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Lower Gros Ventre River Hydrology, Diversions, and Water Rights, Grand Teton National Park, Wyoming

Natural Resource Technical Report NPS/NRSS/WRD/NRTR—2012/619



ON THE COVER

Top Photo: Dry Gros Ventre River along southern boundary of Grand Teton National Park, Wyoming, just downstream of State Hwy 89/191 in July 2006. Photograph by: Jennifer Miller

Bottom Photo: Discharge Measurement on Gros Ventre River along southern boundary of Grand Teton National Park, Wyoming, just upstream of State Hwy 89/191 in October 2008. Photograph by: Gwen Gerber

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Glossary

Adjudication: A process in which a *water right* [1] permit is assigned a certificate of *appropriation* issued publicly recognizing the defined *water right* and conveying property-right status on the *appropriation*.

Appropriation: The acquisition of a *water right* by fulfilling the requirements of law for a certain portion of the waters of the state and the application to a *beneficial use.*

Beneficial Use: The use of the amount of water that is reasonable and appropriate under reasonably efficient practices to accomplish, without waste, the purpose for which the diversion is lawfully made and without limiting the generality of the foregoing, and can include impoundment of water for recreational purposes, including fishery or wildlife.

Cubic feet per second (cfs): A standard measure of discharge for streamflow, indicating one cubic foot of water passing through a channel cross-section every second, also known as a second-foot.

Daily Mean Value: The daily average of *discharge* at a *gaging station*.

Direct Flow Water Right: A *water right* defined under the terms of a permit to *beneficially use* natural streamflow, as opposed to reservoir storage or groundwater.

Discharge: The amount of water flowing in a channel or diversion structure.

Drainage Basin: A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Excess Water Right: The water right for an additional cfs per 70 acres, when flows are available, if an appropriator's priority date is between 1945 and 1985.

Free River Doctrine: Allows water rights holders to divert more than one's appropriated water rights if superior rights are satisfied and the source stream is not regulated.

Gage Height: The water surface elevation referred to some arbitrary gage datum. Gage height is often used interchangeably with the more general term *stage* although gage height is more appropriate when used with a reading on a gage.

Gaging Station: A particular site on a stream, canal, lake, or reservoir where systematic observations of *gage height* or *discharge* are obtained.

Hydrograph: A graph showing *stage*, flow, velocity, or other property of water with respect to time.

Nonconsumptive Use: A use of water that does not reduce the supply, such as for hunting, fishing, boating, water-skiing, swimming, and power generation.

[1] Words defined elsewhere in glossary are shown in *italic.*

Point of Diversion: The physical point that water is taken from the main channel of a river into a ditch or diversion channel. The point of diversion used in this report may or may not be the same as the point of diversion of record for a given water right in the Wyoming State records.

Prior Appropriation: A term describing the general process by which limited water is distributed among several claimants. In the West the first person to file and use the water beneficially gets the first *water right*, whether or not that person owns land next to the river or lake from which the water is diverted.

Priority: The relative seniority of a *water right* as determined by the permit application date. Other factors are sometimes involved in determining priority. The priority of a *water right* determines its ability to divert in relation to other rights in periods of limited supply.

Rating Curve: A graph showing the relation between the *gage height* (or *stage*), usually plotted as ordinate, and the amount of water flowing in a channel (*discharge*), expressed as volume per unit of time, plotted as abscissa. Also referred to as a *stage-discharge* relationship.

Rating Table: *Stage-discharge* relationship in tabular form.

Reservoir Supply: See *storage water right*.

Seepage Run: A series of simultaneous *discharge* measurements taken at various locations along a reach of river used to help determine gaining and losing reaches.

Stage: The height of a water surface above an established datum (e.g. a staff plate); also *gage height.*

Storage Water Right: A right defined in terms of the volume of the water that may be diverted from the flow of the stream and stored in a reservoir or lake to be released and used at a later time either within the same year or a subsequent year.

Supplemental Supply Water Right: An additional irrigation water supply right from a separate stream that supplements an original surface water permit; limited to one cfs per 70 irrigated acres.

Surplus Water Right: A water right for an additional cfs per 70 acres, when flows are available, if an appropriator's priority date is prior to 1945.

Water Budget: An accounting of the inflow, outflow, and change in storage in a hydrologic unit, such as a river *drainage basin*.

Unadjudicated: A water right permit before it has been publicly recognized by proof inspection and advertisement. See *adjudication.*

Water Right: A right to use, in accordance with its priority, a certain portion of the waters of the state by reason of the specific *appropriation.*

Watershed: *Drainage basin* or catchment area

Executive Summary

Grand Teton National Park resource managers are concerned that seasonally dry reaches of the lower Gros Ventre River below the Wyoming State Highway 89/191 Bridge are potentially impacting natural resources. The park requested assistance from the National Park Service Water Resources Division to determine the feasibility of restoring and/or maintaining perennial flow in these reaches. In 2006 the Water Resource Division initiated a study to research water rights, inventory and measure diversions, conduct a seepage run, and develop a water budget for the lower Gros Ventre River.

Historically up to 24 ditches existed along the lower Gros Ventre River dating back to the 1890s. Only eight ditches conveyed water from the lower Gros Ventre River during the 2006 to 2009 study period due to ditch consolidation, non-use, source changes, or changes in points of diversion. A total of 221 cubic feet per second of direct flow and supplemental water rights can be diverted from the eight ditches on the lower Gros Ventre River; 44 percent are owned by the United States and 56 percent are privately owned.

One hundred forty-seven discharge measurements were collected on eight ditches on the lower Gros Ventre River with 54 percent of the ditch measurements exceeding total adjudicated direct and supplemental water rights and 28 percent exceeding direct, surplus, excess, and supplemental water rights.

