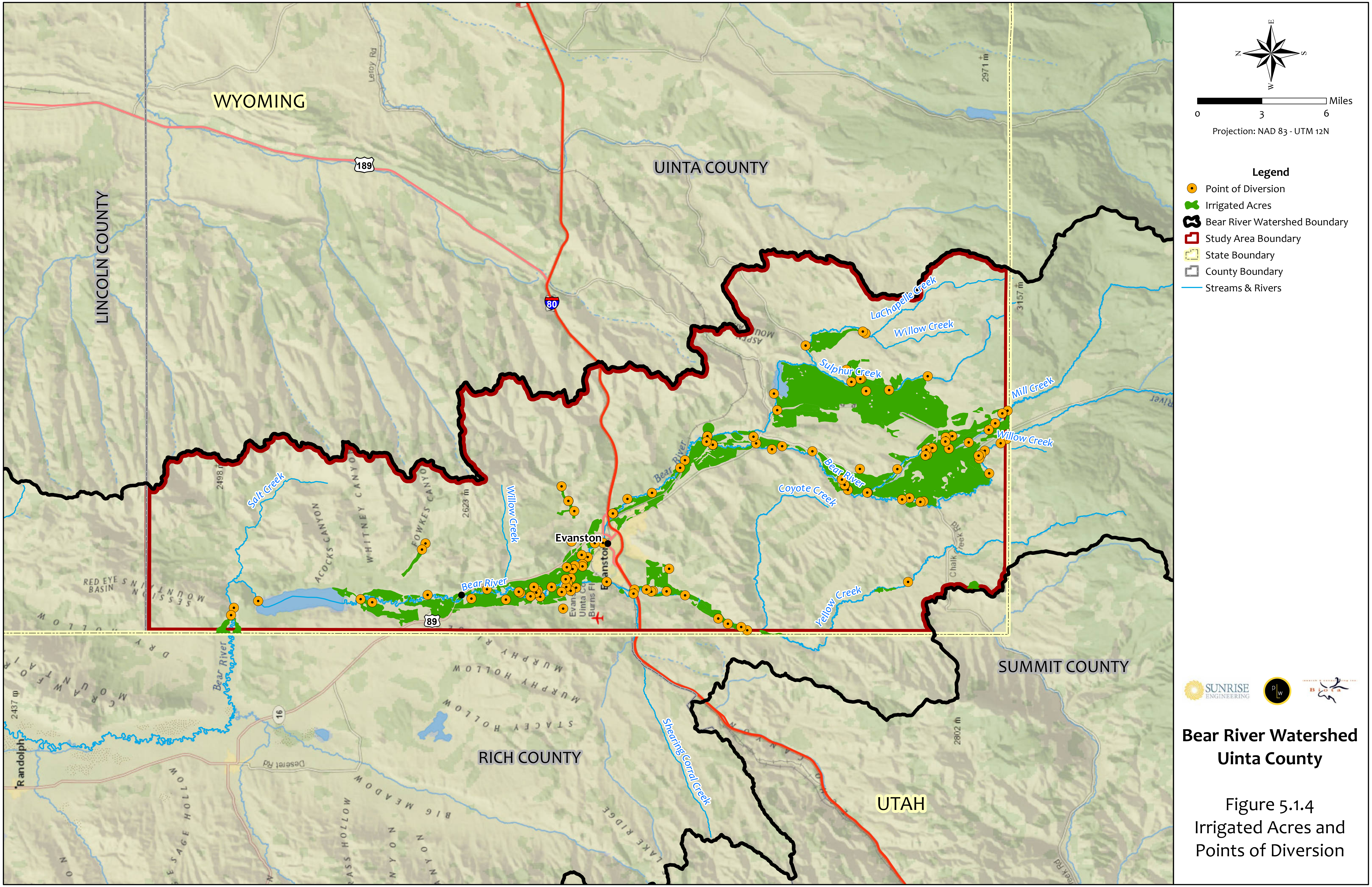
Bear River Watershed

Figure 5.1.4
Irrigated Acres and
Points of Diversion



Bear River Watershed
Lincoln County

Figure 5.1.4
Irrigated Acres and
Points of Diversion



Bear River Watershed Uinta County

Figure 5.1.4 Irrigated Acres and Points of Diversion

Table 5.1.4.2a Average Annual Diversion - Lincoln County

Major Diversions Name	Major Diversions 2012 (AFY)	Major Diversions 2013 (AFY)	Major Diversions 2014 (AFY)	Average Diversion (AFY)
Bear River near Randolph	36640	13270	35330	**28,413**
Abraham Stoner (Sub. County)	158.68	444.2	246	**283**
Alonzo F. Sights	1710	1277.37	1311.92	**1,433**
Bourne (S. Branch)	909.02	933.5	1300.99	**1,048**
Bridge Pump	1.39	0	5.95	**2**
Button Flat	730	388.5	953.52	**691**
C.B.D. No. 7	110.68	0	342.8	**151**
Cokeville Water (M Branch)	466.41	11.11	225.03	**234**
Cook Brothers Irrigation	13487.7	11083.4	11698.28	**12,090**
Cooper	573.67	353.28	2593.65	**1,174**
Covey Headgate	12300	6679.16	16272.96	**11,751**
Covey (Bruner Ck.)	1832.59	1248.73	1698.02	**1,593**
Covey (Spring Ck.)	1409.65	1173.08	1573.62	**1,385**
Curtis Pump (Bruner Ck.)	91.93	0	90.2	**61**
D.C.P. (Bruner Ck.)	0	234	97.1	**110**
Diamond No. 2 (Spring Ck.)	0	0	29.77	**10**
Emelle	2180	1332.3	2330.07	**1,947**
Forgeon Irrigating (S. Branch)	507.47	590.6	771.87	**623**

Table 5.1.4.2a (Cont.)

Major Diversions Name	**Major Diversions 2012 (AFY)**	**Major Diversions 2013 (AFY)**	**Major Diversions 2014 (AFY)**	**Average Diversion (AFY)**
Francis Larson	841	432.4	1093.11	**789**
Gastenaga North (M Branch)	207.27	51.2	186.4	**148**
Gastenaga South (M Branch)	369.92	138.3	186.47	**232**
Goodell (Pine Cr)	3650	2455	2980	**3,028**
Grade (Grade Canyon Cr)	331.24	340.14	305.4	**326**
Haggerty No. 3 (Bruner Cr)	0	0	0	**-**
Igo No. 2 (M Branch)	6.94	33.01	18.75	**20**
Igo No. 3 (M Branch)	178.39	0	0	**59**
J.R. Richards	248	794.2	1213.43	**752**
Kenyon (Spring Cr)	0	0	0	**-**
Larson Pump	0	0	0	**-**
Minnie Roberts (M Branch)	212.73	20.02	859	**364**
N Cokeville / Morgan (M Branch	1208.13	415.4	1378	**1,001**
Nate North Pump	0	0	72.9	**24**
Nate South Pump	0	0	0	**-**
Oscar E. Snyder	2740	2498	8740	**4,659**
Peterson Pump (S Branch)	136.07	87.7	167.2	**130**
Peterson Yard P.L.		1.55	6.82	**4**
Progress	253.3	199	406.2	**286**

Table 5.1.4.2a (Cont.)

Major Diversions Name	**Major Diversions 2012 (AFY)**	**Major Diversions 2013 (AFY)**	**Major Diversions 2014 (AFY)**	**Average Diversion (AFY)**
Quinn Bourne	1260	799.93	1495.09	**1,185**
Reed (N Branch)	651.47	397.8	665.4	**572**
Rocky Point D2	1740	703.74	3032.05	**1,825**
Seven C Ranch N Pivot & Pipeline	81.76	45.6	97.2	**75**
Seven C Ranch S Pivot & Pipeline	39.68	8.33	0	**16**
Smith's Fork Ditch (M Branch)	932.94	467.9	1365.37	**922**
South Branch Irrigating (N Branch)	3250	1257.01	4055.54	**2,854**
Star (M Branch)	0	0	8.57	**3**
Star 2 Pump (M Branch)	7.5	0	0	**3**
Stoner & Nichols (M Branch)	669.42	86.83	932.46	**563**
Tanner (M Branch)	68.33	0	89.8	**53**
Teichert Bro's Ditch			15.9	**16**
Teichert Bro's Spreader Dike			152.7	**153**
Thornock Pump & Pivot	297.5	97.5	242.33	**212**
V.H. (Pine Cr)	2350	3134	3331	**2,938**
Wheelock	1270	309.5	1939.9	**1,173**
Whites Water	4571	30.88	3743	**2,782**
Wyman No. 1 (East)	262.84	679.12	2423.47	**1,122**
Wyman No. 2 (West)	3680	1340.85	7718.88	**4,247**

Table 5.1.4.2a (Cont.)

Major Diversions Name	**Major Diversions 2012 (AFY)**	**Major Diversions 2013 (AFY)**	**Major Diversions 2014 (AFY)**	**Average Diversion (AFY)**
B.Q. East	12800	6029.01	13901.12	**10,910**
B.Q. West	2367	1260	1384.35	**1,670**
C-12 Pump	376.2	271.03	269.7	**306**
Johnson Pipeline 1	309.4	278.39	304.2	**297**
Johnson Pipeline 2	105.7	90.3	44.18	**80**
Johnson Pipeline 2 (Pivot 3)		80.9	51.14	**66**
Johnson Pipeline 3 (Pivots 4-8)	77.91	441	242.25	**254**
McFarland	838	539.51	1326.6	**901**
Pixley Irrigating (East)	2960	1649.8	4216	**2,942**
Pixley Irrigating (West)	5215	2611.69	5666.18	**4,498**
Weston Ranch Pump 1	482.62	482.62	269.8	**412**
Weston Ranch Pump 2	406.6	476.82	275.21	**386**
Alonzo F. Sights (Tributary)	0-5.7	0-3.8	0-3.8	
Bernadine Pump and Pipeline	0			
Corina Pipe Line	0-1		0.5	**1**
Yellow Indicates Measurement Only	**93,923**	**56,785**	**118,415**	**89,844**
🟨				

Table 5.1.4.2b Average Annual Diversion - Uinta County

Major Diversions Name	Major Diversions 2012 (AFY)	Major Diversions 2013 (AFY)	Major Diversions 2014 (AFY)	Average Diversion (AFY)
Grassy Lake Storage Release	278	214.5	141.9	**211**
Whitney Reservoir				
Whitney Reservoir Storage Release	4976	3059	1418	**3,151**
Whitney Reservoir Outflow	5160			
Sulpher Creek Reservoir				
Sulpher Creek Res. Storage Release	7787	6933	5534.5	**6,752**
Sulpher Creek Below Res.	12903	8713.61	12158.68	**11,258**
Woodrow Narrows Res.				
A.W.Sims	355.3	283.4		**319**
Almy	188.19	316.8	290.5	**265**
Anel Irrigating	1310	1225	1012.32	**1,182**
B.E.A.R. Project Pipeline	68	51.18	60.7	**60**
Bear (Bear R)	4298	6590.93	8394.31	**6,428**
Bear River Canal	6575	3995	5249	**5,273**
Booth	2155	2137	2433.04	**2,242**
Bowns	164.45	356.8	222.64	**248**
Bowns & Bruce	2.58	14.1	127	**48**
Bruce-Barton	359.8	369.57		**365**
Chapman Headgate	13400	20599.8	22465.32	**18,822**
Chapman (Stateline)	6899.57	13823.9	16049.84	**12,258**
Coffman	305.67	313.97	229.11	**283**

Table 5.1.4.2b (Cont.)

Major Diversions Name	Major Diversions 2012 (AFY)	Major Diversions 2013 (AFY)	Major Diversions 2014 (AFY)	Average Diversion (AFY)
Cornelison	474.94	341.36	634.09	**483**
Crown & Pine Grove	3060	2927.22	270.33	**2,086**
Danielson	550.23	555.1	780.54	**629**
Evanston Pipeline	2754	2521	2453	**2,576**
Evanston Water	3030	2833.53	2813.36	**2,892**
Evanston Water Supply	165.37	172.9	816.6	**385**
Faulkner	137.53	70.05	234.5	**147**
Fearne Irrigating (and Saxton-Thomas)	231.78	252		**242**
Fife Irrigating	0	0	0	**-**
Frances Lee	2572.4	2096.93	1465.4	**2,045**
Fritzy	227.35	207.89		**218**
Hare	40.7	173.88	308.2	**174**
Hatch (W Fk)	425.07	482.3	798.08	**568**
Havorka (E Fk)	691	933	1024.47	**883**
Hillard East Fork (E Fk)	3402.11	3039.99	3099.64	**3,181**
Hillard West Side	2920	3106.87	3711.64	**3,246**
Homer	206	195.7	373.5	**258**
John Sims	2160	2495.28	1942.21	**2,199**
Johnson No. 1 Pump	0	0	0	**-**
Johnston & Narramore	96.2	173.3	213.4	**161**

Table 5.1.4.2b (Cont.)

Major Diversions Name	Major Diversions 2012 (AFY)	Major Diversions 2013 (AFY)	Major Diversions 2014 (AFY)	Average Diversion (AFY)
Junction	0	8.33		**4**
Knight No. 1 & 2	569.71	762.48	1121.85	**818**
Knoder	758.72	844.16	589.94	**731**
Kreider Domestic Pump	9.91	0	0	**3**
Lannon & Lone Mtn.	2803.32	2174.26	2671.67	**2,550**
Lewis (D4)	1020.83	638.32	591.57	**750**
Lewis & Blanchard	155.2	200.74	311.44	**222**
McGraw	1920	1766.06	2541.08	**2,076**
Michael Sims	0	13.5	89.3	**34**
Morganson	0	5.16		**3**
Morris Bros Irrigating (Lower)	673.1	776.7	486.63	**645**
Myers Irrigating	1020	1122.56	1066.78	**1,070**
Myers No. 1	420.41	388.05	473.85	**427**
Myers No. 2	494.07	331.39	390.94	**405**
Nixon West Side	2.38	24.97	0	**9**
Olson No. 1 Pump	17.65	16.84	19.44	**18**
Rocky Mtn & Blyth (and Compton)	1390	1393.2	1589.25	**1,457**
S.P.	1470	1571.93	2378.4	**1,807**
Sim's Creek Slough Diversion			1558.4	**1,558**
Sims, Blight & Turner	327.04	418.03	460	**402**

Table 5.1.4.2b (Cont.)

Major Diversions Name	**Major Diversions 2012 (AFY)**	**Major Diversions 2013 (AFY)**	**Major Diversions 2014 (AFY)**	**Average Diversion (AFY)**
State Hospital Ditch	0	0	0	-
Tropic	437.09	488.82	489.48	**472**
Tunnel	1492.48	2324.11	2959.08	**2,259**
Turner	323	396	311.4	**343**
Wilson Irrigating	253.3	44.26	300.94	**200**
Yellow Indicates Measurement Only	**67,885**	**74,542**	**81,824**	**76,173**

Table 5.1.4.2c Spot Flow Measurements - Lincoln County

Minor Diversions Name (Spot Measurements)	**Minor Diversions 2012 CFS Range (Spot Measurements)**	**Minor Diversions 2013 CFS Range (Spot Measurements)**	**Minor Diversions 2014 CFS Range (Spot Measurements)**
Buyers No. 1	0-.1	0-.1	0.1
Cash No. 1	0	0-.3	0
Chalk Creek Pipe Line	0-1.5		0
Fred	0-.2	0	
Fossil Pipeline	0		0
Lower No. 1	0-.3	0-.2	0.2
Lower No. 2	0-.3	0-.2	.1-.2
Maggie Lewis No. 1	0-.5	0	0-.3
Maggie Lewis No. 2	0	0-.3	0
Susana	0-.5	0-.2	
C.B.D. No. 4	.3-3		
Shuster No. 2	0-.1		
Shuster No. 4	0		
Icebox No. 1	0-.2	0-1	0
Icebox No. 2	0-.1	0-.2	0
Icebox No. 3	0-.2	0-.3	0

Table 5.1.4.2c (Cont.)

Minor Diversions Name (Spot Measurements)	**Minor Diversions 2012 CFS Range (Spot Measurements)**	**Minor Diversions 2013 CFS Range (Spot Measurements)**	**Minor Diversions 2014 CFS Range (Spot Measurements)**
JD No. 1	0	0	
JD No. 2	0	0-.1	
Schuster No. 1	0-.1		
Francis (D2)	0-1.5	0	0.3
McLennan	2.4-5.7	0-.7	0.8
Petereit	0-.3	0-.1	0.1
Raymond & Foreman	0-1.6	0	0
Cooper Pipeline	0		0
Failoni No. 5	0-.5	0-.5	0
Failoni No. 3	0-1.5	0-1.5	0
Jane No. 1	0-2	0-1.5	0
Jane No. 3	0-1	0-1	0
Morrision Pipe Line	0-.5	0-.1	0.1
Porter No. 1	0-3	0-2	0-.2
Buyer No. 5	0-.1	0-.1	0
Buyer No. 5-A	0-.2	0-.1	0.3
Buyer No. 6	0-.5	0-.1	0
Succor Springs Ditch	0-3	0-3	0-3.0
Sulpher Springs Pipeline	0	0	0
Sage	0-2.5	0-2.5	0
Twin Creek Ditch	1.9-8.5	1.6-4.6	1.6-18.5
Ulrich Pipeline	0	0	0

Table 5.1.4.2d   Spot Flow Measurements - Uinta County

Minor Diversions Name (Spot Measurements)	**Minor Diversions 2012 CFS Range (Spot Measurements)**	**Minor Diversions 2013 CFS Range (Spot Measurements)**	**Minor Diversions 2014 CFS Range (Spot Measurements)**
Clark-Titmus		.5-1	1.5
Broadbent (Bones)	0.1		0
Heber Supply	0	0-.1	0
Broadbent (LaChapelle)	0.8	1-2.5	0.5
Dexter	0	1-1.5	0
Eureka	0	2.0-3.0	0
Fearn & Rufi	2	3	1.5
Garden	0-1	0	0
Gerrard	0	2	0
Goodman Terr Irrigating	1	0	0
Goodman Terr Irrigating No. 2	0	0-3	0
Goodman-Cunningham	0	.2-8	
Hardscrabble	2.0-3	2.5-3	0
Hatten Irrigating	0	0	0.5
Hillard East Fork (Mill)	.8-5	0-4	0.5
John Goodman		0-3	0
Lewis & Coffman	0-5	3	2
Lewis (Mill Creek rediversion)	0-3	3	1
Lowham Irrigating	1	3	0
Lowham No. 2	0	3	0
Lowham No. 3	0	1	0
Myers No. 2 (Mill Creek rediversion)	0	4	2
Pioneer (D4)	0	2	0
Stedman No. 1	0	1	0.5
Tibbets No. 1	0	1	0
Tibbets No. 2	0	3	0
Willow	0.1	0-2	0
B. & L.	0		0.4
Banks	0.1	2	0.8
Bear (Sulphur Cr)	0	1.5	0
Bell's	0	0.5	0
Cornelison No. 5 Pump	2.1	1.9	1.9
Holmes	0	0	0

Table 5.1.4.2d (Cont.)