The October 22, 2008, seepage run measured natural gains and losses in the lower Gros Ventre River. Natural gains of 43 cubic feet per second occurred between the Grand Teton National Park/Bridger Teton National Forest boundary and U.S. Geological Survey Kelly Gage, and 42 cubic feet per second occurred between the U.S. Geological Survey Zenith Gage and the Snake River confluence. Natural losses of 120 cubic feet per second occurred between the U.S. Geological Survey gages at Kelly and Zenith.

Historically the lower Gros Ventre River has been seasonally dry from just downstream of the Highway 89/191 Bridge to the Spring Gulch Road Bridge. Dry reaches have been documented in seven of the last 22 years and typically occurred in average to dry runoff years.

An initial water budget, considering diversions and natural gains and losses, indicates that flows of about 220 cubic feet per second are required at the U.S. Geological Survey Kelly Gage to meet total direct flow water rights and maintain perennial flow for fish passage in the seasonally dry reach (310 cubic feet per second for direct flow, surplus, and excess water rights; and 364 cubic feet per second for direct flow, surplus, excess, and supplemental water rights). Based on these findings it appears that there are opportunities to manage water use on the lower Gros Ventre River to restore perennial flows and protect natural resources in Grand Teton National Park.

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The University of Montana and Gregory Aquatics performed fisheries studies on the Gros Ventre River concurrent with this study. Scott Yates with Trout Unlimited coordinated the multidisciplinary project. Susan O'Ney was fundamental in administering the project at the park level. Eric Lord and Scott Yates provided the water rights summary.

Field work and the associated data support were provided by Lindsay Patterson, Celeste Fiumara, John Rice, Craig Bentley, John Clune, Jessie Meeks, Luke Bruner, Brian Villalobos, Emily Faivre, and Chad Whaley. GIS was used to depict the study area's hydrology. The GIS project would not have been possible without the help of Linda Halverson, Danelle Malget, Jacob Morgan, Kathryn Mellander, Janice Vogel, Stephani Schupbach, and Mara Kali. The NPS seepage run in October 2008 was vital to the development of the water budget. Thanks to those that contributed and/or participated in this demanding task: Jim Broderick, Celeste Fiumara, John Rice, Scott Yates, Jeff Hughes, James Harte, Eric Lord, Ryan Rumelhart, and Susan O'Ney.

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Introduction

Grand Teton National Park (GRTE) is concerned that seasonally dry reaches below the Wyoming State Highway 89/191 Bridge are potentially impacting natural resources in the lower Gros Ventre River (GVR). The park requested assistance from the National Park Service Water Resources Division (NPS-WRD) to determine the feasibility of restoring and/or maintaining perennial flow near the bridge. In 2006 the NPS-WRD initiated a study to research water rights, inventory and measure diversions, conduct a seepage run, and develop a water budget for the lower Gros Ventre River. This report summarizes those findings.

Goals and Objectives

The goal of the study was to determine the feasibility of restoring and/or maintaining perennial flow in the seasonally dry reaches of the lower GVR. The study objectives were to (1) develop a diversion and water rights inventory, (2) measure ditch diversions, (3) determine natural gains and losses, and (4) develop a water budget to aid in water use management for the lower GVR.

Study Period

NPS-WRD conducted field work from May 2006 through September 2009. Discharge data collected by the Teton Science School (TSS) from June 2005 through August 2006 and gaging station data from the United States Geological Survey (USGS) for April 2006 through November 2009 were used in the analysis. In this report, the “study period” generally refers to 2006 to 2009.

Study Area

The GVR watershed is located in northwestern Wyoming (WY) northeast of Jackson (Figure 1). The study area, also referred to as the "lower GVR," begins at the GRTE/Bridger-Teton National Forest (BTNF) boundary and extends downstream approximately 15 river miles to the Snake River confluence (Figure 2). The headwaters of the GVR begin in the Gros Ventre Mountains east and southeast of GRTE. From the Gros Ventre Mountains, the GVR flows westerly towards the Teton Valley and eventually joins the Snake River about five miles northwest of Jackson.

The GVR watershed has an area of approximately 680 square miles (USGS 2009e). Elevations in the GVR watershed range from over 10,000 feet in the Gros Ventre Mountains to about 6,200 feet at the GVR's confluence with the Snake River.

Upstream of the Highway 89/191 Bridge, the GVR is bordered on the north bank by GRTE and to the south by the National Elk Refuge (NER). Downstream of the Highway 89/191 Bridge, the GVR flows entirely within GRTE for approximately one mile and then through private property for the remaining three miles before it joins the Snake River. The seasonally dry reach of the GVR generally occurs downstream of the Highway 89/191 Bridge within GRTE (Figure 2).

Weather/Climate

The average annual precipitation for Jackson, Wyoming, is about 16 inches per year; some areas in the upstream portions of the GVR watershed receive up to 50 inches per year. Afternoon thunderstorms throughout the summer are common. Monthly average temperatures range from approximately 16°F in January to 61°F in July (WRCC 2009). The average growing season is approximately 145 days, and low summer precipitation requires crop irrigation to maximize crop production. (WRCC 2009).

Geology

The geology of the lower GVR watershed is characterized by Paleozoic Pennsylvanian and Mississippian Formations between the GRTE/BTNF boundary and Kelly. The GVR below Kelly is comprised of Cenozoic Holocene and Pleistocene Formations. Tensleep Sandstone, Amsden and Phosphoria Formations, and Madison Limestone outcrops are found adjacent to the river from the GRTE boundary downstream to Kelly, Wyoming, where the GVR is confined to a single, relatively straight channel due to the narrow valley bounded by bedrock outcrops. A concealed normal fault crosses the river and runs north/south just upstream of Kelly. Kelly Warm Springs and Teton Valley Ranch Warm Springs manifest along the downthrown (west) side of this normal fault.

From Kelly downstream to the GVR's confluence with the Snake River, the channel is comprised of alluvial gravel; the banks and floodplain are comprised of terrace gravel, floodplain and swamp deposits, and glacial outwash. The GVR is wide and highly braided downstream of Kelly due to the lack of bedrock to confine the river channel. Buttes on the north and south sides of the river are comprised of loess, Bull Lake glacial till, and sedimentary rocks of the Teewinot and Shooting Iron Formations (Love et al. 1999, Love and Love 1988).