Minor Diversions Name (Spot Measurements)	Minor Diversions 2012 CFS Range (Spot Measurements)	Minor Diversions 2013 CFS Range (Spot Measurements)	Minor Diversions 2014 CFS Range (Spot Measurements)
Lester (10-13-119)	0	0.5	0.8
Lester (27-13-119)	.1-1	5.0-7.0	
Rocky Point (D4)	0	1.5-2.5	1.5
Sulphur Creek Res. Inflow	0	0-115	
Mary	0	0.5	0
Bergen Portable Sprinkler	0	0	0
Easton Irrigating System	0	0	0
McCauig Supplementary	0	0-.2	
Linder Portable Sprinkler	0		0
Stevens Portable Sprinkler	0	0	
Christensen	0-3	0-4	0
Christensen No. 2	0-3	0-3	0
Daniel Cochran	0-3	0-2.5	0-1
Forbes	0-2.2		0-.9
Harriet Cook	0	1.0-4.0	0
Jacob Stahley No. 1	.1-1.5	0-4	.7-1
Jacob Stahley No. 2	0	0	0
Jacob Stahley No. 3	0		0
Joseph Cook	0-4	0-1	0
McCuaig	0-10	0-.3	0
Moon	0-1.5	0-2	0
Saxton Irrigating	0-5	0-4	0
Thomas	0-3	0-2.5	0
Wahsatch Irrigating		0-2.5	0
Yellow indicates measurement only			

5.2 CONSUMPTIVE USE IN THE BEAR RIVER BASIN

Irrigation water in the Bear River Basin is mostly obtained from surface water diversions. Many center pivot pumps rely on surface water pumped from ditches. Crops grown in the Bear River Basin are almost exclusively grass hay, barley hay, sainfoin, alfalfa, malt barley, and oats. Flood irrigation remains the most common irrigation method, with limited but growing use of pivots for barley, oats and sainfoin.

Crop irrigation requirement (CIR) is the amount of water required by the crop to meet evapotranspiration throughout the growing season. It can be viewed as the maximum amount of water that could be used by a specific crop. Consumptive use (CU) is the amount of water that the crop actually uses. When it is less than CIR, it is most often because water is not available to irrigators for the entire irrigation season.

To fully meet the CIR at the field level, additional water must be diverted from the source. A significant portion of the diverted flow is typically lost to seepage from canals and ditches; inefficiencies at head gates; scheduling inefficiencies; and on-farm losses. On-farm losses can include evaporation from sprinklers; runoff and tail water from fields; deep percolation out of the root zone and inefficient and lack of uniformity in application of water.

Table 5.2.1.a is taken from the Bear River Basin Plan Update, 2011 and shows the average annual irrigation water requirement and supply limited consumptive use. The supply-limited consumptive used includes both surface and ground water sources.

Table 5.2.1a Average Annual Crop Consumptive Use Estimates (1971-1998)

	Irrigation Water Requirement	**Supply Limited Consumptive Use**	
Division	(Acre-Feet)		**Percent Short**
Upper Division	64,300	62,600	2.6%
Central Division	32,600	31,600	3.1%
Total Bear River Basin	**96,900**	**94,200**	**2.8%**

Source: Bear River Basin Plan Update 2011

Converting the use estimates from a Compact based accounting to a county based estimate results in county use estimates shown on Table 5.2.1b.

Table 5.2.1b Average Annual Crop Consumptive Use Estimates (1971-1998)

	Irrigation Water Requirement	**Supply Limited Consumptive Use**
County	(Acre-Feet)	
Unita	49,980	48,655
Lincoln	46,920	45,545
Total Bear River Basin	**96,900**	**94,200**

Irrigated acreage is less in a dry year, but in actuality, shortages are more in a dry year because irrigators can't irrigate the acreage they'd like to or would irrigate in a normal or wet year. So this doesn't represent the 100% shortage on those acres not irrigated in a dry year.

Flow records were available for numerous structures within each county. The structures with long term flow records are shown in Tables 5.1.4.2a & b. Additional diversions are spot checked during the season and those checks result in the data on tables 5.1.4.2c & d. Table 5.2.2 sumarizes these tables in terms of total diverted flow based on the recorded data and estimated diverted flow based on the spot checks.

Table 5.2.2 Irrigation Diversion Summary

Average Irrigation Diversion in AF for 2012 to 2014					
	Recorded Diversions			**Major Diversion 2012 to 2014 Average Diversion (AFY)**	**Minor Diversions Estimated Average Diversion (Estimated AFY)**
County	**Major Diversions 2012 (AFY)**	**Major Diversions 2013 (AFY)**	**Major Diversions 2014 (AFY)**		
Lincoln County	93,923	56,785	118,415	89,844	7,462
Uinta County	67,885	74,542	81,824	76,173	14,379
Total Diversions	**161,808**	**131,327**	**200,240**	**166,017**	**21,841**

5.3 STRUCTURE CONVEYANCE EFFICIENCY

Conveyance efficiency can be estimated by comparing Table 5.2.1b Average Annual Crop Consumptive Use Estimates (1971-1998) with Table 5.2.2 Irrigation Diversion Summary. Please note that since the flow data is at least 14 years more recent than the irrigated acreage data, the irrigated acres may be understated thereby understating the efficiency.

In 1994 there were 14 full or partial pivots. By 2014 there were 43 additional pivots with 8 of these being placed in upland areas that had not previously been cultivated. In most cases center pivots still rely on ditches to deliver water to the pump meaning there are still ditch losses.

Table 5.2.3 Estimated Irrigation Efficiency

County	**Average Annual Crop Consumtive Use (AFY)**	**Major and Minor Diversions (AFY)**	**Approximate Efficiency**
Lincoln County	46,920	97,306	48%
Uinta County	49,980	90,552	55%

The above table is a broad approximation of efficiency. The 2013 Permitting and Hydrology Evaluation Report- Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II, Phase II Project by RJH Consultants provides further insight into efficiencies. This project studied the Covey Canal in detail using instrumented wiers to segment the canal between the diverson on Smiths Fork and the reservoir site at Sublette Creek. The estimated loss in this segment was 39%. Along the full length of the canal water delivered to the end could expect about a 50% loss.

References

Water Development Office. 2011 Bear River Basin Plan Update, June, 2012. 157 pp.

Pochop, L., T. Teegarden, G. Kerr, R. Delaney, and V. Hasfurther. Consumptive use and consumptive irrigation requirements in Wyoming. University of Wyoming Cooperative Extension Service, Wyoming Water Research Center. WWRC Publication No. 92-06. October 1992. 59 pp.

Wyoming State Engineer's Office. 2012 - 2014 Hydrographers' Annual Report – Water Division 4.

VI. WATER SUPPLY AND STORAGE OPPORTUNITIES

6.1 INTRODUCTION

This section of the report involved investigation and analysis of water supply issues and storage needs and opportunities in the Bear River basin. This work involved a hydrological analysis, permitting, economic analysis, cost estimates and funding opportunities for various water storage projects. The potential opportunities for water supply and storage were comparatively ranked. Recommendations for advancement of projects were made.

The storage alternatives all have the primary purposes of supplemental agricultural irrigation water and stock water supply. However, economic feasibility is substantially enhanced with a multi-purpose project.

6.2 BEAR RIVER BASIN HYDROLOGY

The 2011 Bear River Basin plan was the most recent update of the Bear River Basin hydrology. This report extends that update to 2015 by adding 2012 to 2015 streamgauge data and diversion data to the model.

A spreadsheet model for the Bear River basin within Wyoming was developed in 2001 as part of the Bear River Basin Water Plan. The spreadsheet model data was partially updated in 2011. The spreadsheet models have been used to estimate available flow over one year, on a monthly time step. Three spreadsheet models have been developed – one each for a representative wet, dry, and average hydrologic year.

As described in the 2011 Basin Plan Update *"The models are made up of nodes that represent gauges, diversion, and storage sites. Nodes are organized into reaches defined by tributaries or sections of the main stem of the Bear River. The gauge data represent the inflow to the system and the diversions represent water taken from a reach and used for irrigation. Efficiency calculations are applied to each diversion to determine the water consumptively used and the water that returns back to the system. Available water is calculated at the bottom of each reach based on gauge data, return flows, and reach gains or losses. The gains and losses are attributed to ungauged tributaries that are not explicitly modeled, and water that may be lost in the system to sub-irrigated riparian areas and/or recharge of aquifers."*

To update the model, gauge data for the most recent 30 years was evaluated to determine wet, dry, and normal years. First missing data was filled using linear and in some cases polynomial regression analysis. Then the years were ranked according to flow. The top 20% of flows were classified as "wet", the bottom 20% as "dry" and the remainder as "normal". The average values of these classifications became the "average wet", "average dry", and "average normal" conditions.

The analysis drops the data over 30 years old in exchange for the most recent data. Of note was the loss of the wet years 1982, 1983, and 1984 and their replacement with dry to normal years of 2012 to 2015.

Due to the updated source data, values for the new averages changed slightly (downward) from the 2011 Basin Plan Update reflecting a new normal. Table 6.2 shows the new normal, wet and dry years.

Table 6.2 30-Year Wet, Dry and Normal Years

USGS Gauge	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
10011500	⬜	🟦	⬜	🟨	⬜	⬜	⬜	🟨	⬜	⬜	🟦	⬜	🟦	🟦	🟦	⬜	🟨	🟨	⬜	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟨	⬜	⬜	⬜
10016900	⬜	🟦	⬜	⬜	⬜	⬜	⬜	🟨	🟦	🟨	🟦	⬜	🟦	🟦	🟦	🟨	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟨	⬜	⬜	⬜
10020100	⬜	🟦	⬜	⬜	⬜	🟨	⬜	🟨	🟦	⬜	🟦	⬜	🟦	🟦	⬜	⬜	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟨	🟨	⬜	⬜
10020300	🟦	🟦	⬜	⬜	⬜	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟦	🟦	⬜	🟨	🟨	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟨	⬜	⬜
10026500	⬜	🟦	⬜	⬜	⬜	🟨	⬜	🟨	x	x	x	x	x	x	x	x	x	x	x	x	x	x	🟨	⬜	⬜	⬜	🟦	⬜	🟨	⬜	🟨
10028500	🟦	🟦	⬜	⬜	⬜	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	🟦	🟦	⬜	🟨	🟨	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟨	⬜	⬜
10032000	⬜	🟦	🟨	⬜	⬜	⬜	⬜	🟨	⬜	🟨	⬜	🟦	🟦	⬜	🟦	⬜	🟨	🟨	⬜	⬜	⬜	⬜	🟨	⬜	🟦	⬜	🟦	⬜	⬜	⬜	⬜
10038000	🟦	🟦	⬜	⬜	⬜	🟨	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟦	🟦	⬜	🟨	🟨	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟨	⬜	⬜
10039500	🟦	🟦	⬜	⬜	⬜	🟨	⬜	🟨	⬜	⬜	⬜	🟦	🟦	🟦	🟦	⬜	🟨	🟨	🟨	🟨	⬜	⬜	⬜	⬜	⬜	⬜	🟦	⬜	🟨	⬜	⬜

🟨 Dry Year
⬜ Normal Year
🟦 Wet Year
x No data for entire year

6.2.1 BEAR RIVER MODELS

The 2001 model averages stream gauge data for each category of years (dry, normal and wet) and this average value is then run in the model with the average diversion values corresponding to the same group of years. The diversion values were taken from the annual SEO hydrographers reports. A few groups of data, such as cumulative Idaho diversions and Utah diversions, were not updated in 2011 or in this update. The lack of data in some of these areas is mitigated by the averaging effect and consequently the impact of the missing data is not as great as it might be if the model were looking at individual years.

The model was run for the dry, nomal and wet year scenarios to project how these differing hydrological conditions interact with the terms of the Bear River Compact and to identify when the terms of the Compact would be enforced. Appendix F contains selected data from the hydrologic models.

6.2.2 MODELING RESULTS

The model yields numerous datasets related to diversions and the Compact allocations. Tables 6.2.2.1 and 6.2.2.2 highlight the model results. Of particlar note are those conditions for which Compact restrictions are predicted to have effect. Each table contains a line or lines related to "Water Emergency" (W.E) and the conditions for the declaration of an emergency. Note that water emergencies are predicted to occur in every year. Wet years delay the emergency until August or September while dry years can be in regulation for the entire season.

Table 6.2.2.1 Upper Division Modeling Summary

Upper Division - Summary of Modeling Results for the Bear River Planning Model

	Month				
	May	June	July	August	September
Normal Year					
Upper Utah Section Diversion	418	886	503	349	134
Upper Wyoming Section Diversion	16,226	24,452	17,685	7,650	5,472
Woodruff Narrows Reservoir Change in Storage Water	968	(18,097)	(6,250)	(1,366)	(1,052)
Lower Utah Section Diversions	40,410	64,396	24,578	4,339	5,555
Lower Wyoming Section Diversions	5,669	12,259	3,027	148	79
Bear River Below Pixley Dam	9,366	16,532	12,441	3,752	2,615
Total Upper Division Divertible Flow (ac-ft)	73,057	100,428	51,985	14,871	12,804
Total Upper Division Divertible Flow (cfs)*	1,188	1,688	845	242	215
If Total Upper Division Divertible Flow less than 1250 cfs Water Emergency (* ***W.E* *.) exists.*	W.E.	No W.E.	W.E.	W.E.	W.E.
Upper Utah Section Allocation	438		312	89	77
Upper Wyoming Allocation	36,017		25,629	7,331	6,312
Lower Utah Section Allocation	29,588		21,054	6,023	5,186
Lower Wyoming Section Allocation	7,013		4,991	1,428	1,229
Dry Year					
Upper Utah Section Diversion	492	718	377	200	119
Upper Wyoming Section Diversion	19,767	24,029	12,076	4,482	3,623
Woodruff Narrows Reservoir Change in Storage Water	(3,633)	(28,303)	(2,289)	(0)	0
Lower Utah Section Diversions	22,452	48,728	9,629	2,168	2,680
Lower Wyoming Section Diversions	4,110	10,927	2,945	206	166
Bear River Below Pixley Dam	6,566	6,962	1,836	1,356	483
Total Upper Division Divertible Flow (ac-ft)	49,755	63,061	24,573	8,412	7,071
Total Upper Division Divertible Flow (cfs)*	809	1,060	400	137	119
If Total Upper Division Divertible Flow less than 1250 cfs Water Emergency (* ***W.E* *.) exists.*	W.E.	W.E.	W.E.	W.E.	W.E.
Upper Utah Section Allocation	299	378	147	50	42
Upper Wyoming Allocation	24,529	31,089	12,114	4,147	3,486
Lower Utah Section Allocation	20,151	25,540	9,952	3,407	2,864
Lower Wyoming Section Allocation	4,776	6,054	2,359	808	679
Wet Year					
Upper Utah Section Diversion	291	1,121	968	601	237
Upper Wyoming Section Diversion	12,363	25,197	23,145	10,994	9,136
Woodruff Narrows Reservoir Change in Storage Water	(18,185)	(16,838)	8,798	(6,992)	(4,657)
Lower Utah Section Diversions	24,752	52,336	21,320	1,633	3,508
Lower Wyoming Section Diversions	6,067	9,808	2,317	167	150
Bear River Below Pixley Dam	76,827	88,223	36,335	18,563	11,693
Total Upper Division Divertible Flow (ac-ft)	102,116	159,847	92,882	24,967	20,068
Total Upper Division Divertible Flow (cfs)*	1,661	2,686	1,511	406	337
If Total Upper Division Divertible Flow less than 1250 cfs Water Emergency (* ***W.E* *.) exists.*	No W.E.	No W.E.	No W.E.	W.E.	W.E.
Upper Utah Section Allocation				150	120
Upper Wyoming Allocation				12,309	9,894
Lower Utah Section Allocation				10,112	8,128
Lower Wyoming Section Allocation				2,397	1,927

Table 6.2.2.2 Central Division Modeling Summary

Central Division - Summary of Modeling Results for the Bear River Planning Model					
	Month				
	May	June	July	August	September
Normal Year					
Wyoming Diversions	12,074	21,899	18,385	9,780	5,306
Idaho Diversions	15,027	25,359	14,104	6,943	6,542
Rainbow Inlet Canal plus Bear River Main Stem Flow below Stewart Dam	30,816	44,548	31,323	8,977	6,484
Total Central Division Divertible Flow (ac-ft)	57,918	91,807	63,811	25,701	18,332
Total Central Division Divertible Flow(cfs)	942	1,543	1,038	432	308
If Total Divertible Flow (2) < 870 cfs; Water Emergency (**W.E.** *) exists.*	No W.E.	No W.E.	No W.E.	W.E.	W.E.
Flow of Bear River at Border Gaging Station (ac-ft)	34,927	49,088	26,475	10,607	7,769
Flow of Bear River at Border Gaging Station(cfs)	587	825	431	178	131
If Flow at Border < 350 cfs; Water Emergency (**W.E.** *) exists.*	No W.E.	No W.E.	No W.E.	W.E.	W.E.
Allocation in the State of Wyoming				11,051	7,883
Allocation in the State of Idaho				14,649	10,449
Dry Year					
Wyoming Diversions	10,887	16,875	13,782	7,538	4,483
Idaho Diversions	14,147	15,309	8,206	5,183	4,384
Rainbow Inlet Canal plus Bear River Main Stem Flow below Stewart Dam	23,565	23,768	13,064	4,845	3,885
Total Central Division Divertible Flow (ac-ft)	48,599	55,952	35,052	17,566	12,752
Total Central Division Divertible Flow(cfs)	790	940	570	295	214
IfTotal Divertible Flow (2) < 870 cfs; Water Emergency (**W.E.** *) exists.*	W.E.	No W.E.	W.E.	W.E.	W.E.
Flow of Bear River at Border Gaging Station (ac-ft)	18,671	20,301	9,702	5,301	3,793
Flow of Bear River at Border Gaging Station(cfs)	314	341	158	89	64
If Flow at Border < 350 cfs; Water Emergency (**W.E.** *) exists.*	W.E.	W.E.	W.E.	W.E.	W.E.
Allocation in the State of Wyoming	20,898	24,059	15,073	7,553	5,483
Allocation in the State of Idaho	27,702	31,893	19,980	10,013	7,269
Wet Year					
Wyoming Diversions	8,670	23,547	18,729	9,898	5,404
Idaho Diversions	10,091	24,426	14,442	7,496	6,193
Rainbow Inlet Canal plus Bear River Main Stem Flow below Stewart Dam	91,726	88,053	44,631	17,848	13,269
Total Central Division Divertible Flow (ac-ft)	110,487	136,026	77,803	35,242	24,866
Total Central Division Divertible Flow(cfs)	1,797	2,286	1,265	592	418
IfTotal Divertible Flow (2) < 870 cfs; Water Emergency (**W.E.** *) exists.*	No W.E.	No W.E.	No W.E.	W.E.	W.E.
Flow of Bear River at Border Gaging Station (ac-ft)	134,313	165,753	72,688	30,991	19,890
Flow of Bear River at Border Gaging Station(cfs)	2,257	2,786	1,182	521	334
If Flow at Border < 350 cfs; Water Emergency (**W.E.** *) exists.*	No W.E.	No W.E.	No W.E.	No W.E.	W.E.
Allocation in the State of Wyoming				15,154	10,692
Allocation in the State of Idaho				20,088	14,173

6.2.3 BEAR RIVER BASIN INSTREAM FLOWS

Several rivers and streams in the Bear River basin are permitted for instream flow water rights.

The instream flow process in Wyoming involves three State agencies: the Game and Fish Department (WGFD), the Water Development Commission (WWDC), and the State Engineer's Office (SEO). The WGFD identifies stream reaches where instream flows are critical and unappropriated surface water appears available. The WGFD conducts field studies and prepares a biological report that identifies the minimum flows necessary to maintain or improve existing fisheries. A water right application with the requested minimum flows is then prepared by the WGFD that lists the WWDC as the applicant. The application is submitted to the SEO along with the biological report. The date that the application is submitted establishes the priority date of the water right. The WWDC then completes a hydrologic study on the feasibility of unappropriated water in the stream supporting the application's requested flows. Upon completion, the WWDC study is supplied to the State Engineer for his consideration. The State Engineer then conducts a public hearing to present WGFD and WWDC information and receive public comments. Following the public input period, the State Engineer determines whether or not to approve the application or approve with modifications to the requested flows. The State Engineer issues a decision and permits the instream flow right. The instream flow appropriation goes into effect the date the State Engineer approves the permit. It then becomes the Board of Control's job to finalize or "proof" the water right by physically measuring stream flows to validate that the permitted flows are present. However, the water right cannot be fully finalized, or adjudicated, by the Board of Control for at least three years after the permit is granted.

WWDC's hydrologic study primarily involves a collection of data, a water rights inventory, flow measurements, and a hydrology analysis. Data collection entails gathering available time-series records of stream flow, diversions, reservoir storage, and other pertinent information. During the water rights inventory, SEO records are researched, and all existing water rights are inventoried that encompass areas located upstream from the downstream end of each instream flow segment. Stream flows are verified during the course of the study by periodic flow measurements and the installation and monitoring of stage recording equipment. A comprehensive hydrology analysis is performed to estimate virgin flow in the basin during a dry, average, and wet year. The analysis typically involves the use of stream flow data, diversion records, consumptive use estimates, depletions and return flows, return flow patterns, and return flow timing. Available unappropriated flows are then determined for the dry, average, and wet year classifications based on the water rights inventory and the hydrology analysis. If shortages are indicated, the feasibility of placing storage above the instream flow segment is evaluated. Lastly, exceedance flows are determined along with the percent of time the requested instream flows are equaled or exceeded and compared to unappropriated flows.

As of the date of this report, a total of 16 instream flow segments reside within the Bear River Basin study area. The segments are associated with tributaries to the Bear including Smiths Fork. All have been issued permits by the State Engineer's Office and have been proofed by Division 4 of the State's Board of Control. A summary of these 16 instream flow segments is presented in Table 6.2.4. Further information and maps pertaining to instream flow filings in Wyoming can be found on the WWDC's website: http://wwdc.state.wy.us/instream_flows/instream_flows.html. A more complete tabulation of the State's instream flow filings can be found in Appendix J.

Table 6.2.4 Instream Flow Segments within the Bear River Basin Study Area

Stream Name	Stream Length (mi)	Temp Filing No.	Priority Date	Permit No.	Date Issued	County	Current Status
Coal Creek Seg No. 1	0.80	29 6/38	6/20/95	16 IF	1/10/2002	Lincoln County	Active
Hobble Creek Seg No. 1	2.70	29 1/39	06/20/95	14 IF	10/3/2001	Lincoln County	Active
Huff Creek Seg No. 1	3.30	29 2/39	06/20/95	20 IF	10/9/2002	Lincoln County	Active
Raymond Creek Seg No. 1	1.60	29 6/74	12/19/95	18 IF	9/15/2002	Lincoln County	Active
Porcupine Creek Seg No. 1	1.30	29 1/75	12/19/95	27 IF	12/8/2002	Lincoln County	Active
Smiths Fork Seg No. 1	5.00	29 4/75	12/19/95	26 IF	11/26/2002	Lincoln County	Active
Salt Creek Seg No. 1	4.50	29 1/128	6/27/96	17 IF	1/18/2002	Lincoln County	Active
Water Canyon Ck Seg No. 1	1.20	29 2/128	6/27/96	22 IF	10/31/2002	Lincoln County	Active
Coal Creek Seg No. 1	4.20	29 5/128	6/27/96	23 IF	11/1/2002	Lincoln County	Active
Giraffe Creek Seg No. 1	2.40	29 2/129	6/27/96	19 IF	10/9/2002	Lincoln County	Active
Coantag Creek Segment No. 1	4.90	29 3/129	6/27/96	15 IF	1/2/2002	Lincoln County	Active
Lander Creek IF Segment No. 1	0.4	29 6/237	8/25/97	32 IF	12/01/03	Lincoln County	Active
North Fork Smiths Fork R Seg No.1	2.4	29 2/238	8/25/97	31 IF	12/1/2003	Lincoln County	Active
Packstring Ck If Segment No. 1	1.3	29 3/238	8/25/97	24 IF	11/4/2002	Lincoln County	Active
Poker Hollow Ck IF Segment No 1	1.6	29 4/238	8/25/97	21 IF	10/9/2002	Lincoln County	Active
Trespass Ck IF Segment No 1	1.00	29 5/238	8/25/97	75 IF	1/17/2008	Lincoln County	Active

6.2.4 WATER AVAILABILITY

The model input includes full supply water demands to meet crop water requirements for lands identified as currently irrigated in the 2011 model. The model input includes full supply water demands to meet crop water requirements for lands currently under irrigation. The full utilization of water rights, though, to meet demands on the permitted acreage associated with the water rights would further limit flow available for upland storage or in a new storage facility.

6.3 PRELIMINARY RESERVOIR SCREENING

6.3.1 PREVIOUS STUDIES AND PLANNING DOCUMENTS

This present study was designed to be a review of existing studies with reservoir storage components. This study does not pursue new detailed analysis of previously identified reservoir sites. A few new sites have been identified in this study by land owners and operators. This study compiles the previously identified sites along with basic site information and study results.

Numerous studies have addressed storage opportunities in the Bear River Watershed. Of the planning documents reviewed, the following studies (included in the digital library) had reservoir planning components:

- US Department of the Interior, Bureau of Reclamation. (June 1970). *Bear River Investigations, Status Report*
- USDA-Soil Conservation Service Economic Research Service, Forest Service in cooperation with States of Idaho, Utah and Wyoming. (February 1976). *Existing and Potential Reservoirs, Working Paper for Bear River Basin Type IV Study, Idaho-Utah-Wyoming.*
- *Banner Associates Inc. (1983). Level I Fesibility Study Smiths Fork Drainage.*
- Forsgren-Perkins / Rollins, Brouwn & Gunnell (March 1984). *Upper Bear River Drainage Water Resource Investigation Level II Feasiblity Study*
- G.B.R. Consultants Group, Inc. (1985). *Smiths Fork Project Level II Study Final Report*
- Sunrise Engineering, Inc. (August 2004) *Cokeville Reservoir Lvel I Study*
- Short Elliott Hendrickson Inc. (February 9, 2009). *Sublette Creek Reservoir and Covey/Mau Canal Rehabilitation Project, Level II Study*
- RJH Consultants, Inc.; November. (2010). *Preliminary Design Report Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II Project*
- RJH Consultants. (2015) *Memorandum, Fatal Flaw Evaluation for Dry Fork Reservoir Site*
- RJH Consultants. (2015) *Memorandum, Sublette Creek Third Site Selection*

Most studies focused on headwater sites located on the northeastern or southern portions of the drainage. One site (Twin Creeks) is about the middle of the basin. The above studies mentioned or reviewed about 40 potential reservoir sites or enlargements in the basin area. Of these sites several were constructed such as Sulpher Creek, Meyers, Neponset, and Chapman. More popular sites were reviewed by multiple studies. The potential sites range in size from 50,000 acre-feet (Tiechert Bagley on Smiths Fork) down to about 400 acre-feet (Stowe Creek site). The exact size at any given site can vary between studies. Since the earliest investigations, to the present, environmental and social changes, along with physical land development, have changed expectations of reservoir sizes and locations. The additional years of hydrologic data have also better defined what is possible and practical. Earlier documents tend to have fewer, but larger and more aggressive storage proposals, while later documents tend to focus on multiple smaller off-channel sites. The fact that the larger on-channel sites were eliminated in most recent studies reflects the improbability anticipated with permitting of a large reservoir on the main stem of the Bear River or Smiths Fork. The NEPA process necessitates the consideration of a range of reasonable alternatives that would achieve the objective of the purpose and need for the project. The intent of the process is to identify the Least Environmentally Damaging Practicable Alternative (LEDPA). In addition to the dam and reservoir impact of the reservoir alternatives, construction of a costly conveyance system would be required for off channel sites. The on going investigations at Sublette Creek demonstrate the difficulty with finding a site that is truly off-channel. Sites with any natural flows regardless of flow size, should be approached with caution from a fish and wildlife perspective. Table 6.3.1.1 is a matrix illustrating which studies addressed various sites and the ranking of the top sites in the respective study.

Table 6.3.1.1 Previous Reservoir Studies

		Site																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Previous Studies Containing Reservoir Components*	Lower Teichert - Bagley	Upper Teichert - Bagley	Smiths Fork	Ashby	Ferney Glade	Trespass	Lower Sublette Creek	Lower Sublette Creek	Upper Sublette Creek	Larson Reservoir Expansion	Larson Reservoir Expansion	Sublette Flat	Sublette Flat	Trail Creek	Dry Fork	Giraffe	Pokerhollow	Spring Creek	Thomas Fork	Twin Creek
1	[1]US Department of the Interior, Bureau of Reclamation. (June 1970). Bear River Investigations, Status Report																		🟩	🟩 X	
2	USDA-Soil Conservation Service Economic Research Service, Forest Service in cooperation with States of Idaho, Utah and Wyoming. (February 1976). Existing and Potential Reservoirs, Working Paper for Bear River Basin Type IV Study, Idaho-Utah-Wyoming.	🟩	🟩		🟩	🟩	🟩									🟩	🟩	🟩	🟩	🟩	🟩
3	Banner Associates Inc. (1983). Level I Fesibility Study Smiths Fork Drainage.	🟩	🟩	🟩 X	🟩 X	🟩	🟩														
4	Forsgren-Perkins / Rollins, Brown & Gunnell (March 1984). Upper Bear River Drainage Water Resource Investigation Level II Feasiblity Study;																				
5	G.B.R. Consultants Group, Inc. (1985). Smiths Fork Project Level II Study Final Report	🟩	🟩																		
6	Sunrise Engineering, Inc. (August 2004) Cokeville Reservoir Lvel I Study.	🟩	🟩		🟩	🟩	🟩														
7	Short Elliott Hendrickson Inc. (February 9, 2009). Sublette Creek Reservoir and Covey/Mau Canal Rehabilitation Project, Level II Study							🟩 X	🟩	🟩	🟩	🟩	🟩	🟩	🟩						
8	RJH Consultants, Inc.; November. (2010). Preliminary Design Report Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II Project.							🟩 X	🟩 X	🟩											
9	RJH Consultants. (2015) Memorandum, Fatal Flaw Evaluation for Dry Fork Reservoir Site.															🟩					
10	RJH Consultants. (2015) Memorandum, Sublette Creek Third Site Selection.		🟩	🟩				🟩 X	🟩		🟩	🟩	🟩	🟩							
11	Forsgren Associates/Inc. (2002) Bear River Basin Water Plan, Final Report.					🟩															
12	Water Development Office. (2012) 2011 Bear River Basin Plan Update.								🟩												
13	JT Banner & Associates Inc. (1968) Wyomings Water Supplies and Needs in the Bear River Basin.				🟩	🟩															

		Site																		
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	Previous Studies Containing Reservoir Components*	Muddy Creek	Greasy Spoon (Smiths Fork in Later Studies)	Needles; Needle Rock (Coyote Creek)	Stowe Creek	Woodruff Narrows Enlargement	Coyote Creek	Myers	Pleasant Valley	Mill Creek	West Fork	South B Jones	Splash Dam	East Fork	Still Water	Mill City	Yellow Creek	Wyuta	Gold Hill	Lilly Lake
1	[1]US Department of the Interior, Bureau of Reclamation. (June 1970). Bear River Investigations, Status Report	🟩						Constructed												
2	USDA-Soil Conservation Service Economic Research Service, Forest Service in cooperation with States of Idaho, Utah and Wyoming. (February 1976). Existing and Potential Reservoirs, Working Paper for Bear River Basin Type IV Study, Idaho-Utah-Wyoming.	🟩	🟩	🟩		🟩	🟩		🟩	🟩			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩
3	Banner Associates Inc. (1983). Level I Fesibility Study Smiths Fork Drainage.																			
4	Forsgren-Perkins / Rollins, Brown & Gunnell (March 1984). Upper Bear River Drainage Water Resource Investigation Level II Feasiblity Study;										🟩									
5	G.B.R. Consultants Group, Inc. (1985). Smiths Fork Project Level II Study Final Report																			
6	Sunrise Engineering, Inc. (August 2004) Cokeville Reservoir Lvel I Study.																			
7	Short Elliott Hendrickson Inc. (February 9, 2009). Sublette Creek Reservoir and Covey/Mau Canal Rehabilitation Project, Level II Study																			
8	RJH Consultants, Inc.; November. (2010). Preliminary Design Report Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II Project.																			
9	RJH Consultants. (2015) Memorandum, Fatal Flaw Evaluation for Dry Fork Reservoir Site.																			
10	RJH Consultants. (2015) Memorandum, Sublette Creek Third Site Selection.																			
11	Forsgren Associates/Inc. (2002) Bear River Basin Water Plan, Final Report.	🟩		🟩																
12	Water Development Office. (2012) 2011 Bear River Basin Plan Update.	🟩																		
13	JT Banner & Associates Inc. (1968) Wyomings Water Supplies and Needs in the Bear River Basin.						🟩			🟩				🟩						

X = Leading site for Study

6.3.2 POTENTIAL RESERVOIR SITES ELIMINATED

Most of the previous reservoir studies tended to have a relative narrow focus of a few sites. Notable exceptions were the 1976 USDA study that identified up to 25 sites, and the Smiths Fork studies that included up to 7 sites. Comparative analysis in the previous studies generally pertained to only a few sites in any study and were not basinwide. The 2004 Smiths Fork study (Sunrise) viewed multiple on-channel sites and concluded the sites lowest in the basin (Tiechert-Bagley or Smiths Fork) offered the best feasibility. However significant wildlife and environmental hurdles existed with each of these main channel sites. After the 2004 study, off-channel sites became more attractive from a permitting perspective. Recent studies (RJH) related to Smiths Fork water contained numerous off-channel alternatives with the Sublette Creek sites being the most favorable. Continued investigations and permitting efforts have identified issues with off-channel sites related to endangered fish and instream flow requirements of the mainstem of Smiths Fork below where the water would be taken (Covey Canal Diversion).

In the Uinta County portion of the basin, interest in Yellow Creek and Coyote Creek have been the focus of reservoirs in Wyoming. At least one land owner has contining interest in establishing a small amount of storage on Yellow Creek or Coyote Creek. He presently operates a small off-channel reservoir (Coy) supplied by Yellow Creek and will attempt to enlarge this reservoir should there be no interest from other users in establishing a larger reservoir.

During this study a site on Stowe Creek was identified by a landowner as a potential reservoir site for a dam of 300 to 400 acre feet.

Other sites higher in the Utah portion of the basin fall on Private or USFS land; are on tributary stems; and are expected to encounter stiff resistance due to fishery and environmental concerns.

6.3.3 STORAGE EVALUATION MATRIX

The following Table 6.3.3 shows a short list of potential reservoir sites along with issues and features gleaned from previous studies that could impact feasibility. The blank spaces on the matrix are due to limited information in previous studies.

The costs were taken from historic studies then updated to 2016 dollars and reflect the cost of the reservoir and identified conveyance infrastructure. In all cases, delivery of stored water will occur in natural drainage paths. The color coding on Table 6.3.3 is of particular significance in that it reflects concerns with the particular site that are associated with the current permitting and mitigation climate. In many instances, reservoir sites once considered feasible from a water supply, cost and engineering standpoint, now have permitting and mitigation hurdles that are insurmountable.

Table 6.3.3 Potential Reservoir Storage Sites

Site #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Proposed Reservoir Site Name	**Lower Teichert - Bagley**	**Upper Teichert - Bagley**	**Smiths Fork**	**Ashby**	**Ferney Glade**	**Trespass**	**Lower Sublette Creek**	**Lower Sublette Creek**	**Upper Sublette Creek**	**Larson Reservoir Expansion**	**Larson Reservoir Expansion**	**Sublette Flat**	**Sublette Flat**	**Trail Creek**	**Dry Fork**	**Giraffe**	**Pokerhollow**	**Spring Creek**	**Thomas Fork**
Historic Studies Addressing Site (see list at bottom)	**2, 3, 5, 6**	**2, 3, 5, 6, 10**	**3, 10**	**2, 3, 6**	**2, 3, 6,11, 13**	**2, 3, 6**	**7, 8, 10**	**7, 8, 10, 12**	**7, 8**	**7, 10**	**7, 10**	**7, 10**	**7, 10**	**7,**	**9**	**2,**	**2,**	**1, 2, 13**	**1, 2**
On Channel/Off Channel	On Channel	On Channel	On Channel	On Channel	On Channel	On Channel	On Channel	On Channel	On Channel	Off Channel	Off Channel	Off Channel	Off Channel	Off Channel	On Dry Fork	On Channel	On Channel	On Channel	On Channel
Source Stream Name	Smiths Fork	Smiths Fork	Smiths Fork	Smiths Fork	Smiths Fork	Hobble Creek-Trib Smiths Fork	Sublette Creek	Sublette Creek	Sublette Creek	Unnamed Creek	Unnamed Creek	Unnamed Creek	Unnamed Creek	Trail Creek	Smiths Fork and Hobble Creek				
County	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln	Lincoln
Reservoir Size (Acre Feet)	14,000 - 50,000	14,000 - 50,000	17,000	5,000 -21,000	10,000 - 25000	4,400 - 10,000	5,000	9,000	1,700	5,000	15,000	5,000	15,000	5,000	5,000	10,000	3,600-6,000	5,000	10,000 - 11,500
Reservoir Height (ft.)	114	107	109	70 - 125	105 - 157	84 - 155	60	71	142	78	103	70	100	73		85	70 - 98	75	117
Crest Length	1,980	1,850	2,250	1,070 - 1,450	600 - 1570	780 - 1780	1,955	1,957	610	3,716	5,174	2,951	5,586	2,809		460	690	1,200	710
Tributary Area (Sq. Mi.)	178	174	157	147	90	42	29.7	30.0	4.3	3.0	3.0	3.8	3.8	9.3			15.0		44.0
Mean Basin Elevation							7,100.0	7,100.0	7,600.0	6,440.0	6,440.0	6,420.0	6,420.0	7,050.0					
Irrig. Conv. Eff.	50%	50%	47%	46%	45%	45%	50%	50%	50%	50%	50%	50%	50%	50%					
Min. Instream Flow (cfs)	65	65	65	65	40	26												🟧 Adequate Supply?	
Supply Conveyance (miles)							🟩	🟩	🟩	🟧 26	🟧 26	🟧 26	🟧 26	🟧 31	🟧 Yes				
Geology							🟥	🟥	🟥	🟨	🟨	🟨	🟨	🟨	🟨 Not Ideal but Works				
Land ownership	Private, State, BLM	ivate, State, BL	ivate, State, BL	ivate, State, BL	BLM, Forest	BLM, Forest									🟧 USFS				
Inundated Acreage	380	425	570	320 - 355	390	323 - 524	🟧 291	🟧 404	30	238	544	213	473	212				220.0	400.0
Inundated Infrastructure	🟨 Yes	🟨 Yes	🟨 Yes	🟢 Minimal	🟩 No	🟩 No	🟧	🟥 Ranch	🟨	🟧	🟧	🟨	🟨	🟧	🟧 roadway				
Cultural or Archaeological							🟧	🟧	🟢	🟧	🟧	🟢	🟨	🟧	🟧				
Wetlands Impacts	171	141	125	99	204	105	🟧 27	🟥 84	🟨 5	🟨 13	🟨 15	🟨 13	🟨 13	🟧 38	🟨 12				
Threatened or Endangered							🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟢	🟧 Canada Lynx - Yellow Billed Cockoo				
Sage Grouse																			
Big Game Impacts	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟨	🟧	🟥	🟧	🟧	🟧	🟧				
Fish	🟧	🟧	🟧	🟧	🟧	🟧	🟧 Bonneville Cutt & Leatherside Chub	🟧 Bonneville Cutt & Leatherside Chub	🟨	🟨	🟨	🟨	🟨	🟨	🟥 Leatherside Chub				
Year of Most Recent Cost Estimate	2004	2004	2004	2004	2004	2004	2009	2009	2009	2009	2009	2009	2009	2009					
Cost on Date of Estimate	13,800,000	10,800,000	10,572,000	11,040,000	13,020,000	13,560,000	15,794,000	19,600,000	10,100,000	25,800,000	58,000,000	25,300,000	62,900,000	28,500,000					
$ Cost in 2016 @ 3%/annum inflation																			
2016 $ Cost/Acre Ft																			