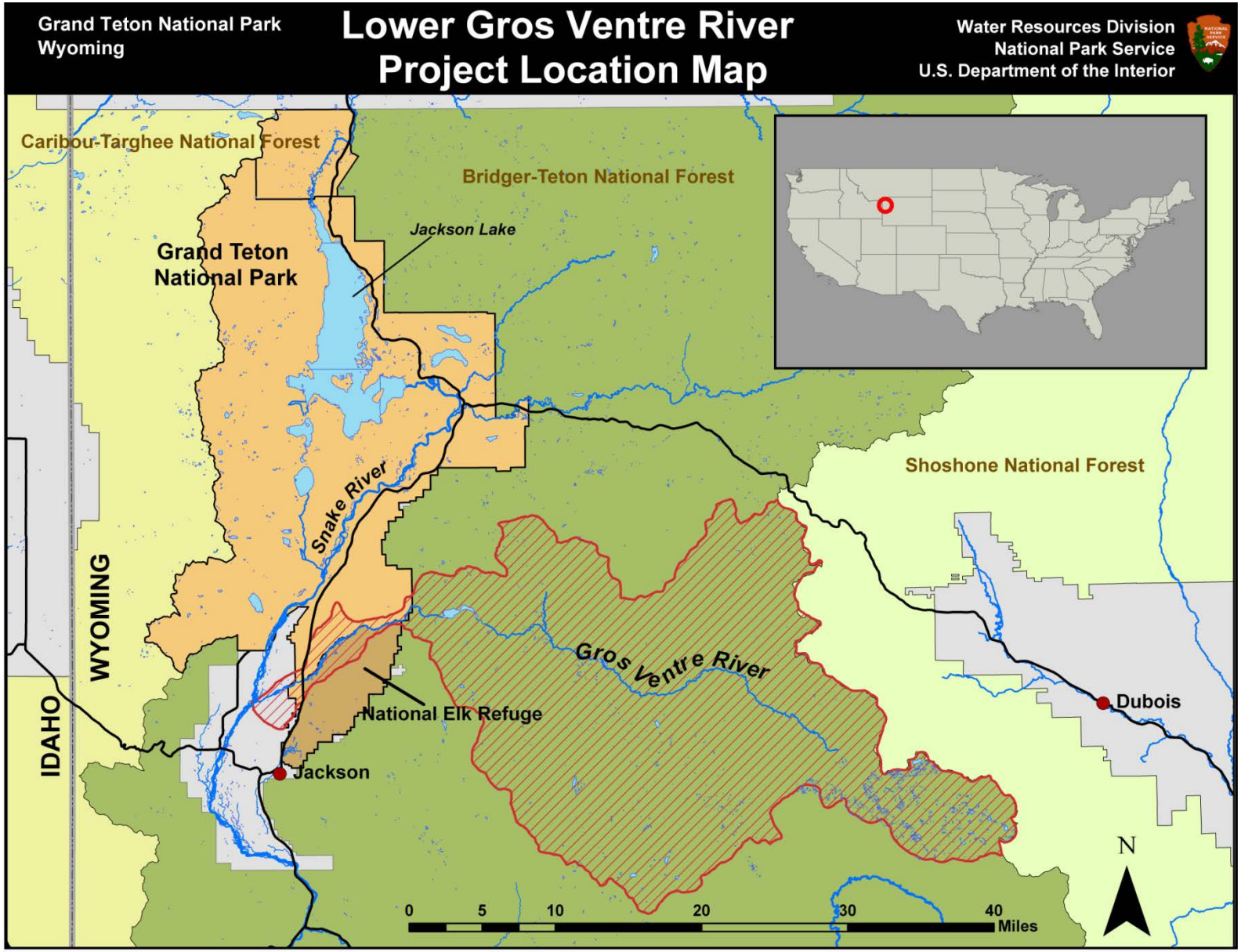


Figure 1. Location of Gros Ventre River watershed (red hatch).