[1] US Department of the Interior, Bureau of Reclamation. (June 1970). *Bear River Investigations, Status Report*

[2] USDA-Soil Conservation Service Economic Research Service, Forest Service in cooperation with States of Idaho, Utah and Wyoming. (February 1976). *Existing and Potential Reservoirs, Working Paper for Bear River Basin Type IV Study, Idaho-Utah-Wyoming.*

[3] *Banner Associates Inc. (1983). Level I Fesibility Study Smiths Fork Drainage.*

[4] Forsgren-Perkins / Rollins, Brown & Gunnell (March 1984). *Upper Bear River Drainage Water Resource Investigation Level II Feasiblity Study;*

[5] G.B.R. Consultants Group, Inc. (1985). *Smiths Fork Project Level II Study Final Report*

[6] Sunrise Engineering, Inc. (August 2004) *Cokeville Reservoir Lvel I Study.*

[7] Short Elliott Hendrickson Inc. (February 9, 2009). *Sublette Creek Reservoir and Covey/Mau Canal Rehabilitation Project, Level II Study*

[8] RJH Consultants, Inc.; November. (2010). *Preliminary Design Report Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II Project.*

[9] RJH Consultants. (2015) *Memorandum, Fatal Flow Evaluation for Dry Fork Reservoir Site.*

[10] RJH Consultants. (2015) *Memorandum, Sublette Creek Third Site Selection.*

[11] Forsgren Associates/Inc. (2002) *Bear River Basin Water Plan, Final Report.*

[12] Water Development Office. (2012) *2011 Bear River Basin Plan Update.*

[13] JT Banner & Associates Inc. (1968) *Wyomings Water Supplies and Needs in the Bear River Basin.*

🟩	***Favorable for Project***
🟢	***Minimal Difficulty***
🟨	***Cost / Permitting Impact***
🟧	***Caution; Could be Fatal Flaw***
🟥	***Potential Fatal Flaw***

Table 6.3.3 Potential Reservoir Storage Sites (Continued)

Site #	20	21	22	23	24	25	26	27	28	29
Proposed Reservoir Site Name	**Twin Creek**	**Muddy Creek**	**Greasy Spoon (Smiths Fork in Later Studies)**	**Needles; Needle Rock (Coyote Creek)**	**Stowe Creek**	**Woodruff Narrows Enlarge ment**	**Coyote Creek**	**Myers (Construc ted)**	**Pleasant Valley**	**Mill Creek**
Historic Studies Addressing Site (see list at bottom)	2,	1, 2, 11,12, 13	2,	2,11		2,	2, 13	2,	2,	2, 13
On Channel/Off Channel	On Channel	Off Chanel	On Channel	On Channel	On Channel	On Channel	On Channel	Off Chann	On Channel	On Channel
Source Stream Name				Yellow Creek	Stowe Creek		Bear River Via Tunnel			Mill Creek
County	Lincoln	Lincoln	Lincoln	Uinta	Uinta	Uinta	Uinta	Uinta	Uinta	Summit-Utah
Reservoir Size (Acre Feet)	5,850	5,000	4,900	35,000	400	28,400	15,000 - 25,000	15,000	50,000	2350
Reservoir Height (ft.)	117		70	111	20	70	70 - 85	86	117	70
Crest Length	710			825	450	615		1310	1,000	
Tributary Area (Sq. Mi.)			150.0							45
Mean Basin Elevation										
Irrig. Conv. Eff.										
Min. Instream Flow (cfs)		Adequate Supply?			None					
Supply Conveyance (miles)										
Geology										
Land ownership										
Inundated Acreage	853.0				30		1900			120
Inundated Infrastructure					near RR					
Cultural or Archaeological										
Wetlands Impacts										
Threatened or Endangered										
Sage Grouse										
Big Game Impacts										
Fish										
Year of Most Recent Cost Estimate					2016		1968			1968
Cost on Date of Estimate					2,094,000		1,200,000			940000
$ Cost in 2016 @ 3%/annum inflation										
2016 $ Cost/Acre Ft										

Site #	30	31	32	33	34	35	36	37	38	39
Proposed Reservoir Site Name	**West Fork**	**South B Jones**	**Splash Dam**	**East Fork**	**Still Water**	**Mill City**	**Yellow Creek**	**Wyuta**	**Gold Hill**	**Lilly Lake**
Historic Studies Addressing Site (see list at bottom)	4,		2,	2, 13	2,		2,	2,	2,	2,
On Channel/Off Channel	On Channel			On Channel				On Channel		
Source Stream Name	West Fork			East Fork						
County	Summit-Utah	Summit-Utah	Summit-Utah	Summit-Utah	Summit-Utah	Summit-Utah	Uinta and Summit-Utah	Summit-Utah	Summit-Utah	Summit-Utah
Reservoir Size (Acre Feet)	20,000			8,500			44,700	146,000	1,055	2,000 - 2,500
Reservoir Height (ft.)	140			100				170		53
Crest Length								1850		
Tributary Area (Sq. Mi.)				38						
Mean Basin Elevation										
Irrig. Conv. Eff.										
Min. Instream Flow (cfs)										
Supply Conveyance (miles)										
Geology										
Land ownership										
Inundated Acreage				350			1200			
Inundated Infrastructure										
Cultural or Archaeological										
Wetlands Impacts										
Threatened or Endangered										
Sage Grouse										
Big Game Impacts										
Fish	Bonneville Cutthroat									
Year of Most Recent Cost Estimate				1968						
Cost on Date of Estimate				1,124,000						
$ Cost in 2016 @ 3%/annum inflation										
2016 $ Cost/Acre Ft										

[1] US Department of the Interior, Bureau of Reclamation. (June 1970). *Bear River Investigations, Status Report*

[2] USDA-Soil Conservation Service Economic Research Service, Forest Service in cooperation with States of Idaho, Utah and Wyoming. (February 1976). *Existing and Potential Reservoirs, Working Paper for Bear River Basin Type IV Study, Idaho-Utah-Wyoming.*

[3] *Banner Associates Inc. (1983). Level I Fesibility Study Smiths Fork Drainage.*

[4] Forsgren-Perkins / Rollins, Brown & Gunnell (March 1984). *Upper Bear River Drainage Water Resource Investigation Level II Feasiblity Study;*

[5] G.B.R. Consultants Group, Inc. (1985). *Smiths Fork Project Level II Study Final Report*

[6] Sunrise Engineering, Inc. (August 2004) *Cokeville Reservoir Lvel I Study.*

[7] Short Elliott Hendrickson Inc. (February 9, 2009). *Sublette Creek Reservoir and Covey/Mau Canal Rehabilitation Project, Level II Study*

[8] RJH Consultants, Inc.; November. (2010). *Preliminary Design Report Sublette Creek Reservoir Mau/Covey Canal Rehabilitation Level II Project.*

[9] RJH Consultants. (2015) *Memorandum, Fatal Flaw Evaluation for Dry Fork Reservoir Site.*

[10] RJH Consultants. (2015) *Memorandum, Sublette Creek Third Site Selection.*

[11] Forsgren Associates/Inc. (2002) *Bear River Basin Water Plan, Final Report.*

[12] Water Development Office. (2012) *2011 Bear River Basin Plan Update.*

[13] JT Banner & Associates Inc. (1968) *Wyomings Water Supplies and Needs in the Bear River Basin.*

Favorable for Project

Minimal Difficulty

Cost / Permitting Impact

Caution; Could be Fatal Flaw

Potential Fatal Flaw

6.3.4 SUMMARY OF RESULTS

Comparison of the 40+ reservoir sites previously studied is difficult due to the 45 year timespan over which the studies were completed and the many changing factors related to mitigation, wildlife and wetlands. Earlier studies did not contemplate the current permitting and mitigation climate and consequently costs are understated. The cost per acre-foot at the bottom of Table 6.3.3 are based on inflating old cost estimates at 3% per year to the current year 2016, then dividing the cost by the anticipated acre-foot volume associated with the cost. In many instances costs from a more recent report were used in conjunction with storage volume available in a different older report. On Table 6.3.3 the top sites in terms of cost/ acre-foot tend to be the older sites with large storage volumes, but that did not include current permitting and mitigation costs. The Sublette Creek sites that account for the current permitting and mitigation cost still show well with acre-foot costs in the $2,680 range.

Many of the sites on Smiths Fork have better cost/ acre-foot but struggle with fish and wildlife issues that are potential fatal flaws.

This cursory analysis is not meant to be a substitute for a detailed reservoir study of a particular site. Each site has a variety of issues, impacts and benefits. In general terms, enlargement of existing facilities and off-channel sites appear to be most likely to be permitted and constructed.

Previous studies have identified both public and private lands are involved with most projects. Some off channel (Sublette Creek) sites do have conveyance into the reservoir that crosses a variety of land owners. All sites utilize the natural drainages for delivery of the stored water.

6.4 RESERVOIR ECONOMIC ANALYSIS

6.4.1 PROJECT BENEFITS

In the 2004 Cokeville Reservoir Level I Study several direct benefits of a reservoir included supplemental irrigation, municipal and industrial uses, hydropower, recreation, flood control, and environmental and water quality benefits. In the 2004 study, the larger Tiechert Bagley and Smiths Fork sites were evaluated. Although many of the potential basin reservoir sites listed in this study are smaller than the 2004 study sites, the potential benefits still apply in many cases. The following excerpts are taken from the 2004 study as prepared by Harvey Economics, and are specific to Smiths Fork water. However, the agricultural similarities between the upper and lower portions of the basin lend these statements to the entire basin.

> *Ranchers presently irrigate 20,411 acres of alfalfa, grain and meadow grass haylands using Smiths Fork water or water from the Bear River just downstream of Smiths Fork. The Natural Resources Conservation Service (NRCS) estimates that these lands, with system losses and precipitation, require roughly 48,500 acre-feet of water from the Smiths Fork site (2.37 acre-feet per acre) and 45,500 acre-feet from the Upper Teichert site (2.23 acre-feet per acre) to produce the maximum amount of hay for this area, or roughly three tons per acre. Any less water than these amounts is a shortage to ranchers in the Smiths Fork drainage. Applying these assumptions, Smiths Fork water produces about 1.3 tons of hay per acre-foot of water drawn from the reservoir for irrigation. Crop budgets for*

> *alfalfa and meadow grass hay, along with insight from local agricultural experts tend to corroborate these production figures. According to interviews with several ranchers and agricultural experts in the study area, ranchers in the Smiths Fork basin need supplemental irrigation water for their crops when streamflows are low, especially in drier years. According to the reservoir models, ranchers have an average unmet demand for streamflow water of 7,714 acre-feet at the Smiths Fork site and of 6,329 acre-feet at the Upper Teichert site. The models predict that the reservoir at the Smiths Fork site will be able to provide an average of 5,260 additional acre-feet of water to satisfy that unmet need, whereas the Upper Teichert site will satisfy on average 4,233 acre-feet of that unmet demand, with both sites offering 80 percent reliability. With production levels at roughly 1.3 tons of hay per acre-foot of water, ranchers might expect an additional 6,800 tons of hay from the Smiths Fork site and 5,500 tons of hay from the Upper Teichert site.*

In addition to the increased production on existing lands illustrated in the 2004 study, reservoir water may allow increased production from upland sagebrush areas presently used for grazing. Locations around Evanston and south and east of Cokeville offer opportunity for center pivot irrigation. Numerous pivots installed in the Cokeville area demonstrate the success of this strategy.

Municipal benefits of additional storage in the basin are primarly to secure water resources for future growth. For the City of Evanston and Town of Bear River, the benefit may take the form of a transfer of water from a downstream reservoir allowing additional storage in Sulpher Creek Reservoir. Cokeville's primary benefit would be in diversification of water supply and ability to supply an industrial user. The current town wells are adequate and require no additional treatement as reservoir water will require.

Hydropower benefits are very limited for most of the smaller reservoirs and potential reservoirs identified in this study. Capital cost is the primary hurdle for any hydropower project. In addition, each of the sites have a relatively low head and limited abilty to provide a good winter power flow while maintaining pool elevation.

Indirect benefits are a result of locally produced "on-ranch" dollars being spent locally and circulating locally and resulting in income in other sectors that support agriculture. In 1992 the US Department of Commerce estimated the indirect multiplier for the Wyoming agriculture sector to be 2.36 meaning every $1.00 produced on the ranch generates $2.36 in indirect benefits. Consequently, the direct benefit from an active capacity reservoir grows 70% in the local economy.

Other potential project benefits include recreation, flood control, hydropower and wildlife. Few of these beneficiaries have the organization or means to directly pay significant project costs. However, these benefits will be considered by the State when analyzing project funding and should be considered with potential reservoir planning. The benefits identified in previous studies include:

- Late season flows benefiting aquatic wildlife and riparian habitat
- Tailwater fisheries
- Sediment control
- Direct wildlife and stock watering opportunity at reservoir
- Flood control capability
- Waterfowl habitat

- Flat water recreational opportunities
- General shore recreational opportunities
- Water quality

6.4.2 PROJECT FINANCING

Spending all or most of the benefit on the project debt service negates the benefit. The beneficiary of the reservoir will spend part of the benefit (perhaps up to 50%) on the reservoir project debt service. This leaves the remaining 50% for operations and maintenance and as potential increased income to the beneficiary.

Each reservoir project requires significant grant resources in order for the project to be financially affordable to the end user. The recent Sublette Creek Reseroir Mau/Covy Canal Rehabilitation Study, Level II established that grant levels on the order of 93% are required before the end user has the ability to pay the outstanding 7%. At lower grant levels, such as the standard 67% grant offered by the WWDO, the end user can only pay a portion of the outstanding debt payment.

None of the projects can finance and carry their entire cost as a loan paid by the subscribers to the system. All projects will require grants in the range of 90% in order for the irrigators to afford the user rates. The WWDC realizes the value of storage projects and has adopted special criteria specific to the Dam and Reservoir Program to address affordability. See Funding Opportunities Section 8.3.4.1

6.4.3 OPERATION AND MAINTENANCE COSTS

After project completion, there will be ongoing maintenance tasks associated with the operation of the facility. These operational costs will be the responsibility of the beneficiaries (irrigators that have formed a district). On-going maintenance costs include annual special use permit payments (if on BLM), vegetation control, debris removal, slope maintenance, inspections, mechanical components, etc.

The estimated annual costs for these expenses are tied to the size, location and complexity of the facility. On Federal lands, a general liability policy may also be required of the permittee. Inundated lands, embankments, and roads all count in the fee estimation. These fees alone can be a significant hurdle and potential fatal flaw when considering storage feasibility.

Maintenance costs are site dependent. Travel time to the site, number of release adjustments per season along with acres of embankment to maintain all affect annual costs. Annual fees for a 5,000 acre-foot reservoir were estimated by as follows:

Maintenance Costs

Debris Removal	$	2,000/yr (as needed)
Vegetation Control	$	1,500/yr (once every other year)
Slope Maintenance	$	1,000/yr (once every 5 years)
Drain Inspections	$	600/yr (once per year)
Gate Maint./Operation	$	6,000/yr (20 to 25 visits per season)
Subtotal	$	11,100 (annual cost)

Smaller embankments will be less expensive based on the number of acres that must be maintained and the complexity of the dam infrastructure. Many of the reservoirs contemplated by landowners in preparation of this report are less than 1,000 acre-feet. Their maintenance costs will be lower due to a smaller footprint and reduced number of visits for release adjustments.

6.4.4 INTERSTATE COMPACTS

The Bear River Compact addresses the rights and obligations of the three States, Idaho, Utah, and Wyoming, that are party to the original and amended Compacts. The following provides a general review of water right and interstate compact considerations, administration factors, and limitations that may affect the potential implementation of the proposed watershed management plan and rehabilitation projects and practices in the Bear River Watershed.

6.4.4.1 BEAR RIVER COMPACT

The 1958 Compact divided the Bear River basin into three different divisions; The Upper Division, the Central Division, and the Lower Division. The Compact assigned river flows and canal diversions into specific Divisions.

The direct flows of Bear River and its tributaries in the Upper Division were apportioned between Utah and Wyoming upstream of Pixley Dam. The direct flows of Bear River and its tributaries in the Central Division were apportioned between Idaho and Wyoming between Pixley Dam and Stewart Dam.

The Compact recognized existing storage rights above Stewart Dam that were constructed prior to February 4, 1955 and established rights to store 36,500 acre feet of additional water above Stewart Dam. Table 6.4.4.1a lists the breakdown of recognized existing storage and the allocation of additional storage.

Table 6.4.4.1a 1958 Bear River Compact

	Existing Storage Rights above Stewart Dam[1]	**Original Compact Storage**
State	**Storage** (ac-ft)	**Storage** (ac-ft)
Utah	11,850	17,750
Wyoming	2,150	17,750
Idaho	324	1,000
Total	14,324	36,500

Note: *1. Constructed prior to February 4, 1955*

The Bear River Commission amended the original Compact in 1980. The Amended Bear River Compact granted additional storage and depletion allocations.

The Amended Bear River Compact granted additional storage of 74,500 acre-feet. This additional storage and appropriated water which includes tributary groundwater, applied to beneficial uses after January 1, 1976 is limited to a annual depletion of 28,000 acre-feet. Table 6.4.4.1b provides the storage and depletion quantities allocated to each of the three States. If the water level elevation of Bear Lake drops below 5,911 feet, the additional storage is not allowed to accrue in the Upper and Central Divisions.