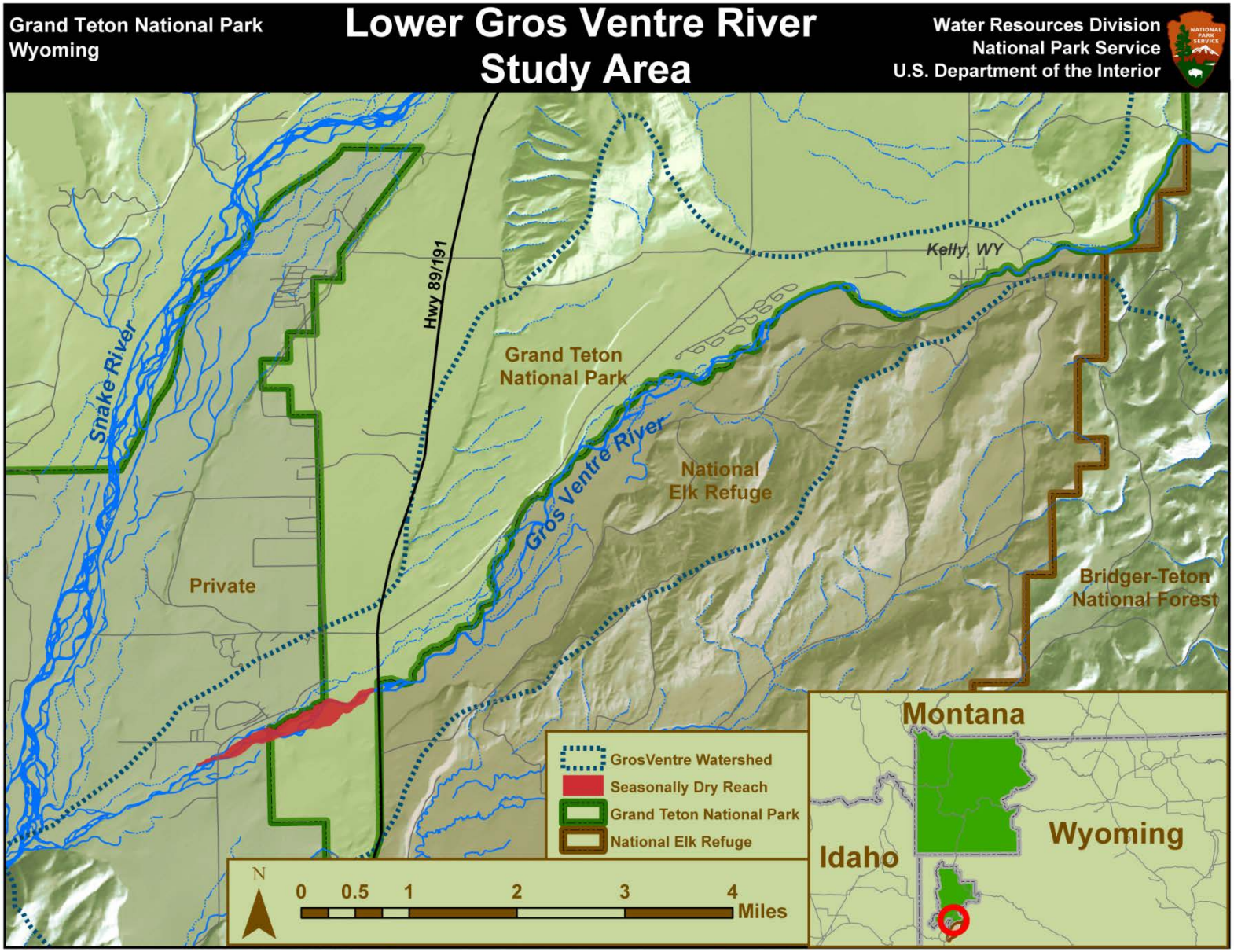


Figure 2. Location of Gros Ventre River study area, Grand Teton National Park.

The geology of the basin has had a great influence on the form and pattern of the GVR (Mulhern 1975). Soft and young geologic layers, including Cretaceous shale and betonitic claystone, were subjected to high rates of erosion from water saturation due to shrink and swell characteristics (Love and Love 1988). Glacial activity in the form of melting and scouring, along with the westward tilting of the eastern part of the Jackson Hole Valley toward the Teton Fault, caused further instability and erosion in the Gros Ventre Basin (Love and Love 1988). As a result, frequent earthquakes and landslides have produced unstable soils and steep channel gradients which create high stream power and extensive bed load transport.

The 1925 Gros Ventre Slide significantly affected the form, pattern, and sediment transport of the GVR. The landslide, located approximately two miles upstream from the GRTE/BTNF boundary, caused an estimated 20 to 50 million cubic yards of debris to mobilize and slide down the mountain (Figure 3). It is considered one of the largest landslides on record in the United States (Voight 1978, Love and Love 1988). Slide debris created a natural dam in the GVR and formed Lower Slide Lake, a three-mile-long lake approximately 200 feet deep (Love and Love 1988). In 1927 heavy rains and rapid snowmelt caused the river to breach part of the natural dam and resulted in a flood and extensive transport of sediment downstream towards Kelly. The town of Kelly was nearly destroyed in the flood and six people perished (Daugherty 1999).



Figure 3. Slide scar from the 1925 Gros Ventre landslide with the Gros Ventre River in the foreground, Teton County. Date: 6/29/06. Source: Gerber

Geomorphology

The morphology of the GVR continues to be influenced by the 1925 Gros Ventre Slide and other smaller-scale landslides in the watershed. Extensive bedload transport occurs in the GVR as is evident from downstream migration of cobble bars (Mulhern 1975). Lower Slide Lake functions as a siltation basin, trapping fine clay and silt sediments and preventing them from migrating downstream (Mulhern 1975). The resulting lack of fine sediments moving downstream further enables erosion, channel braiding, bank sloughing, and reduced riparian vegetation establishment and growth.

Two distinct channel morphologies exist along the lower GVR. From the GRTE boundary downstream to the town of Kelly, a single entrenched river channel is confined by highly resistant banks comprised of limestone and sandstone outcrops. This reach is classified as C2 (Rosgen 1996). From Kelly downstream to the Snake River, the channel is highly braided, wide, and shallow. Sand, cobble, gravel, and non-cohesive soils, as well as sparse riparian vegetation, cause frequent bank erosion and sloughing. This reach is classified as D3b (Rosgen 1996). Mulhern (1975) calculated the average channel gradient of the GVR below Kelly to be 0.0054 ft/ft (0.54%) with an average channel sinuosity of 1.10.

Hydrology

The GVR hydrology is predominately influenced by snowmelt runoff. On average, peak flows occur in May/June coincident with the timing of spring melt. GVR flows are often affected by ice from November through March. Three stream gages exist along the lower GVR and are shown in Figure 4.

NPS-WRD installed a stream gage (NPS Gage) on the GVR at the GRTE/BTNF boundary. The NPS Gage was operated seasonally (July through November) from 2006–2008. A USGS gage at Kelly (Station #13015400) is located 2.7 miles downstream of the NPS Gage and has been operated annually for 14 years (1945–1958) and seasonally for three years (June through September in 1918, and April through November in 2008 and 2009). NPS-WRD funded the re-installation of the Kelly Gage in 2008. High flows at the Kelly Gage occur in May and June and low flows occur in February and March (Figure 5). The highest flow on record was 6,960 cubic feet per second (cfs) on June 16, 1918; the mean peak flow is 3,500 cfs and generally occurs the first week of June. The lowest daily value for the period of record was 101 cfs on March 12, 1956.

The USGS gage at Zenith (Station #13015000) is located approximately 14 miles downstream of the NPS Gage and has operated seasonally for 25 years (July through September in 1917 and 1918, and April through September for 1987–2009). The highest flow on record at the Zenith Gage was 6,170 cfs on June 6, 1997; the mean peak flow is 2,440 cfs and generally occurs the first week of June (Figure 6). Zero flow at the Zenith Gage is common in August and September. Flows at the Zenith Gage less than 1.0 cfs occurred in 10 out of the 25 years of record. Flows at the Kelly and Zenith gages are affected by diversions; therefore flows in Figure 5 and Figure 6 do not represent natural flows.

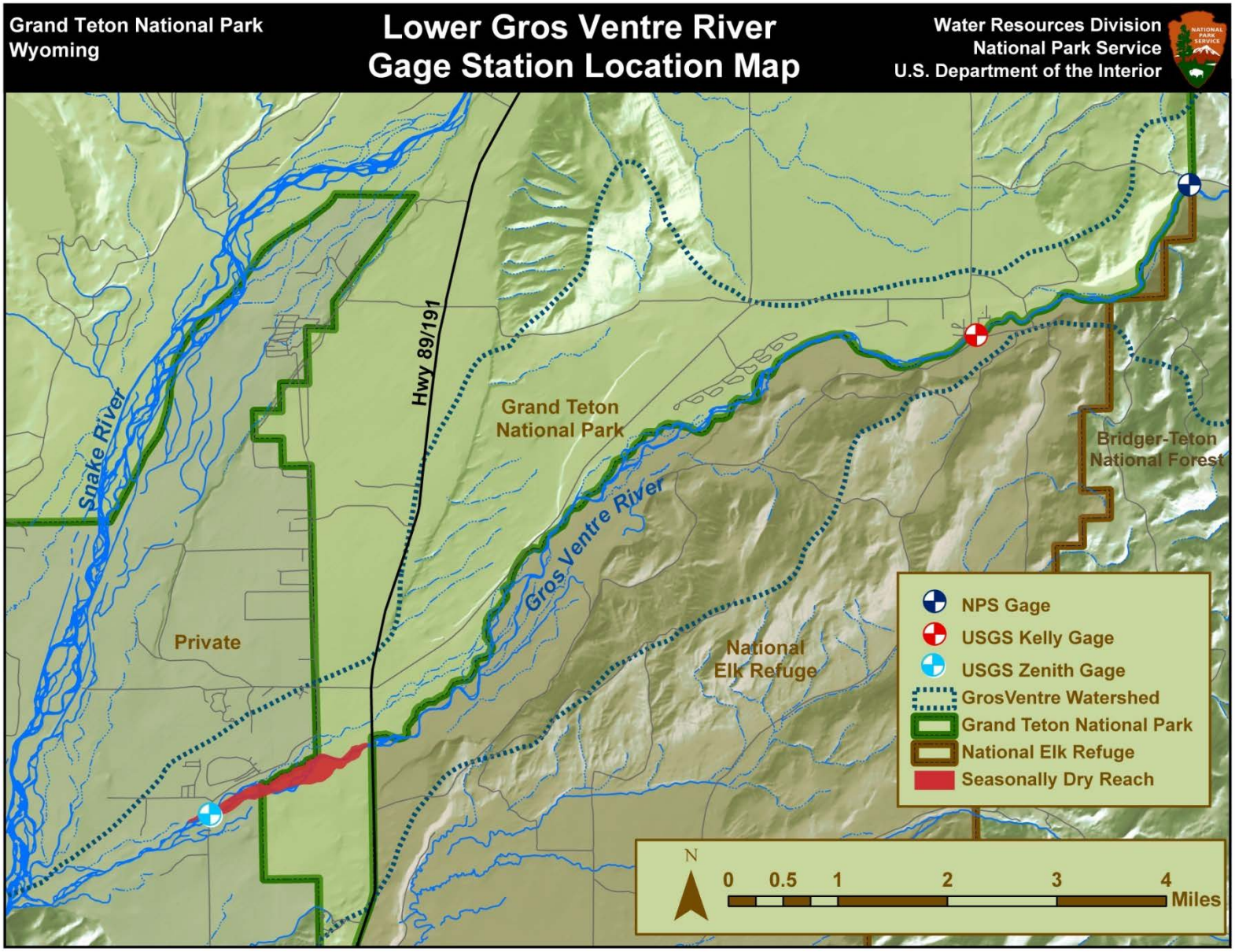


Figure 4. Location of stream gages within the lower Gros Ventre River Study Area, Grand Teton National Park.