Table 6.4.4.1b 1980 Bear River Compact Amendment

Additional Compact Storage above Bear Lake		**Post Jan. 1, 1976 Beneficial Use**
State	**Storage** (ac-ft)	**Depletion (ac-ft)**
Idaho	4,500	2,000
Wyoming	35,000	13,000
Utah	35,000	13,000
Total	74,500	28,000

Wyoming’s Storage under Original and Amended Compacts

Wyoming has constructed approximately 13,650 acre-feet of storage under the original 1958 Compact. An estimated 4,100 acre feet that remain under the original Compact has been allocated to a potential reservoir in the Smiths Fork drainage. The reservoirs constructed in Wyoming under the original Compact are listed in Table 6.4.4.1c. The storage accruals in these reservoirs are not subject to the 5,911 foot water elevation limitation in the Amended Compact.

Table 6.4.4.1c Wyoming Storage Constructed under the Original Compact

Wyoming	**Storage** (ac-ft)
Sulphur Ck. Res.	4,614
Sulphur Ck. Res. Enl.	1,100
J.L. Martin Res. Sulphur Ck.	88
Woodruff Narrow Res.	3,250
Whitney Res.	4,200
Wyman Res.	22
Massae Res.	107
Massae Res. Enl.	51
Coy Res.	50
Bear River Regional JPB	168
Total	13,650
Wyoming's 1958 Compact Storage	17,750
Allocation Remaining (Smiths Fork)	4,100

Wyoming has constructed 13,994 acre-feet of storage under the Amended Bear River Compact with the 1980 enlargement of Woodruff Narrows Reservoir, the 1988 enlargement of Sulphur Creek Reservoir, and the enlargement or new construction of four smaller reservoirs. An estimated 21,006 acre-feet of storage allocation remains under the Amended Compact. The reservoirs constructed in Wyoming under the Amended Compact storage allocation are listed with their respective storage and depletion allocations in Table 6.4.4.1d.

Table 6.4.4.1d Wyoming Storage Constructed under Amended 1980 Compact

Wyoming	**Storage** (ac-ft)	**Depletion** (ac-ft)
1980 Woodruff Narrow Res. Enl.	2,960	871
1988 Sulphur Ck. Res. Enl.	10,315	701
Broadbent Reservoir	350	209
Enl. Ben Reservoir	300.29	150.15
Bonneville Reservoir	41.39	17.84
Coy Reservoir	26.9	25.4
Total	13,994	1,974
Wyoming's Allocation	35,000	
Allocation Remaining	21,006	

Depletions and Reporting under the Bear River Compact

The Amended Compact of 1980 stipulated Commission-approved procedures and methods for calculating the post-January 1, 1976 depletions. During the April 2014 Bear River Commission meeting the depletion procedures were amended and the new depletion estimate methods are to be included in each future Biennial Report. The new methodologies address the calculation of crop consumptive use and other depletion estimating procedures, which are applied to water use activities within the three States.

The estimated annual depletions for Wyoming between January 1, 1976 and December 31, 2009 are 2,407 acre feet for agricultural, 401 acre-feet for municipal and industrial, and 197 acre-feet for reservoir evaporation. Wyoming's total annual depletions as of December 31, 2009 are 3,005 acre feet so an estimated 9,995 acre-feet remained to be allocated after 2009. The calculation of the depletion quantities under Wyoming's allocation will be performed in the future in accordance with Commission-approved methodologies. New methodologies for calculating crop consumptive use and depletions quantities will be applied. Since 2009, Wyoming has been tracking and reporting new water right permitting activity to the Commission. Under Article VI. F. in the Amended Compact, each state is allowed the use of water, including groundwater, for ordinary domestic and stock watering purposes including the right to impound water for reservoirs having capacities less than 20 acre-feet with no required deduction of the respective State's allocation.

If the new water management projects being reviewed for consideration under this watershed plan do not meet this domestic or stock watering requirement and proposes to impound new storage or cause new depletions within Wyoming, the permitted facility will be assigned an estimated depletion quantity under Wyoming's allocation. The depletion quantity assigned to the facility will be based on the Commission- approved methodologies during the water right permitting process conducted by the Wyoming State Engineer's Office.

As of December 2009, approximately 9,995 acre-feet of depletions remained available for allocation within Wyoming under the Amended 1980 Compact.

VII. PERMITTING

Permitting can become a complex, lengthy and expensive process. The Bear River Watershed study area contains lands administered by the USFS, BLM, NPS, State, and private individuals. The projects identified in this study range from maintenance or replacement of existing and permitted facilities to new reservoirs. Depending on the location and type of project, permitting may be as simple as a water rights application to as complicated as a full Environmental Impact Statement (EIS). The following sub-sections detail various permitting requirements.

7.1. IRRIGATION SYSTEM REHABILITATION PROJECTS

For the most part, the U.S. Army Corps of Engineers will allow irrigation system rehabilitation projects to proceed with the acquisition of a Nationwide Permit. This includes replacement of irrigation diversion structures in the same location. The process for applying for and receiving a Nationwide Permit involves providing a project description, preliminary design documents and photos of the area involved. Once the Corps has received these documents they simply issue a letter to proceed.

7.2 NEW RESERVOIR PERMITTING

Permitting requirements will vary depending upon whether the proposed project is situated upon private, State or Federal lands. The only exception relates to Section 404 permitting through the U.S. Army Corps of Engineers. An Army Corps of Engineers Section 404 permit will be needed regardless of land ownership. A summary of new reservoir permitting is presented below.

7.3 FEDERAL PERMITTING REQUIREMENTS

7.3.1 NEPA PROCESS FOR RESERVOIR PROJECTS

One of the first steps in the National Environmental Policy Act (NEPA) process is to develop an accurate and defensible Purpose and Need statement for the project. The Purpose and Need statement consists of three parts: the purpose, the need, and goals and objectives. The purpose defines the problem. The need provides data to support the problem. The goals and objectives describe other issues and possible opportunities that could be realized as part of the potential solutions to the problem. The Purpose and Need statement should provide enough information to develop and support a “reasonable range” of alternatives and guide the alternative development and screening process. The NEPA process requires analysis of the “No Action” alternative and a reasonable range of alternatives that fully address the project's purpose and need.

7.3.2 U.S. ARMY CORPS OF ENGINEERS SECTION 404 PERMITTING

The Corps of Engineers has regulatory authority under the Clean Water Act and the River and Harbor Act. The purpose of these laws is to restore and maintain the chemical, physical and biological integrity of waters of the United States. Section 404 of the Clean Water Act authorizes the Corps to regulate the discharge of dredged or fill material into waters. This would include dams and dikes, levees, riprap, bank stabilization and development fill. There are three kinds of permits issued by the Corps. They are individual, nationwide and Regional General Permits.

For any new reservoir, the Applicant must submit a Section 404 permit application to the U.S. Army Corps of Engineers (COE) office. Prior to submitting the application, the Applicant should address the proposed project's purpose and need and any other alternatives considered and the reasons for their elimination.

Most of the current alternatives for the Bear River Watershed study area are proposed "off-channel" storage options, some of which have significant wetlands present. The applicant must address these wetlands and also be prepared to discuss the potential impact of the new diversion structures and the impacts on current flow patterns in the designated water source (Bear River or tributaries).

Due to the requirements of the National Environmental Policy Act (NEPA), the Corps of Engineers will require an Environmental Assessment (EA) for those projects that have minimal impacts identified. Most EA's can be completed within a year from the date of application. Those projects that have identified impacts to aquatic resources greater than 0.5 acres or have impacts to threatened or endangered (T&E) species will likely require that an Environmental Impact Statement (EIS) be prepared. The time requirements for completing an EIS can range from 2-5 years and be quite expensive. For this reason, it becomes imperative that the applicant investigate thoroughly those projects with the least damaging impacts to area wildlife, fisheries and aquatic resources.

Once the application package has been accepted, the Corps of Engineers (COE) will prepare a Public Notice of the pending application and announce public scoping meetings to be held in the area of interest. Public notices will be sent to most local, State and Federal agencies along with all surrounding landowners. Upon the completion of public scoping meetings, a scoping document will be prepared summarizing all comments received regarding the proposed project. The COE will then finalize the scope of work for conducting the environmental analysis. Unlike most Federal land management agencies, the COE does not require reimbursement of their NEPA/404 participation costs.

7.3.3 BUREAU OF LAND MANAGEMENT (BLM) PERMITTING

For those potential projects located upon BLM lands, the Bureau of Land Management will become the Lead Federal Agency and to initiate the process for permitting a new reservoir or upland development projects, the applicant must submit a right-of-way application. This application requires the completion of a thorough project description and a summary of alternatives investigated and the reasons for their elimination. The application also requires an explanation of all the environmental effects anticipated from the construction and operation of the proposed reservoir. As the Lead Federal Agency, the BLM will manage and direct the preparation of all environmental documentation (EA/EIS). The BLM will also manage all NEPA requirements for the proposed project. In most cases, projects on public lands will also include the U.S. Army Corps of Engineers as a Cooperating Federal Agency. The process for providing public notice and comments is nearly identical to the COE process outlined above. Upon initiating the NEPA environmental process, the applicant will agree to pay all costs of the EA/EIS preparation and will also sign a "Cost Collection Agreement", whereby the applicant agrees to reimburse the BLM for all their costs associated with the NEPA document preparation process.

7.3.4 UNITED STATES FOREST SERVICE (USFS) PERMITTING

Much like the BLM, the USFS becomes the Lead Federal Agency for all projects located upon Forest Service lands. To initiate this process with the USFS, the applicant must complete a Special Use Permit application. The application process is nearly identical to the BLM right-of-way application process. The USFS will also then be responsible for all NEPA compliance issues and the COE will become a cooperating entity, The USFS also requires the applicant to pay all EA/EIS preparation costs and to reimburse the Agency for all their project related NEPA compliance and document preparation expenses.

Although the applicant pays all NEPA EA/EIS and agency expenses related to applications, this does not allow the applicant to direct the work product of the third party consultants selected by the agency to prepare the NEPA documentation. Third party environmental consultants work directly for the Federal agency involved.

7.3.5 UNITED STATES FISH AND WILDLIFE SERVICE (USFWS)

On new projects, the applicant is required to consult with the USFWS under Section 7 of the Endangered Species Act to make certain that the project is in compliance. The lead agency will prepare a biological assessment to determine project effects on threatened and endangered plant and animal species listed or proposed for listing under the Endangered Species Act. The USFWS will then issue an opinion on whether federal actions are likely to jeopardize the continued existence of a threatened or endangered species, or adversely modify critical habitat. The USFWS must approve the preparation of a biological assessment to comply with the Endangered Species Act in order to render its decision. lf the USFWS determines that the proposed project could adversely impact a protected species, mitigation measures or changes to the project scope, location and methods will be required.

The Fish and Wildlife Coordination Act requires federal agencies involved in actions that will result in the control or structural modification of any natural stream or body of water for any purpose to take action to protect the fish and wildlife resources which may be affected by the action. It requires federal agencies or applicants to first consult with state and federal wildlife agencies to prevent, mitigate, and compensate for project caused losses of wildlife resources, as well as to enhance those resources.

7.3.6 U.S. DEPARTMENT OF INTERIOR - ADVISORY COUNCIL ON HISTORIC PRESERVATION (SECTION 106)

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to take into account the effects of their undertakings on historic properties, and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. Laws and regulations addressing cultural resources include: the National Historic preservation Act (NHPA) of 1966; the National Environmental Policy Act (NEPA) of 1969; the Archaeological Resources Protection Act (ARPA) of 1979; the National Park Service (NPS) procedures concerning the National Register of Historic Places (NR); the Advisory Council on Historic Preservation's Procedures for the Protection of Cultural Properties; the Treatment of Archaeological Properties of 1980: Determination of Eligibility of Inclusion in the National Register; the Secretary of Interior's Standards and Guidelines for Archaeological Historical Preservation of 1983; Reservoir Salvage Act of 1960; and the 1974 Amendment to the Reservoir Salvage Act of 1960.

The Wyoming State Historic Preservation Office (SHPO) is the point of contact to meet compliance with NHPA requirements. SHPO should be contacted early in the planning stages for their comments that could impact project approach and cost.

7.4 STATE OF WYOMING PERMITTING

In addition to the Federal permits outlined above, there are a host of additional permits/approvals required for any new dam construction. Outlined below are the State of Wyoming permits required for new dam construction.

7.4.1 WYOMING STATE ENGINEER’S OFFICE (WSEO) SURFACE WATER STORAGE PERMITS

The Wyoming State Engineer’s Office (WSEO) administers the water rights system of appropriation. Prior to diverting surface water, the appropriator must complete a filing and obtain a permit from WSEO for the proposed beneficial uses.

The applicant must obtain the necessary water right storage permits from the WSEO for the diversion and storage of the State's surface water. If an existing ditch is utilized for reservoir supply, an enlargement permit for this ditch would be required. Stock reservoirs constructed in existing draws and or ephemeral streams will require completion of Forms S.W. 3 and/or S.W. 4. The project sponsors will need to obtain water right permits and appropriations for the proposed development of surface water or groundwater sources serving the potential land use and water management practices. Potential water projects that require water rights permitting or may require reviews by the Wyoming State Engineer’s Office (WSEO) are: 1) installation of new wells or spring developments for stock watering purposes; 2) rehabilitation or construction of other stock watering facilities, which can include conveyances, tanks, and troughs; 3) repair, rehabilitation and construction of diversion and headgate facilities; 4) replacement or new installations of water measurement structures; and 4) constructing small reservoirs serving stock and other water uses. Some of the smaller reservoirs being evaluated would serve irrigation water needs. Bank stabilization and snow storage are examples of potential projects listed in this study which may not require any involvement of the WSEO.

The Wyoming Dam Safety Law (W.S.41-3) requires that any proposed dam which is greater than 20 feet high or which will impound more than 50 acre-feet of water, or a diversion system which will carry more than 50 cfs must obtain approval by the Wyoming State Engineer's Office. The applicant must provide plans and specifications to the WSEO for a permit to construct through the Dam Safety office. Design, construction, and operation of jurisdictional dams must also comply with dam safety regulations pursuant to the Dam Safety Act. The upland water development projects identified in this plan utilize dams that fall under the 20' height limit and the 50 acre-foot threshold. Several reservoirs (Leeds, Stowe Creek, & Quealy) have the potential to exceed 50 acre-feet with a dam less than 20' tall.

Surface Water

In Wyoming the peak surface water flows typically occur in the spring and early summer months coinciding with the snowmelt runoff within the higher elevation areas of each basin. In some of the potential upland locations, there may be adequate surface water supplies available for diversion or impounding for a proposed stock watering facility. In other basin areas, significant runoff flows only occur over a very short period of time that can be as short as a few days or weeks every year.

Applications to appropriate surface water are processed by the Surface Water Division of the Wyoming State Engineer's Office (WSEO). The review and approval process can be less than 1 month for simple applications and up to 6 to 12 months for more complicated applications. If the permit applicant is required to seek consents from other appropriators to enlarge an existing permitted facility, the permitting process can require much more time.

Many of the stock watering facilities listed in this study include the construction of a small reservoir or pond to address the proposed water needs. Wyoming has a simplified surface water permitting process for small reservoirs that typically takes less than 1 ½ months for approval of a permit. A reservoir less than 20 feet in embankment height and less than 20 acre-feet in size qualifies under the simplified application process. Impoundments with dam heights greater than 20 feet or capacities greater than 50 acre-feet require a more complex application process and fall under the Wyoming's Safety of Dams Law.

New stock ponds may serve other beneficial uses, such as fish and wildlife purposes. Most new reservoirs will require a low-level outlet so that the reservoir can be drained during periods of regulation. Different conditions and limitations will apply to off-channel and on-channel reservoirs, although, the permitting process is the same.

Groundwater

To drill a new well or develop a spring, the water user must apply for, and receive a new permit and appropriation from the Ground Water Division of the Wyoming State Engineer's Office. If the total yield or flow of the spring development is 25 gpm or less and the beneficial use is stock or domestic, the water source can be appropriated as a groundwater source. If the proposed spring development exceeds a flow quantity of 25 gpm, the proposed water source would be treated as a surface water source and will need to be permitted and appropriated through the Surface Water Division.

If the applicant does not own the land, an access agreement will be needed with the current landowner. The applicant needs to hire a Wyoming licensed well driller and pump installer for drilling and completion of the well.

For all groundwater applications, WSEO will review the potential for interference impacts to existing wells or surface water rights within the vicinity of the new well. New well applications for stock watering needs are currently taking approximately three to six weeks for complete processing by WSEO.

WSEO Dam Safety Program Reviews

The Wyoming Safety of Dams Law requires that the project sponsor proposing to construct a jurisdictional dam will obtain the necessary reviews and approvals from the WSEO's Dam Safety Program. The WSEO staff must review and approve plans and specifications, which are prepared by a registered professional engineer licensed in Wyoming. In addition, the construction of the jurisdictional dams requires dam inspections by a professional engineer.

7.4.2 WYOMING STATE DEPARTMENT OF ENVIRONMENTAL QUALITY (WDEQ) PERMITTING

The Wyoming DEQ administers the National Pollution Discharge Elimination System (NPDES) permit and corresponding Section 401 Certification. The NPDES permit controls the discharge of storm water pollutants associated with construction activities. The Section 401 Certification is the State's approval to insure that the activities authorized under Section 404 (COE) meet State water quality standards and do not degrade water quality.

7.4.3 WYOMING HISTORIC PRESERVATION OFFICE (SHPO) ARCHAEOLOGICAL CLEARANCE

SHPO coordinates with federal agencies in determining the significance of cultural resources potentially affected by ground disturbing activities. Contact with SHPO should be made early in the planning process.

7.4.4 WYOMING BOARD OF LAND COMMISSIONERS

The Wyoming Board of Land Commissioners, through the State Lands and Investments Board (SLIB), is responsible for regulating all activities on state lands, including granting of rights-of-way. Any facility, utility, road, ditch, or reservoir to be constructed on state or school lands must have a right-of-way, as required in the "Rules and Regulations Governing the Issuance of Rights of Way" (W.S. 36-20 and W.S.36-202).

7.4.5 WYOMING GAME AND FISH

Coordination with the WGFD is encouraged when planning and implementing upland water resource projects. Many of the upland water projects identified in this study fall on private ground and coordination may not be mandatory, however coordination may bring expertise and funding that will enhance the scope of the project.

7.5 NEPA PROCESS FOR OTHER PROJECT TYPES

The applicability of NEPA to projects other than reservoir storage (non-stock pond) must be determined on a case-by-case basis. For example, proposed new wildlife/livestock watering developments including tank/pipeline systems that cross and/or serve Federal or State land will require that an appropriate NEPA process be followed. In this case, and for many of the lesser potential impact projects (e.g., a well, stock/wildlife pond, guzzler, etc.), it is possible that an EA process will be found appropriate rather than a full EIS. Most of the upland water projects identified in this plan have some component that crosses, or is located on, federal or state land.

BLM

At the time of this reporting, compliance with NEPA will be guided in large part by the Approved Resource Management Plan (RMP) for Public Lands administered by the BLM Kemmerer Field Office (BLM 2010) and any subsequent new or additional guidance and/or updates. The RMP was developed on the basis of a NEPA-compliant EIS.