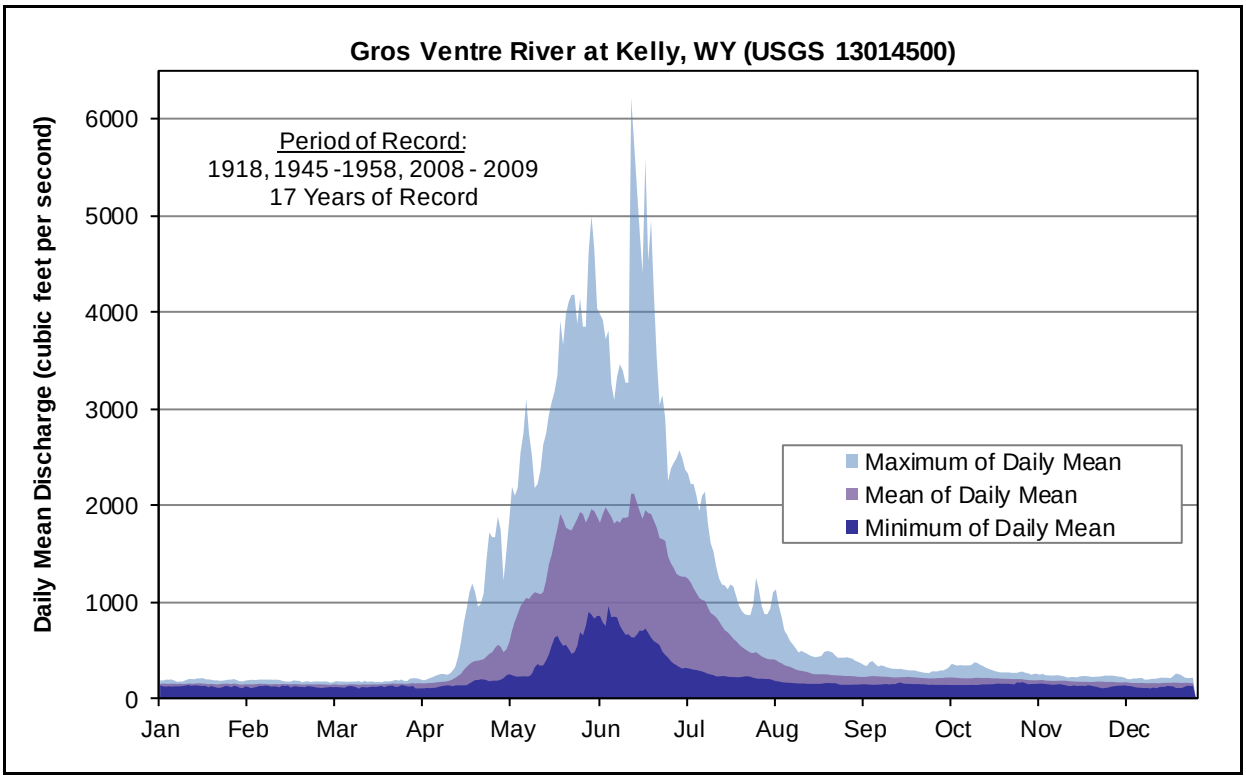


Figure 5. Daily mean flow for the period of record, 1918, 1945–1958, and 2008–2009, for the Kelly Gage, Gros Ventre River.

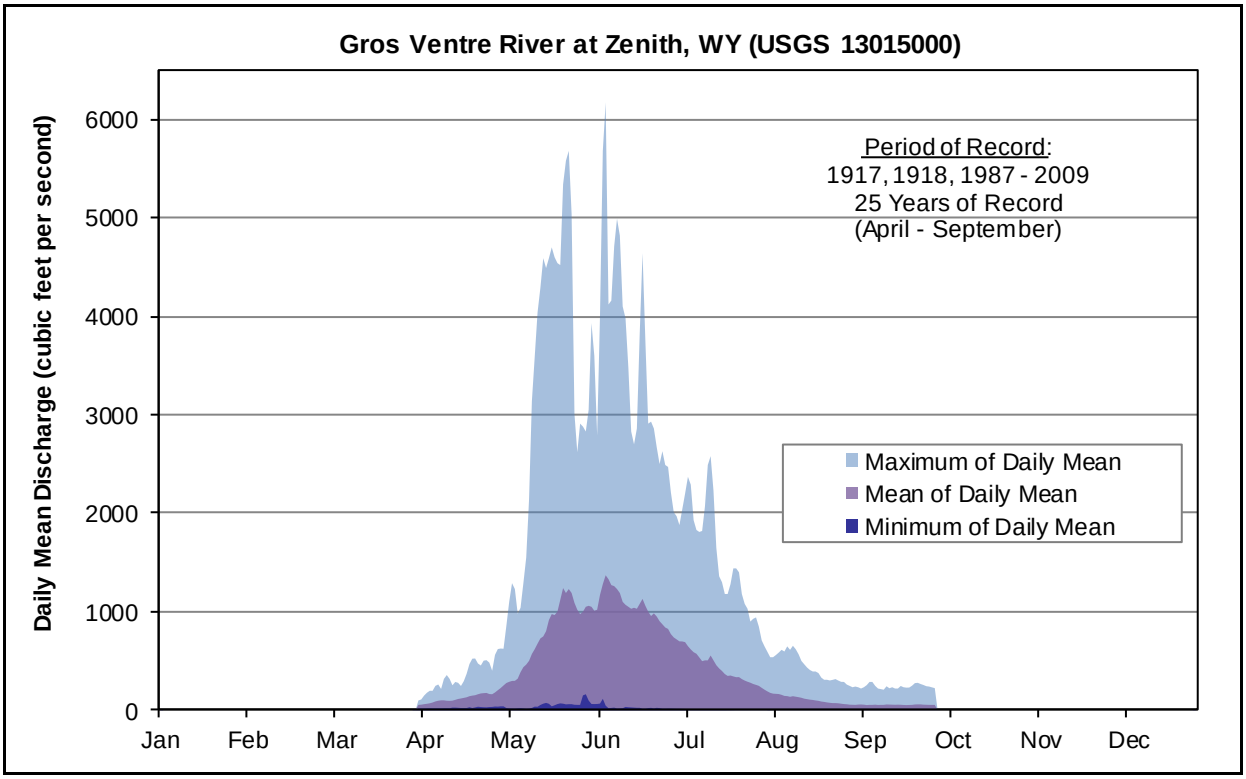


Figure 6. Daily mean flow for the period of record, 1917, 1918, and 1987–2009 (April to September), for the Zenith Gage, Gros Ventre River.

Diversions

The GVR has been used to irrigate adjacent lands since the late 1800s. Historically, as many as 24 ditches diverted water from the lower GVR (WYSEO ~1920; see Appendix A, Figure **12**). Many diversion structures were seriously damaged or destroyed in the May 1927 flood caused by the breach of the natural dam on Lower Slide Lake. New diversions and structures were constructed following the flood and many points of diversion were consolidated and/or changed. A diversion inventory was completed as a part of this study to determine the ditches currently being used, their condition, location, and type of diversion structure.

GRTE acquired ditches through the 1950 boundary expansion and from purchased and donated lands. Other ditches are owned by the NER and private landowners. All lower GVR ditches originate either on GRTE or NER lands and many terminate on private property. Ditches are generally used for irrigation, but permitted uses also include stock and domestic. Ditches are unlined, and primary diversion points are either cobble bars or headgates. Maintenance and operation of ditches and headgates is the responsibility of the water user. There is currently no federal land permitting system being utilized for non-federal access for ditch, headgate, or diversion point maintenance on the GVR.