Other State/Federal Agencies

Depending on the specific circumstances of a particular project, it is possible that another state or federal agency may lead the NEPA process. For example, a project proposed within the Bridger-Teton National Forest would presumably be led by the U.S. Forest Service, most likely from the Jackson Regional Office while a project in the Uinta-Wasatch-Cache National Forest might be led by the supervisor’s office in South Jordan, UT. All of the relevant state and federal land management agencies have management plans developed from NEPA-compliant processes where appropriate. As discussed above for BLM, these plans will guide these agencies' NEPA process for any applicable proposed projects.

Watershed Wide Environmental Analysis

In other watershed studies a watershed wide approach to the environmental permitting of upland stock and wildlife water projects has been proposed as a way to establish baseline data for all sites. This baseline data could then be supplemented by additional data on a case by case basis. The approach is intended to eliminate duplication and in the long term reduce overall costs for environmental analysis. While certain aspects of this approach are attractive for the Bear River Watershed Study Area, there are some considerations that indicate a case-by-case basis may be the best approach. The Bear River Basin Study Area includes lands with varied topography, administration, ownership, climate, and other characteristics. Many of the proposed projects will require unique work based on location and adminstration that will not translate directly to other sites. If baseline work could be funded and completed independently of individual projects, the watershed wide environmental analysis approach may work well provided individual assessments are not required to reanalyze the established watershed wide baseline conclusions.

Non-Reservoir Project Permits, Clearances, and Approvals

The permits, clearances and approvals required for projects other than dam and reservoir projects will depend on the specific nature and location of the project. The various permits and clearances discussed above in Sections 7.3 and 7.4 may also apply to other types of projects. For example, if a new groundwater well is associated with a proposed wildlife/livestock watering development, then the applicant must obtain the necessary groundwater right permit from the Wyoming State Engineer's Office (WSEO), which includes Forms U.W. 5 & 6. New wildlife/livestock watering development projects that utilize existing groundwater wells must include stock as a use in the associated water right. The specific permits and clearances necessary for a particular project should be determined early in the planning stages of the project to ensure compliance with applicable laws and regulations, and to avoid possible delays, increased costs and possible re-design during project implementation. Additionally, coordination with the Wyoming Game and Fish Department is encouraged when planning and implementing natural and water resource improvement projects.

7.6 MITIGATION

Mitigation could be required at any of the identified reservoir projects or other potential projects described in Sections 4 and 5 to address impacts to wetlands, fish and wildlife resources, sensitive or ESA-listed species, and cultural resources.

Wetlands

If wetland impacts associated with any future projects are above the threshold (typically 0.1 acres) set by the US Army Corps of Engineers (USACE), detailed compensatory mitigation plans to replace lost wetland functions will need to be prepared and approved. The ratio of wetland replacement mitigation would be determined during the permitting process. Any required mitigation plans will follow guidance provided by the 10 April 2008 “Compensatory Mitigation for Losses of Aquatic Resources; Final Rule” in 33 CFR Parts 325 and 332 and 40 CFR Part 230, which requires compensatory mitigation plans to contain 14 elements as outlined in Part 332 Section 332.4.

Sensitive and ESA-Listed Species

Prior to constructing a project, surveys for sensitive wildlife and plant species would likely be required. If any sensitive species are found, mitigation measures would likely be required. Mitigation of potential raptor and big game impacts would generally involve stoppage of certain construction activities during sensitive time periods and avoidance of direct disturbance of the subject species. Impacts to crucial big game habitat will likely have more significant mitigation requirements. If any threatened and endangered species were encountered at a given site, special studies would be required to determine if appropriate mitigation could be implemented.

Sage-Grouse

In 2008, the State of Wyoming adopted a regulatory mechanism (Greater Sage-Grouse Core Area Protection Strategy) to provide increased protection for greater sage-grouse and restrict habitat alterations within designated sage-grouse core population areas. The policy was subsequently updated in 2011 (Wyoming Executive Order 2011-5) and most recently in 2015 (Wyoming Executive Order 2015-4). An updated map of the sage-grouse Core Population Areas within the state is presented in Figure 7.6.1. The Core Area Protection strategy focuses on avoidance, minimization, and mitigation of anthropogenic disturbances to sage-grouse habitat. Mitigation is reserved for those circumstances where avoidance and minimization are either inadequate or impossible. In instances where sage-grouse habitat is impacted, impacts must be offset through compensatory mitigation.

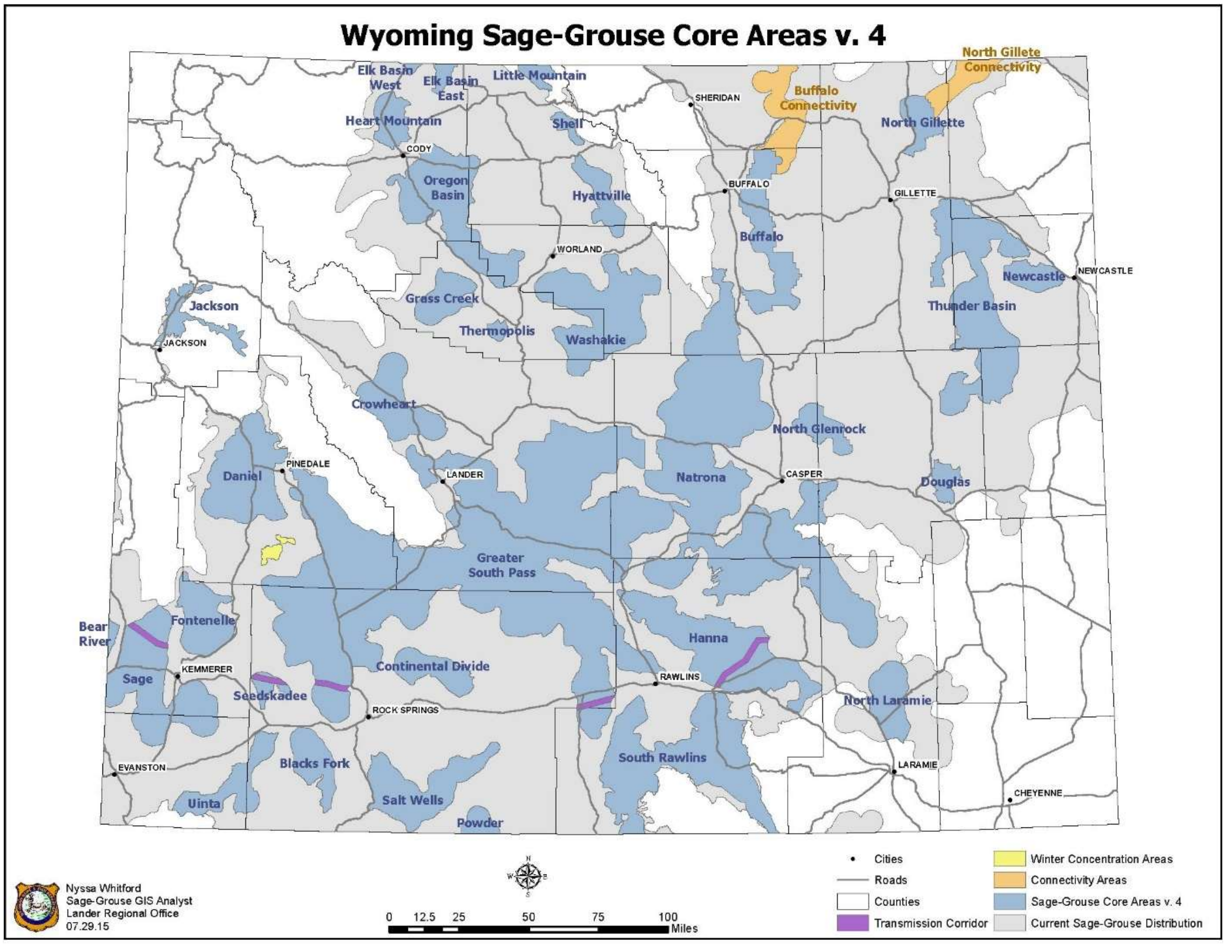


Figure 7.6.1. Map depicting greater sage-grouse core areas in the State of Wyoming.

The Wyoming Sage-Grouse Mitigation Assessment provides the framework for sage-grouse habitat mitigation requirements in the state (see Appendix H). The assessment includes a mitigation debit formula that provides a means by which compensatory mitigation obligations are calculated based upon location, functionality, indirect impacts and size of both the debits (impacts to sage-grouse habitat) and credits (habitat protected to offset the debits). The formula captures the importance of both function and location of habitat impacted by a disturbance (debit determination) and the 'value' needed to offset the associated loss of habitat function (credit conversion rate) to ensure the overall conservation benefit is at least commensurate.

Fisheries

Impacts to fishery resources will require mitigation. Impacts related to reservoir projects could potentially be mitigated through minimum reservoir release requirements and creation of a minimum pool for aquatic habitat. Fish passage on main-stem sites will likely be required as well as fish screening on major intakes or diversions to canals or off-channel storage sites.

Cultural Resources

Cultural and historic resource fieldwork will need to be completed to identify and document any such resources that will be impacted. This would include a class I (literature search) survey, a class II (reconnaissance inventory) survey, and if needed, a class III (intensive inventory) survey.

Ultimately, a mitigation plan for cultural resources will be developed culminating in a Memorandum of Agreement (MOA) between the Wyoming SHPO and the lead federal agency with concurrence by the project sponsor, and possibly affected Native American tribes. The agreement would require approval from the Advisory Council on Historic Preservation.

7.7 LAND OWNERSHIP AND PROPERTY OWNERS

All upland projects listed in this study are on land owned by the sponsor proposing the project or on State, BLM, or USFS administered lands. Most upland projects will require permits from one or more of these entities. Potential reservoir projects in the basin and ancillary canals can span multiple landowners and agencies. In this study, some upland water projects were identified that involve pipelines and easements across more than one private/public landowner, however, most upland projects involve state and/or federal lands and possibly the private land of the project sponsor.

VIII. FUNDING OPPORTUNITIES

8.1 OVERVIEW

Multiple funding sources exist to assist with the cost of project implementation. Selection of the proper program(s) can result in a significant portion of the cost being covered by complimentary sources.

This section briefly describes some of the programs available and provides details regarding where more information can be obtained regarding these programs. In general, most of the future watershed improvement projects can reasonably expect to tap into the funding sources identified herein.

An investigation of federal, state and local funding sources was conducted to identify potential opportunities for watershed improvement projects.

The following documents provide extensive information pertaining to project funding opportunities for projects investigated within this Level I study:

- **Water Management & Conservation Assistance Programs Directory, Fourth Edition** (WWDC May 2009). This directory provides funding agency direct contacts to assist with potential project funding throughout the area.
  http://wwdc.state.wy.us/wconsprog/WtrMgntConsDirectory.html

- **Catalog of Federal Funding Sources for Watershed Protection.** This EPA website provides information pertaining to numerous funding sources including grants, loans, and cost sharing programs which are applicable to watershed projects. The document is available at:
  http://ofmpub.epa.gov/apex/watershedfunding/f?p=fedfund:1

- **Habitat Extension Bulletin No. 50 - Fisheries and Wildlife Habitat Cost Share Programs and Grants (Wyoming Game & Fish Department, August 2007)** The Wyoming Game & Fish Department has developed this informative bulletin pertaining to financial assistance programs available for fisheries and wildlife habitat projects.
  http://wgfd.wyo.gov/Habitat-Information/Habitat-Extension-bulletin

As government programs frequently change according to the available budgets of the funding agencies, the grants, loans, and cost share opportunities presented herein are subject to change. As such, it is recommended that additional inquires be made if interested parties wish to pursue the opportunities presented in this section.

Significant competition for funding associated with many of the opportunities presented is frequently encountered by applicants. To increase the potential for success in obtaining funding from other sources, applicants may wish to have other funds available to leverage against these opportunities. By showing the financial commitment to projects, funding agencies may look more favorably to fund specific projects that have a higher likelihood of timely implementation. Contacts for key local groups who can provide current information on funding sources relevant to watershed projects include:

- Bureau of Land Management/Kemmerer Field Office (307-828-4500)
- NRCS - Cokeville Field Office (307-279-3256)
- NRCS - Lyman Field Office (307-787-3211)
- Lincoln Conservation District (307-279-3256)
- Uinta Conservation District (307-787-3070)
- Wyoming Water Development Office (307-777-7626)

8.2 LOCAL AGENCIES

8.2.1 LINCOLN AND UINTA COUNTY CONSERVATION DISTRICTS

Lincoln and Uinta County Conservation Districts serve as the local liaison between local landowners and resource users and state and federal government agencies. In addition to their many other roles and responsibilities, this district can also provide funding assistance as follows:

- In-kind technical assistance as local resources, capacity and expertise allow.
- Administration of programs, projects and grants on behalf of recipients of state and federal natural resources program funding.
- Assistance in development of leveraged, partnered programs and projects.
- Assistance in preparation of grant applications.

8.2.2 LINCOLN AND UINTA COUNTY WEED AND PEST DISTRICTS

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

- Cost-share in the control of noxious weeds.
- Assistance in the identification of noxious weeds and other undesirable plants.
- Organization and/or participation in local meetings, seminars and field trips to educate local landowners and agencies on the problems and potential solutions for weed and other undesirable plant control, and
- Facilitating weed control work days attended by a broad base of stakeholders.

8.3 STATE PROGRAMS

8.3.1 WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

The Wyoming Department of Environmental Quality (WDEQ) provides funding for implementation of best management practices (BMPs) to address non-point sources of pollution under Section 319 of the Clean Water Act. Section 319 grant funding requires a non-federal (i.e., local) match of 40 percent from the applicant with cap of $400,000. These matching funds may be provided by landowners, a conservation district, other quasigovernmental entities (e.g., watershed improvement district, irrigation district, etc.), and/or nonprofit organizations (e.g., Trout Unlimited, Ducks Unlimited, and the Rocky Mountain Elk Foundation). Applications (proposals) conforming to a specified format are required. The proposal describes in some details the issues to be addressed and the proposed methods/BMPs to be implemented, as well as providing all other information required to evaluate the proposed project and matching fund entity(ies). These proposals are normally due in August or September of each year.

Projects located within watersheds of streams on the 303d list are eligible for the 319 -Incremental Funds, which has historically been a larger amount. Projects located within watersheds which are not listed on the 303d list, such as the Bear River are only eligible for 319-base funds.

See http://deq.wyoming.gov/wqd/water-quality-assessment/rsources/reports/) for the latest Water Quality Assessment and Impaired Waters List (2014)

Periodically, DEQ conducts workshops on how to apply for 319 and 205j funds. Contact the Water Quality Division for dates and locations (307 777-7781).

8.3.2 WYOMING GAME AND FISH DEPARTMENT

Wyoming Game & Fish Department funding assistance can best be summarized by the following:

'The Wyoming Game and Fish Department may offer technical and funding assistance to help landowners, conservation groups, institutions, land managers, government agencies, industry and non- profit organizations develop and/or maintain water sources for fish and wildlife. Assistance may also be provided for protecting and improving riparian areas/wetlands, restoring streams, and upgrading fish passage or diversion screens. (WWDC, 2015)

Current programs offered by the Wyoming Game & Fish Department include: Riparian Habitat Improvement Grant, Water Development/Maintenance Habitat Project Grant, Upland Development Grant, Fish Wyoming, and Wyoming Sage Grouse Conservation Fund. A few of these programs are described below.

Habitat Trust Fund

Funds can be used for acquisition, maintenance or improvement of wildlife habitat or for the promotion of human understanding and enjoyment of the fish and wildlife resource (habitat or information and education projects). All proposals must have a Department sponsor and be entered into a Departement proposal database by early January or early August annually. No cost share is required, but is strongly recommended. Approximately $600,000 to $1,200,000 is allocated annually to projects across Wyoming.

Fish Passage Grants

Funds can be used for creating or improving upstream or downstream passage of all life stages of fish in Wyoming waterways and for screening diversions. Examples include developing fishways or fish ladders, assisting with the replacement of traditional push-up diversion dams with more fish-friendly options, and installing various screening technologies to keep fish from becoming entrained into irrigation ditches. All proposals must have a Department sponsor and be entered into a Department proposal database by early January annually. Approximately $25,000 to $90,000 is allocated annually to projects across Wyoming.

Wyoming Sage Grouse Conservation Fund

WGFD administers the Wyoming Sage-Grouse Conservation Fund (WSGCF).

http://gf.state.wy.us

The WSGCF is a special fund established by the Wyoming State Legislature to support the efforts of Local Sage-Grouse Working Groups (LSGWG). The WSGCF funding is intended to promote conservation of sage grouse populations and habitat (sagebrush ecosystems), including socio-economic and human use of the habitat.

Requests for WSGCF funding must be made on a Project Proposal Form.

Funding is normally given to projects with matching funds, established partnerships, multi-species benefits, management relevance and consistency with the local sage-grouse conservation plan, highest wildlife impact, appropriate budgets, landscape scale, and a lasting legacy of benefits. Evaluation criteria include: consistency with the local plan, likelihood of project success, project readiness, and availability of matching funds, multiple species benefits, significance at local/state/regional level, duration of benefits, and adequacy of funding. Application may be made at any time, but should be made by February 1 to receive first round consideration. Funds awarded must be expended between July 1 of the year received and September 30 of the second year after award. The funds are normally distributed as reimbursable grants (i.e., payments are made for expenses incurred and not "up-front"). Requests for funding of habitat improvement projects, including water developments, must include a livestock grazing management plan. A Project Close-out Report must also be submitted upon completion to allow tracking of expenditures and tracking of results.

8.3.3 WYOMING OFFICE OF STATE LANDS AND INVESTMENTS

As the administrative advisory arm of the Board of Land Commissioners and State Loan and Investment Board, the Office of State Lands and Investments (OSLI) administers Regular Farm Loans and Small Water Development Project Loans that are applicable to potential projects identified in Sections 4 and 5.

Regular Farm Loans

These loans are made for a wide range of agricultural purposes, including the potential projects identified in Sections 4 and 5, purchasing, constructing or installing equipment and/or improvements necessary to maintain or improve the earning capacity of the farming operation. Eligible applicants include individuals whose primary residence is in Wyoming and legal entities with a majority of the ownership meeting the individual residency requirements. Single loans or combinations of loans cannot exceed an outstanding principal balance of $800,000. Loan rates are 8% for loans up to 50 percent of the appraised value of the security land and improvements and 9% for loans between 50 and 60 percent of the security. The term of a given loan is limited to 30 years.

Small Water Development Project Loans

These loans are authorized for projects for development and use of water upon agricultural lands for agricultural purposes. These projects may convert dry land into irrigated land or lead to more efficient use of water and/or increased crop or forage production. Eligible recipients may include court approved water districts, agencies of state and local government, persons, corporations, associations, and other legal entities recognized under state law. Individual loans up to $150,000 may be made. Interest is currently set at 4% to 6% percent and the maximum term of loan is 40 years.

8.3.4 WYOMING WATER DEVELOPMENT COMMISSION

The mission of the Wyoming Water Development Commission (WWDC), as defined in the enabling legislation, is to:

"... provide, through the commission, procedures and policies for the planning, selection, financing, construction, acquisition and operation of projects and facilities for the conservation, storage, distribution and use of water, necessary in the public interest to develop and preserve Wyoming's water and related land resources, The program shall encourage development of water facilities for irrigation,..for abatement of pollution, for preservation and development of fish and wildlife resources...and shall help make available the waters of the state for all beneficial uses..," (W.S. 41-2-112(a)).

Key aspects of the Wyoming Water Development Program and the Small Water Project Program administered by WWDC are described in the following subsections.

8.3.4.1 WYOMING WATER DEVELOPMENT PROGRAM

The main Wyoming Water Development Program encompasses new development, dams and reservoirs, rehabilitation, water resources planning and master planning. Of most relevance to the Bear River Watershed in terms of implementing alternative projects are the New Development, Rehabilitation Programs and Dams and Reservoirs Program described below. This information was abstracted from the Operating Criteria of the Wyoming Water Development Program available at:

http://wwdc.state.wy.us/opcrit/final_opcrit.pdf

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

Water Resource Planning

The Wyoming Water Development Commission serves as the water development planning agency for the State of Wyoming. In this capacity, the WWDC can provide assistance for both Basin Wide Plans and Master Plans. These two types of plans are further described below:

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

Master Plans -The program provides a service to municipalities, districts and other entities to assist in the preparation of planning documents which serve as master plans for future water supply systems and improvements. The plans serve as a framework for the entities to establish project priorities and to perform the financial planning necessary to meet those priorities. These plans can assist entities in preparing the reports necessary to achieve federal funding assistance for water development and other water related projects.

Groundwater Grant Program

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

New Development Program

This program provides technical assistance and funding to develop waters of the state that are unused and/or unappropriated at present. It deals with a wide range of projects, including as most relevant to the Bear River Watershed, the following types of projects:

- Multiple Purpose - including, among other uses, two or more of the following: agriculture, recreation, and environmental, flood control, erosion control;
- New Storage - dams and reservoirs more than 2,000 acre-feet;
- Watershed Improvement - for components whose primary function or benefit is water development; and
- Recreation

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

Rehabilitation Program

The Rehabilitation Program addresses the improvement of water projects completed and in use for at least fifteen years in order to assist in keeping existing water supplies effective and viable for the future. Relative to the Bear River watershed, the Rehabilitation Program can improve existing agricultural facilities and conveyance systems to insure safety, decrease operation and maintenance (O&M) costs, and increase the efficiency of agricultural water use. The types of projects supported relevant to this watershed are essentially the same as listed above for the New Development Program.

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

Dam and Reservoir Program

Proposed new dams with storage capacity of 2,000 acre-feet or more and proposed expansions of existing dams of 1,000 acre-feet or more qualify for the Dam and Reservoir program. Legislative approval must be granted prior to allocating funds to a particular purpose or project. Dams and reservoirs typically provide opportunities for many potential uses. While water supply shall be emphasized in the development of reservoir operating plans, recreation, environmental enhancement, flood control, erosion control and hydropower uses should be explored as secondary purposes. Many of the new reservoir projects (Stowe Creek, Quealy, Leeds, Coy, Pine Creek) identified during this study are less than 1,000 acre-feet but larger than 20 acre-feet and consequently do not fit into the dam and reservoir program.

Key Criteria and Procedures

An application for funding under either the New Development or Rehabilitation Programs must meet the following key criteria most applicable to potential projects as identified in Section 4:

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

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

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

- The due date for new project applications is August 15 of each year; the due date for applications advancing to the next study level or construction funding is October 1 of each year.

Financial Plan

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

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

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

- "The best available project financial terms include a grant for Level I and Level II expenses, a grant of 75% of the Level III costs, a loan of 25% of the Level III costs with an interest rate of four percent (4%) and a term equal to the economic life of the project/improvements or fifty (50) years whichever is less. Principal and interest payments may be deferred for five (5) years after project completion. However, these favorable terms will be granted when a project is essential and the project sponsor has a very limited ability to pay."

- "Those sponsors, who feel more favorable terms are warranted due to a limited ability to pay, must make a formal presentation to the Commission documenting their case. Sponsors electing to pursue this option should be aware that the Commission is reluctant to deviate from this standard and such requests will be denied unless they are clearly documented and justified."

The Commission will evaluate whether or not a project will be funded for Level III construction following review of the results of Level II studies. If the Commission determines that the project should not advance due to high repayment costs (as determined by an analysis of the sponsor's ability-to-pay and after other funding sources have been considered), the sponsor has the option of making a formal presentation to WWDC relative to the sponsor's ability and willingness to pay. This presentation must address the need for the project, the direct and indirect benefits of the project, and any other information the sponsor feels is relevant to the Commission's final decision.

The WWDC may waive the requirement that the project sponsor be a public entity under the following exceptions:

1. The WWDC may accept applications for Level I studies from applicants that are not public entities. This will allow the applicant to know if there is a viable project prior to

becoming a public entity. However, the applicant must be a public entity before applying for a Level II study. Under these circumstances, the Level I process will have a two-year duration with the study being completed the first year and the sponsor forming a public entity the second year.

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

The Wyoming State Legislative Services Office maintains current district formation information principly found in the Wyoming State Statues, Title 22, Chapter 29 – Special District Elections Act. This chapter can be viewed at the following web address:

http://legisweb.state.wy.us/statutes/statutes.aspx?file=titles/Title22/T22CH29.htm

8.3.4.2 SMALL WATER PROJECT PROGRAM

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

Planning for small water projects will be generated by a WWDC watershed study or equivalent as determined by the Wyoming Water Development Office. A watershed study will incorporate, at a minimum, available technical information describing conditions and assessments of the watershed including hydrology, geology, geomorphology, geography, soils, vegetation, water conveyance infrastructure, and stream system data.

A management and rehabilitation plan outlining site specific projects that may remediate existing watershed impairments or address opportunities beneficial to the watershed is required for access to the SWPP. Activities should improve watershed condition and function and provide benefit for wildlife, livestock and the environment. Projects may provide improved water quality, riparian habitat, habitat for fish and wildlife and address environmental concerns by providing water supplies to support plant and animal species or serve to improve natural resource conditions."

The Small Water Project Program (SWPP) is intended to be compatible with the conventional WWDC program described above. Small water projects are defined as providing multiple benefits where the total estimated project costs (including construction, permitting, construction engineering, and land procurement) are less than $135,000 or where WWDC's maximum financial contribution is thirty-five thousand dollars. SWPP funding is a "one-time" grant so that ongoing operation and maintenance costs are not included. Loans are not available under SWPP.

Eligibility

The kinds of projects eligible for SWPP funding include, but are not necessarily limited to:

- Small reservoirs and stock watering ponds (up to 20 feet high and 20 acre-feet capacity);

- Wells
- Pipelines and conveyance facilities
- Irrigation
- Spring developments
- Solar platforms
- Windmills
- Wetland developments
- Environmental-streambank stability or erosion protection

Benefits associated with SWPP projects may include, but are not necessarily limited to:

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

These projects may address environmental concerns by providing water supplies to support plant and animal species, and serve as instruments to improve rangeland conditions.

Funding can only be provided to eligible public entities including but not necessarily limited to conservation districts, watershed improvement districts, water conservancy districts, and irrigation districts.

Application, Evaluation and Administration

Details of the application and evaluation process and program administrative procedures are provided in the Small Water Project Program Operating Criteria available online as noted previously. Some key aspects of the process and procedures applicable to the potential projects identified in Sections 4 and 5 include the following:

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

2. Applications shall be received by January l of each calendar year. Applications meeting criteria requirements will be considered during the regularly scheduled WWDC meeting in March. Applications shall include a project application, sponsor project referral, project location map, project cost estimates and any letters of authorization or commitment of participation that may be available from other funding sources.

3. Projects that improve watershed condition and function, provide multiple benefits, and meet the funding criteria specified in W.S. 99-3-703(j)(vii) or W.S. 99-3-704(g)(vii), as described in 8.4 herein, are eligible for consideration.

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

Additional, and occasionally updated, information related to the small water project program can be found at the following link:
http://wwdc.state.wy.us/small_water_projects/SWPPopCriteria.html

8.3.5 WYOMING WILDLIFE AND NATURAL RESOURCE TRUST

The Wyoming Wildlife and Natural Resource Trust (WWNRT) was formed by the state legislature in 2005 to preserve and enhance Wyoming's wildlife and natural resources. Projects funded by WWNRT must provide a public benefit such as continued agricultural production to maintain open space and healthy ecosystems, enhancements to water quality, and maintenance or enhancement of wildlife habitat.

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

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

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

- Improvement and maintenance of existing aquatic habitat necessary to maintain optimum fish populations.
- Conservation, maintenance, protection and development of wildlife resources, the environment, and Wyoming's natural resource heritage.

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

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

8.4 FEDERAL AGENCIES

8.4.1 BUREAU OF LAND MANAGEMENT

BLM's Riparian Habitat Management Program

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

Partnerships have been available for riparian improvement projects and for research into riparian issues. Funding is available on an annual basis subject to budget allocations from Congress. All submitted cooperative projects compete for the funds available in the riparian program, For information on the riparian habitat program within BLM, please contact (307) 367-5300.

Range Improvement Planning and Development

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

All rangeland improvement projects on lands administered by the Bureau of Land Management require the execution of a permit. Although there are a couple of methods for authorizing range improvements on the public lands, Cooperative Agreement for Range improvements form 4120-6 is the method most commonly used. This applies equally to range improvement projects involving water such as reservoirs, pits, springs, and wells including any associated pipelines for distribution. The major funding source for the Bureau of Land Management's share comes from the range improvement fund which is generated from the grazing fees collected. There also is a limited amount of funding from the general rangeland management appropriations. If the cooperator is a livestock operator; their contributions come generally in the form of labor. There are times they also provide some of the material costs as well. Contributions from the conservation/environmental interests is monetary and often come in the form of grants, they also contribute labor on occasion. For information on the range improvement program within BLM, please contact (307) 367-5300.

BLM's Watershed and Water Quality Improvement

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

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

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

Wyoming Landscape Conservation Initiative (WLCI)

The WLCI is a long term, science based program to assess and enhance aquatic and terrestrial habitats at the landscape scale in Southern Wyoming, while facilitating responsible development through local collaboratrion and partnerships. The WLCI partnership formally includes the BLM, USFWS, US Geological Survey, USFS, Wyoming Department of Agriculture, WGF, National Park Service, NRCS, local conservation districts and county commissioners. BLM administers the program.

Additional information may be found at www.wlci.gov.

8.4.2 BUREAU OF RECLAMATION

The Bureau of Reclamation (BOR) administers the Water Smart Grants Program. This program provides funding on a competitive basis for projects focused on water conservation, efficiency and water marketing. Preference is given to projects that can be completed within 24 months that will help to prevent crises over water in areas identified as "hot spots" where potential for conflict is judged to be moderately to highly likely by 2025. There is a 50/50 cost sharing for the grants.

8.4.3 ENVIRONMENTAL PROTECTION AGENCY

The Healthy Watershed Grants Program administered by the Environmental Protection Agency (EPA) "*…is designed to encourage successful community-based approaches and management techniques to protect and restore the nation's watersheds. The Targeted Watersheds Grant* *program is a competitive grant program based on the fundamental principles of environmental improvement: collaboration, new technologies, market incentives, and results-oriented strategies. The Targeted Watersheds Grant Program focuses on multi-faceted plans for protecting and restoring water resources that are developed using partnership efforts of diverse stakeholders. Targeted Watersheds Implementation Grants are focused on individual watershed organizations. Successful watershed organizations are chosen because they best demonstrate the ability to achieve on-the-ground, measurable environmental results relatively quickly, having already completed the necessary watershed assessments and developed a technically sound watershed plan. Each of the watershed organizations exhibits strong partnerships with a wide variety of support; creative, socio-economic approaches to water restoration and protection; and explicit monitoring and environmentally-based performance measures."* as described in the following program website:

http://water.epa.gov/hwp

8.4.4 FARM SERVICE AGENCY

The Farm Service Agency (FSA) administers two potential programs that may be applicable to some of the alternative projects identified in Sections 4 and 5. Technical assistance for the FSA programs is provided by NRCS. Each of these two programs is briefly discussed below.

Conservation Reserve Program-Continuous (CRP-C)

From the USDA Farm Service Agency; "*Conservation Reserve Program (CRP) is a land conservation program that helps agricultural producers safeguard environmentally sensitive land. CRP participants plant long-term, resource-conserving covers to improve the quality of water, control soil erosion, and enhance wildlife habitat. In return, FSA provides participants with rental payments and cost-share assistance."*

"Environmentally desirable land devoted to certain conservation practices may be enrolled in CRP at any time under continuous sign-up. Offers are automatically accepted provided the land and producer meet certain eligibility requirements. Continuous sign-up contracts are 10 to 15 years in duration."

Land in the Bear River Watershed would qualify for this program under marginal pastureland.

Emergency Conservation Program (ECP)

This program provides emergency funding and technical assistance for implementing emergency livestock watering conservation measures during periods of severe drought and rehabilitating farmland damaged during natural disasters. Cost share assistance up to 75 percent of the cost to implement the emergency measure(s) is available.

The damage from the natural disaster or severe drought must create new conservation problems that if not dealt with would:

- Further damage the land
- Significantly affect the land's productive capacity

- Represent damage from a natural disaster unusual for the area (an exception to this is damage from wind erosion)
- Be too costly to repair without Federal assistance in order to return the land to agricultural production

8.4.5 FISH AND WILDLIFE SERVICE

Technical and financial assistance are available to private landowners, profit or nonprofit entities, public agencies and public-private partnerships under several programs addressing the management, conservation, restoration or enhancement of wildlife and aquatic habitat (including riparian areas, streams, wetlands and grasslands). These programs include:

Partners for Wildlife Habitat

This program provides technical and financial assistance directly to private landowners through voluntary cooperative agreements called Wildlife Extension Agreements (WEA). The program targets habitats that are in need of management, restoration or enhancement such as riparian areas, streams, wetlands and grasslands. Under these Wildlife Extension Agreements, private landowners agree to maintain the restoration projects as specified in the agreement but otherwise retain full control of the land.

North American Wetlands Conservation Act Grant Program

This grant program promotes long-term conservation of wetlands ecosystems and the waterfowl, migratory birds, fish and wildlife that depend upon such habitat. Conservation actions supported are acquisition, enhancement and restoration of wetlands and wetlands associated habitat. This program encourages voluntary, public-private partnerships. Public or private, profit or non-profit entities or individuals establishing public-private sector partnerships are eligible. Cost-share partners must at least match grant funds 50/50 with non-federal monies. *Small Grants may not exceed $75,000.*

Cooperative Endangered Species Conservation Fund

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

8.4.6 NATURAL RESOURCES CONSERVATION SERVICE

The Natural Resources Conservation Service (NRCS) administers a number of funding and technical assistance programs applicable to many of the alternative projects identified in Sections 4 and 5. These programs are briefly described below and summarized in Table 8.1 found in Section 8.6 of this study.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is a voluntary program available to agricultural producers that provides technical assistance, cost sharing and incentive payments for projects and practices that improve water quality, enhance grazing lands, and/or increase water conservation.

Non-federal landowners (including American Indian tribes) that engage in livestock operations or agricultural production are eligible for funding. Eligible land includes cropland, rangeland, pasture, forestland, and other farm and ranch lands. Eligibility also requires that the applicant develop an EQIP plan of operations that becomes the basis of the cost-sharing agreement between NRCS and the participant.

EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. In most cases a 25 percent non-federal match is required. Farmers and ranchers may elect to use a certified Technical Service Provider (TSP) for technical assistance needed for certain eligible activities and services. Participants may not receive, directly or indirectly, payments that, in the aggregate, exceed $450,000 for all program contracts entered during any six year period.

Detailed information about the Wyoming EQIP program is available at the following website:

http://www.nrcs.usda.gov/wps/portal/nrcs/main/wy/programs/financial/eqip/

Other NRCS Programs

Other programs administered through NRCS that may be relevant to certain alternative projects discussed in Sections 4 and 5 include, but are not necessarily limited to the following:

Emergency Watershed Protection (EWP)

From the NRCS website: *"The purpose of the Emergency Watershed Protection Program (EWP) was established by Congress to respond to emergencies created by natural disasters. The EWP Program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences. The U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) administers the EWP Program; EWP-Recovery, and EWP–Floodplain Easement (FPE)."* Public and private landowners are eligibile but must be represented by a legal subdivision of the State. The program provides up to 75% of project costs.

Agricultural Management Assistance Program (AMA)

AMA helps agricultural producers use conservation to manage risk and solve natural resource issues through natural resources conservation. Producers receive conservation technical and financial assistance to construct or improve water management or irrigation structures, plant trees for windbreaks or, in order to improve water quality and mitigate risk, diversify their operation and conservation practices including soil erosion control, integrated pest management or transistion to organic farming.

Persons or legal entities cannot receive more than $50,000 in AMA program payments per fiscal year.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/

Conservation Stewardship Program (CSP)

CSP helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns.

Eligible lands include private and Tribal agricultural lands, cropland, grassland, pastureland, rangeland and nonindustrial private forest land.

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/

8.4.7 US ARMY CORPS OF ENGINEERS

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

The Corps of Engineers is authorized to provide technical assistance to local communities, States and federally recognized Indian Tribes in support of their efforts to alleviate flooding impacts, reduce erosion and otherwise plan for the wise and prudent use of the nation's water and related land resources. They also have authority to construct certain water resources related projects and respond to water resource needs. These programs have limited application for the types of upland water projects but could find application for bank stabilization or should a larger reservoir type project be considered. The programs are as follows:

Planning Assistance to States

This program provides for assistance in preparation of plans for the development, utilization and conservation of water and related land resources. The Corps provide technical planning assistance in all areas related to water resources development such as bank stabilization, sedimentation, water conservation, ecosystem and watershed planning and water quality. Assistance is limited to $2,000,000 per state and studies are cost-shared on a 50-50 basis with a non-federal sponsor such as a state, public entity or an Indian Tribe.

Flood Plain Management Services

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

Flood Damage Reduction Projects

This program provides structural and non-structural projects to reduce damages caused by flooding and focuses on solving local flood problems in urban areas, towns and villages. The Corps works with the project sponsor to define the flood problem, evaluate solutions, select a plan, develop the design and construct a project. A feasibility study is conducted to identify potential projects with the first $100,000 of the cost Federal. Any cost above this amount is cost-shared 50-50 with the sponsor in the form of cash and in-kind services. Maximum federal share for planning, design and construction is $10,000,000.

Project Modification for Improvement of Environment

The purpose of this program is to modify structures or operation of previously constructed water resources projects to improve environmental quality, especially fish and wildlife values. Design and implementation is 75% federal and 25% non-federal.

Aquatic Ecosystem Restoration

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

8.4.8 USDA FOREST SERVICE

A number of Federal laws direct or authorize watershed management on National Forest_Service lands. Some of these laws provide broad authority while others deal more narrowly with specific watershed management activities.

The objectives of the Forest Service watershed management program are to protect and enhance soil productivity, water quality, water quantity and timing of water flows and to maintain favorable conditions of stream flow and continuous production of resources from National Forest System watersheds.