Groundwater

Water levels in the shallow alluvial aquifer underlying the GVR indicate that groundwater flows southwest in the direction of the Snake River (Nolan and Miller 1995; see Appendix C, Figure 86). The “Jackson aquifer” (Nolan and Miller 1995), also referred to as the “Snake River alluvial aquifer” (Wright 2010), is unconfined with depth to water ranging from one foot to 234 feet below land surface. Groundwater levels vary annually with the lowest levels occurring in March and April and highest levels occurring in June and July. Groundwater velocities have been measured as low as 26 feet per day and as high as 66 feet per day (Wright 2010).

Groundwater wells in the study area were identified from Wyoming State Engineer’s Office (WYSEO) records. Groundwater levels of 15 feet or less were observed in wells adjacent to the GVR near Kelly, at the Gros Ventre Campground, and downstream of Highway 89/191 (WYSEO 2005). Well yields range from 10 and 1,500 gallons per minute. The effect groundwater pumping has on the surface water flows of the GVR is unknown. Groundwater levels were not monitored as a part of this study.

Water Rights

Water rights investigations by Hayden (1989) and Campbell (1990) reported 152 adjudicated appropriations on the GVR with only nine (totaling 9.47 cfs) located upstream of GRTE/BTNF boundary. Priority dates range from 1894–1966 (Hayden 1989 and Campbell and Lasley 1990). HDR Engineering, Inc., reviewed the water rights record of all lower GVR diversions (HDR 2009). The review included 12 ditches with direct flow water rights of 169.42 cfs and supplemental supply for 5,204 acres.

Water delivery or priority is based on the date that rights were established; those established earlier in time are superior to those established later. Similar to other western states, Wyoming has developed its own nuances regarding water rights administration. Water rights administration

in Wyoming reflects a need to be rigid (based on priority) in times of water scarcity and flexible when water is available. For instance, water right holders are generally granted a “direct flow” appropriation allowing irrigation at a rate of 1.0 cfs for every 70 acres to be irrigated, which is administered in times of shortage based on priority dates.

If additional water is available, after all direct flow water rights are met, water right holders with pre-1945 priority dates have access to “surplus” water (1.0 additional cfs for each 70 acres to be irrigated); and, once those rights are met, 1946–1985 priority water right holders have access to “excess” water (also 1.0 additional cfs for each 70 acres to be irrigated). Further, “supplemental” water rights allow diversion of water from a secondary source (also 1.0 additional cfs for each 70 acres to be irrigated) when sufficient water is not available from the primary source. For example, the GVR is a supplemental source for use on lands southwest of Jackson whose primary source is Flat Creek. Within the study area, 143 appropriations exist for 17 ditches with 168.87 cfs “direct flow” water rights and “supplemental” supply for 5,278.49 acres or 75.41 cfs (Hayden 1989 and Campbell and Lasley 1990).

When water availability from a particular source exceeds the amount of direct flow, surplus, excess, and supplemental rights, the water source is considered unregulated and the “free-river” doctrine applies. The “free-river” doctrine essentially allows water right holders to divert as much water as they need, as long as they do not impact other water rights holders ability to divert water rights as outlined above. Therefore, diversion of water exceeding 2.0 cfs for each 70 acres irrigated is legal if water is available. In many Wyoming waters including the GVR, free river conditions occur in the spring during run-off, when large quantities of water are available.

Wyoming practices allow for additional flexibility based on the location of the legal point of diversion. In some cases on the GVR, a manufactured diversion channel or side channel of the main stem of the river has been created. Cobble bars constructed in the main channel are used to divert water into such diversion or side channel. In some cases, this diversion from the main channel does not constitute the legal point of diversion. Rather, there are often headgates located downstream on such diversion channel or side channel, and these headgates are the legal points of diversion. This distinction operates to allow diverters to take sufficient water from the main channel in order to deliver the authorized diversion amount, i.e., the "paper right,” at the headgates or legal points of diversion. The authorized diversion amount is measured at the legal point of diversion rather than the point of diversion from the main channel. This allows diverters the ability to divert sufficient water from the main channel to compensate for any carriage losses in the diversion channel or side channel. The water budget portion of this report is based solely on the authorized diversion amount and does not account for diverters' ability to divert additional water from the main channel needed to overcome carriage losses.

Fisheries

Gregory Aquatics and the University of Montana conducted fisheries studies to determine the effect of diversions and river de-watering on native trout fisheries. Gregory and Yates (2011) found that the seasonally dry reach of the GVR impedes fish movement between the Snake River and GVR and reduces fish habitat. They also concluded that a minimum flow of 10 cfs is necessary throughout the seasonally dry reach to maintain fish passage.

The University of Montana determined that the principal threats to the Gros Ventre native trout include impediments to movement and the presence of non-native trout (Eby 2010). Eby and Corsi (2011) studied fish habitat and entrainment of ditches on the lower GVR and concluded that diversion ditches do not provide quality summertime habitat for cutthroat trout and cause localized impacts on population productivity. Corsi and Eby (2011) also summarized recent and historical fisheries studies on the GVR and made recommendations to improve the GVR fishery and aquatic resources based on management values of the GRTE, the Wyoming Game and Fish Department (WGFD), and the NER.

Methods

This section describes methods used to (1) classify individual years during the study period by wetness category or "year type," (2) inventory diversions and research water rights, (3) conduct discharge measurements, and (4) construct a water budget for the lower GVR. All field forms, field books, and discharge measurement data are archived at the NPS-WRD office in Fort Collins, Colorado.