It is the policy of the Forest Service to implement watershed management activities on National Forest System lands in accordance with general objectives of multiple use and the specific objectives in the forest land management plans for the area involved. It is also the intent to design management activities of other resources to minimize short term impacts on soil and water resources and to maintain or enhance long term productivity, water quality and water quantity.

The Clean Water Action Plan provides broad water quality direction for the Forest Service. Specific direction for water quality is contained in the Land and Resource Management Plan for each National Forest. The forests in Wyoming are in the process of completing the Inland West Water Reconnaissance which will provide a classification of watersheds and stream reach conditions. Forest Service water quality programs are coordinated with Wyoming Department of Environmental Quality and other appropriate agencies. The Forest Service also has a water rights program that is coordinated with the Wyoming State Engineer.

The Forest Service, in conjunction with other federal, state and local agencies, provides watershed management and condition training. T-WALK and Proper Functioning Condition surveys are field methods used to assess stream reach and other water body conditions.

8.4.9 RURAL UTILITIES SERVICE

The United States Department of Agriculture, Rural Development's utilities program is authorized to provide financial assistance for water and waste disposal facilities in rural areas and towns of up to 10,000 people. This program is intended for non-profit corporations and public bodies such as municipalities, counties, and special purpose districts and authorities.

Funding may be obtained through Rural Development only when the applicant is unable to secure funding from other sources at reasonable rates and terms. The applicant must have legal capacity to borrow and repay loans, to pledge security for loans and to operate and maintain the facilities. The applicant must be financially sound and able to manage the facility effectively as well as have a financially sound facility based upon taxes, assessments, revenues, fees or other satisfactory sources of income to pay costs of operating, debt service and reserve. Grants are also available and are used to supplement loans to reduce debt service where necessary to achieve reasonable user rates. Assistance is also available on how to assemble information concerning engineering, financing and management of proposed improvements.

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

USDA Rural Development also guarantees loans to eligible commercial lenders to improve, develop, or finance water or waste disposal facilities in rural areas. This guarantees a warrant to protect the lender and may cover up to 90% of the principal advanced. The guarantee fee is 1% of the loan amount multiplied by the percent of the guarantee. Interest rates are negotiated between the lender and the borrower.

8.5 NON-PROFIT AND OTHER ORGANIZATIONS

8.5.1 DUCKS UNLIMITED

Ducks Unlimited, Inc. (DU) is a potential funding source for wetlands and waterfowl restoration projects. Direct grant funding is limited but in-kind assistance may be available from the local chapter of DU. Additional information on DU's funding programs and opportunities is available in the Water Management & Conservation Assistance Program Directory referenced previously.

8.5.2 NATIONAL FISH AND WILDLIFE FOUNDATION

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

Pulling Together Initiative

Provides support on a competitive basis for the formation of local Weed Management Area (WMA) partnerships that engage federal resource agencies, state and local governments, private landowners, and other interested parties in developing long-term weed management projects within the scope of an integrated pest management strategy; minimum 1:1 non-federal match is required.

Funding priorities for this program include:

- Projects that focus on a particular well-defined Weed Management Area, such as a watershed, ecosystem, landscape, or county
- Projects supported by private landowners, state and local governments, and the regional/state offices of federal agencies
- Projects with a Steering Committee composed of local cooperators who are committed to working together to manage invasive and noxious plants across their jurisdictional boundaries
- Long-term weed management plans which are based on an integrated pest management approach using the principles of ecosystem management
- Inclusion of a public outreach and education component, as appropriate

Bring Back the Natives Grant Program

This funding source provided by BLM, Bureau of Reclamation, FWS, Forest Service, and NFWF can be used to restore damaged or degraded riverine habitats and their native aquatic species. A minimum 1:1 non-federal match is required. Colorado cutthroat trout are one of the targeted species.

Five-Star Restoration Program

This program provides modest financial assistance on a competitive basis to support community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach and training activities. Grants requested must be $20,000 to $50,000.

Information about all of these and other NFWF grants/programs is available at their website:

http://nfwf.org/

8.5.3 TROUT UNLIMITED

The Wyoming Council of Trout Unlimited provides funding and volunteer labor for a variety of stream and watershed projects such as erosion control and fish habitat structures, willow and other riparian plantings and stream protection fencing. Embrace-A-Stream grants are available for up to $10,000 per project on a 1:1 matching basis. Partnerships are encouraged and can include local conservation districts and state and federal agencies. The grant application is prepared in coordination with the local TU Chapter and submitted by the Chapter. Objectives are to protect, restore, reconnect, and sustain habitat for the conservation of trout. Additional instructions and application can be found at the following website:

http://www.tu.org/conservation/watershed-restoration-home-rivers-initiative/embrace-a-stream

8.6 FUNDING SUMMARY

The following Table 8.1 summarizes the potetntial funding sources discussed above with contact information where available.

Table 8.1 Funding Sources

Agency / Entity	Program Name	Project Type	Internet Site	Telephone
Local				
Uinta County Conservation District		Technical assistance, state and federal grant partnering, grant applications	www.uintacountycd.com	307-787-3070
Lincoln County Conservation Districts			www.lincolnconservationdistrict.org/	307-279-3256
Uinta County Weed and Pest District		Technical assistance and cost share in the control of noxious and invasive weeds	www.ucwp.org	307-789-9289
Lincoln County Weed and Pest District			www.lcwy.org/public_services?weedpest.php	307-367-4728
State				
Wyoming Department of Environmental Quality	Watershed Protection Program	Implementation of BMP's	http://deq.wyoming.gov/wqd/watershed-protection/	307-777-6709
Wyoming Game and Fish Department	Habitat Trust Fund	Habitat acquisition, maintenance or improvements	http://wgfd.wyo.gov/	307 777-4600
	Fish Passage Grants	Creating and improving passage		
	Wyoming Sage Grouse Conservation Fund	Protection and enhancement of sage grouse habitat		
Wyoming Office of State Lands and Investments	Regular Farm Loans	Improvements related to improving farm earning capacity	http://lands.wyo.gov/	307-777-7331
	Small Water Development Project Loans	Water development for agriculture		
Wyoming Water Development Commission - Wyoming Water Development Program	Water Resource Planning	Basin wide plans and master planning of water resource development	http://wwdc.state.wy.us/	307-777-7626
	Groundwater Grant Program	Ground water inventory and development		
	New Development Program	Storage, supply, watershed and recreation projects		
	Rehabilitation Program	Rehab of old (>15yrs) water source and conveyance systems		
	Dam and Reservoir Program	New dams and expansion of existing dams		
Wyoming Water Development Commission - Small Water Project Program		Watershed condition and function, upland water, small reservoirs, wells, pipelines, springs, solar, windmills, and wetlands		
Wyoming Wildlife and Natural Resource Trust Fund		Preservation of open space, ecosystem health, water quality, wildlife habitat	http://wwnrt.wyo.gov/	307 777-8024

Table 8.1 Funding Sources (Continued)

Federal				
Bureau of Land Management	Riparian Habitat Management Program	Wetland function and health	http://www.blm.gov/wyoming1/	307-367-5300
	Range Improvement Planning and Development	Rangeland health, watershed BMP's		
	Watershed and Water Quality Improvement			
	Wyoming Landscape Conservation Initiative	Assessment and enhancement of aquatic and terrestrial habitats in Southern	www.wlci.gov	307-352-0227
Bureau of Reclamation	Water Smart Grant	Water conservation and marketing	http://www.usbr.gov/watersmart/grants.html	801-524-3600
Environmental Protection Agency	Watershed Grants Program	Watershed restoration	http://water.epa.gov/hwp	303 312-6312
Farm Service Agency	Conservation Reserve Program (CRP-C)-Continuous	Marginal pastureland qualifies; watershed restoration riparian buffers, shelter belts, erosion control	http://www.fsa.usda.gov/FSA/	307 261-5231
	Emergency Conservation Program (ECP)	Emergency watering, disaster rehabilitation		
Fish and Wildlife Service	Partners for Wildlife	Riparian, wetland, and grassland restoration	http://www.fws.gov/wyominges/index.php	307 772-2374
	North American Wetlands Conservation Act Grant Program	Wetlands conservation		
	Cooperative Endangered Species Conservation Fund	Habitat surveys, planning, management, land acquisition, public education		
Natural Resources Conservation Service	Environmental Quality Incentives Program (EQIP)	Water Quality, Land Enhancement, Water Conservation	http://www.nrcs.usda.gov/wps/portal/nrcs/main/wy/programs/financial/eqip/	Uinta County 307 787-3211 Lincoln County 307-886-3744
	Emergency Watershed Protection	Watershed protection related to natural disasters	http://www.nrcs.usda.gov/wps/portal/nrcs/main/wy/programs/	
	Agricultural Management Assistance Program	Use conservation to manage risk		
	Conservation Stewardship Program	Maintain existing conservation systems		
US Army Corps of Engineers	Planning Assistance to States	Planning for conservation of water and land resources, sediment control, watershed planning, water quality	http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Wyoming.aspx	(307) 772-2300
	Flood Plain Management Services	Flood plain guidance and special studies		
	Flood Damage Reduction Projects	Flood control in developed areas such as Towns or villages		
	Project Modification for Improvement of Environment	Water resource structure modifications for fish and wildlife benefit		
	Aquatic Ecosystem Restoration	Water resource development modifications for fish habitat enhancement		
	Water Resources Projects	Large projects >$10 million; levees, channels, flood plains		
USDA Forest Service	Watershed Management Program	Soil productivity, water quality, water quantity	http://www.fs.fed.us/	202-205-8333
USDA Rural Utilities Service	Rural Utilities Program	Water and waste water in rural communities	www.rd.usda.gov/wy	307-233-6700
Private				
Ducks Unlimited		Wetlands and waterfowl restoration projects	https://www.ducks.org/wyoming/	Lincoln & Uinta Counties 307-679-092
National Fish and Wildlife Foundation	Pulling Together Initiative	Weed and invasives management	http://www.nfwf.org/	Denver Office 202-857-0166
	Bring Back the Natives Grant Program	Restoration of riverine habitats and native aquatic species		
	Five-Star Restoration Program	Wetlands and riparian habitat restoration		
Trout Unlimited		Erosion control, habitat restoration, fish passage, habitat enhancements	wyomingtu.org/	307-332-7700

IX. CONCLUSIONS AND RECOMMENDATIONS

This study collected and inventoried various data sets and previous studies related to the Bear River Watershed study area and its resources, challenges and potential with regard to watershed improvements. Potential improvements include both projects and management strategies related to rangeland health, irrigation potential, livestock watering, wildlife watering, wildlife habitat and general stream health.

9.1 CONCLUSIONS

The following conclusions and recommendations are the result of the data inventory, field observations, landowner and permittee recommendations, and previous studies. The concepts and ideas can be catetorized into several broad categories:

- Livestock Water Availability and Distribution
- Stream Channel Condition and Stability
- Grazing Management Opportunities
- Invasive Species Treatment
- Irrigation System Rehabilitation
- Reservoir and Storage Rehabiliation and Opportunities

9.1.1 UPLAND/WILDLIFE WATERING OPPORTUNITIES

There are many different types and applications of upland water developments, and the particular design that is selected is highly dependent on local needs, conditions, and available funding. Upland livestock watering systems typically include spring developments, wells, pumps, tanks, diversions, or gravity fed systems. These types of water projects can be mutually beneficial for range health, wildlife, and livestock.

Within the Bear River Watershed study area additional opportunities exist to improve upland water availability for livestock and wildlife. The potential projects range from simple spring developments to projects with piped distribution to multiple tanks and troughs. Many opportunities lie on public lands and agency involvement is required for permitting. Agencies may also present opportunity for partnering on projects that improve range and offer wildlife watering opportunities. Partnering could take the form of design and permitting support or even financial participation.

The small upland water projects included in this study are likely eligible for the WWDC's Small Water Project Program. The total project cost cap for eligibility is $135,000. If eligible, a 50% grant up to a maximum of $35,000, is available to help with the project. The Lincoln or Uinta Co. Conservation Districts can serve as the legal entity sponsor making the program responsive to individual landowners.

With approximately 58 potential projects totaling $4.0 million dollars, some prioritization of project by the landowner/lessee will be required to provide parity with project dollars that may be available. Working with the resource agencies, the best projects in terms of benefits can be identified using the documents contained in the individual county supplements.

9.1.2 STREAM CHANNEL CONDITION AND STABILITY

Landowners and permittees pointed out several areas of concern related to channel stability. Many historic studies have also pointed to channel instability in the Bear drainage as impacting water quality, irrigation structures and farmland. Many areas within the watershed have undergone restoration and the watershed will continue to benefit from continued implementation of these projects.

1. Stream channel morphologic classification results must be interpreted within the context of local valley type and condition. Some channel classifications are considered appropriate in some valley settings and inappropriate or unstable in other valley settings.

2. The basin-wide channel morphology classification identified numerous disequilibrium channel reaches and areas of morphologic concern based upon channel condition and valley setting. The effort generated a list of warranted treatment areas that watershed managers can utilize to identify meaningful channel restoration and stabilization projects across the watershed.

3. The Level I morphologic channel classification was completed at a large scale using remote sensing and limited field verification; individual restoration projects can be weighed in terms of watershed value based upon the results, but each local project should be designed by experienced practitioners based upon local field data and site analysis.

4. High width/depth ratio Rosgen C-type channels are prevalent within the Bear River Watershed study area. These channel segments are not highlighted during the identification of disequilibrium channel reaches and morphologic areas of concern because the initial channel classification is appropriate in the context of local valley conditions even though the width/depth ratio may be excessive. These stream reaches may benefit from aquatic habitat enhancement projects that incorporate bank stabilization, channel narrowing, and/or width/depth ratio reduction.

5. Numerous diversions within the study area incorporate instream structures or require regular channel manipulations to maintain diversion function. These locations present an opportunity where watershed managers and landowners could pursue alternative structure configurations that maintain year-round diversion functionality while minimizing the need for periodic channel manipulations or site maintenance. Such efforts would benefit water users and the aquatic ecology of the proximate watercourse.

9.1.3 GRAZING MANAGEMENT OPPORTUNITIES

Environmental conditions and constraints vary by location, but the following general BMPs for range management can be implemented in concert with the ESD state and transition models to accomplish management objectives:

1. Upland (i.e., off-site) livestock watering systems
2. Strategic salting and/or herding
3. Riparian fences to exclude livestock from, or manage livestock use of, riparian areas
4. Pasture fences or cross-fences to facilitate rotational grazing systems
5. Prescribed fire
6. Chemical brush control

Many of these management practices are mutually beneficial for livestock, range condition, and wildlife. Financial and technical assistance for these practices are available through the NRCS and other federal, state, and local agencies (see Section VIII). With respect to upland water, it is obvious that the permittees understand the value of upland projects and desire continued upland development.

9.1.4 INVASIVE SPECIES TREATMENT

Noxious weed and invasive plant management should be integrated into planning, funding, and implementation of any surface disturbing projects. Recent or prolonged surface disturbing activities are the greatest contributors to the spread of noxious weeds and demands the highest level of proactive control of weed dispersal. All sponsored projects shall integrate coordination with Lincoln County and Uinta County Weed and Pest Districts.

Two Cooperative Weed Management Areas are represented within the boundaries of the study area; the Highlands CWMA and the Bear River Divide CWMA. Assistance in treating noxious weeds within the study area may be available through these organizations. They can be contacted through the County Weed and Pest Districts.

Weed control Best Management Practices as described in this study are strongly recommended as the most cost effective way to manage weeds in coordination with any development projects. In addition, cost share funding opportunities should be explored during project planning to defray weed management expenses for private landowners or industry partners.

9.1.5 IRRIGATION SYSTEM OPPORTUNITIES

Potential opportunities for irrigation projects identified in this study are associated with primary conveyance systems. Identified projects included piping canal sections, replacing head gates, and repairs to troubled spots on canals. Related stream work includes bank stabilization and head level control structures in the river to maintain diversion viablitity.

Several headgate structures were identified as needing replacement/repair due to deteriorated conditions and displacement by earth movement.

Based on the projects identified by landowners, downcutting of the river is a major challenge requiring higher and longer diversion revetments.

In total, 40 irrigation related projects were identified totaling $16,120,000 in estimated cost.

As with upland water projects, the small irrigation improvement projects included in this study are likely eligible for the WWDC's Small Water Project Program. The total project cost cap for eligibility is $135,000. If eligible, a 50% grant up to a maximum of $35,000, is available to help with the project. The conservation districts can serve as the legal entity sponsor making the program responsive to individual landowners. Larger scale projects could be eligible for funding under WWDC's rehabilitation program.

9.1.6 WATER SUPPLY AND STORAGE OPPORTUNITIES

The Bear River Watershed produces excess water that could be beneficially utilized with additional storage capability. Reservoir sites range from small sites (<20 acre-feet) of local significance to larger sites (over 10,000 acre-feet) with potential for regional benefit to the entire Bear River Basin. The smaller sites tend to be located in tributary basins and off the channel of the tributaries. The larger sites (Smiths Fork and East Fork) are located on the main-stem tributaries of the Bear River. The smaller off-channel sites are favored in terms of permitting. Permitting of any of the sites will be rigorous with the main stem sites being the most difficult. Mitigation measures will be required for any site.

During this study, two reservoirs in Lincoln County were specifically pointed out by landowners as needing major maintenance or dredging (Quealy and Leeds). Two reservoirs in Uinta County were specifically pointed out by landowners; one new (Stowe Creek); and one enlargement (Coy). All reservoirs are more than 20 acre-feet but less than 2,000 acre-feet meaning they do not fit well in the reservoir program or the small water program.

Landowners also expressed interest in and suggested projects for storage of Pine Creek flows and Smiths Fork flows.

In Uinta Couty, landowners expressed continued interest in a reservoir such as Needles or Coyote Creek or something in the Yellow Creek drainage but did not have an organization pursing any specific project.

9.2 RECOMMENDATIONS

Based on the interest and input provided by landowners and permittees, a variety of projects should be pursued. Many of the projects will qualify for the WWDC Small Water Project Program (SWPP). Use of other funding sources such as Trout Unimited is also feasible as evidenced by the ongoing work TU is doing in the basin including some projects identified in this study.

The SWPP offers up to a 50% grant or $35,000 on projects less than $135,000. Because the program does not require formation of a district, individual operators can pursue the funds on their own in conjunction with the Conservation District. When the project addresses secondary purposes of importance such as fish entrainment, fish passage, water quality or habitat quality, other fund sources such as TU or the WGFD funds may make the project feasible, and in some cases pay for the entire project.

The larger upland projects identified in this study have multiple troughs over multiple miles and exceed the cost for the SWPP when taken as a whole. However, by paring back the project to the source, tank and first trough, the project cost can be reduced to fit the program. Then, the operator might pursue additional funding from other sources to complete additional extension of the system. A similar approach might be taken on the stream restoration/stabilization projects. In some cases, the BLM has expressed interest in the same project and may be willing to partner in detail design and permitting and perhaps cost.

Permitting is of concern for projects that cross Federal land. Consequently, projects on private and State lands will be most easily implemented.

The primary reservoir storage projects identified in this study are Leeds, Quealy, and Stowe Creek. The Leeds outlet pipe project can qualify for the SWPP. The dredging project, depending on the extent, may exceed the program limit of $135,000. The Quealy and Stowe projects fall in a program funding gap; being too large for the small water program and too small for account III funds.