Year Types

Annual water budgets and/or meaningful minimum flow prescriptions often vary by year type; that is, more water is diverted for irrigation, and seepage losses are often greater, during dry years than wet. Thus in drier years more water is often required in the river channel to ensure reliable minimum flows downstream. Consequently it is useful to classify each year of the study period as Wet, Moderately Wet, Average Wet, Average Dry, Moderately Dry, or Dry based on total volume of runoff and precipitation that occurred during the year and then construct annual water budgets and flow prescriptions accordingly.

Streamflow and precipitation gage data from nearby watersheds were used to define the year type of each individual year during the study period. For the period of record at each nearby gage, total annual precipitation and mean annual flow were ranked from lowest to highest and assigned wetness categories according to the breakpoints shown in Table 1. Long-term hydrology at one nearby precipitation gage (Moran, Wyoming, located 16 miles northeast of Kelly, Wyoming), the Kelly Gage, and three adjacent streamflow gages were analyzed (Buffalo Fork, Cache Creek, and Granite Creek—see Table 2 and Appendix C, Figure 87).

Table 1. Year type

Percent Rank	Year Type Category
0%–10%	Dry
10.1%–30%	Moderately Dry
30.1%–50%	Average Dry
50.1%–70%	Average Wet
70.1%–90%	Moderately Wet
90.1%–100%	Wet

Year type analyses for total mean seasonal flow for April through October and August through October, for each year, was conducted for four stream gages to determine if seasonal flow (rather than annual flow) was a better indicator of year type. November through March was excluded because many of the gages are either only operated seasonally or had estimated daily flows because of ice effect. The August through October period was found to be a more accurate indicator of year type.

Finally, given the spatial and temporal variability of precipitation across the Gros Ventre watershed, greater weight was given to discharge data over precipitation data and to those discharge sites with the longest period of record. Therefore, the overlapping 44-year (1966–2009) discharge record for Buffalo Fork and Cache Creek was selected to characterize the year type for the study period.

Table 2. Period of record used for year type analysis for Kelly, Buffalo Fork, Cache Creek, and Granite Creek gages, Teton County

USGS Gage	Period of Record	Years of Record
Kelly	1945–1957[a], 2006[b]–2009	17
Buffalo Fork	1966–2009	44
Cache Creek	1963–2009	47
Granite Creek	1996–2009	14

[a] 1918 was not used for the USGS Kelly Gage since data was only collected from June through September
[b] The record for the USGS Kelly Gage was estimated from the NPS Gage in 2006 and 2007

Diversion Inventory and Water Rights

In 2006–2009 NPS-WRD conducted an inventory of diversions for the lower GVR. Locations of ditches, headgates, and primary points of diversion[2] were verified in the field and conditions assessed. Photographs were taken and GPS data were collected. The diversion inventory and methodologies used are included in Appendix A.

Adjudicated water rights data for the diversions on the lower GVR were obtained from the WYSEO (WYSEO 1999), past reports (Albright 1993, Campbell 1990, and Hayden 1989), and HDR Engineering, Inc. (HDR 2009) and were tabulated and summarized for private and federal entities for each ditch. Unadjudicated water rights data were not compiled. This report also does not consider water use under the "free river" doctrine.

Hydrology

Discharge Measurements

Discharge data were collected for the lower GVR and diversions during the 2006–2009 field seasons. Standard USGS discharge measurement protocols (Buchanan and Somers 1969) were used. Discharge measurements were made with Price AA and Pygmy vertical axis meters and standard wading rods. All meters were calibrated by the USGS Hydrologic Instrumentation Facility according to USGS protocols (Smoot and Novak 1968). Velocity was recorded using a JBS Instruments Aquacount. Standard NPS-WRD discharge measurement notes forms were used to record all data (NPS 2007). Discharge was computed using the velocity-area method. The discharge was checked using the HMST[3] spreadsheet (Loving 2002).

Discharge measurements were not taken during high flows in May, June, and July on the GVR and the South Park Supply, Price Lucas, May White, and Spring Gulch ditches due to concerns about crew safety. Indirect discharge measurements were not performed.

A seepage run (a series of same-day discharge measurements) was conducted on the lower GVR on October 22, 2008, following the irrigation season. Seepage run methodologies are included in Appendix B.

[2] The point of diversion in this report refers to the physical point that water is taken from the main channel of a river into a ditch or diversion channel and may or may not be the same as the point of diversion of record for a given water right in Wyoming State records.
[3] Hydrographer's Measurement Sheet Toolbox.

Uncertainty in discharge measurements were determined from Sauer and Meyer (1992). Discharge measurement error for each measurement was rated as follows: "good" for measured discharge within five percent of the actual discharge, "fair" for measured discharge within eight percent of the actual discharge, and "poor" for measured discharge eight percent or greater of the actual discharge.

NPS Gaging Station

The NPS Gage was installed by NPS-WRD on the lower GVR just downstream of the GRTE/BTNF boundary (Figure 4) according to standard USGS gaging station protocols (Carter and Davidian 1968 and Rantz et al. 1982). The staff gage was installed on July 25, 2006, and the In-Situ Inc. Level Troll 500 (Serial #108835) datalogger was installed on August 8, 2006. Levels surveys were performed and reference marks were installed according to Kennedy (1990). The datalogger began recording stage at 15-minute intervals starting on August 9, 2006. Rating curves were created with GRSAT software using USGS methodologies (Kennedy 1984). USGS ADAPS[4] software was used to calculate daily mean discharge in accordance with USGS methodologies (Kennedy 1983 and 1984 and Rantz et al. 1982). Uncertainty in computed discharges was determined based on Novak (1985): "good" implies that about 95 percent of the daily discharges are within 10 percent of the true discharge; "fair" within 15 percent; and "poor" means that daily discharges have less than "fair" accuracy.

The NPS Gage was operated year-round, but data analysis was limited to July through November (during the irrigation season). The gage was discontinued on November 30, 2008. Flows above the rating (6.10 ft or 443 cfs) were not computed[5]. Flows above 250 cfs were rated poor due to the difficulties of collecting discharge measurements safely and were not used in the analysis. Table 3 shows the period of record for each year. The data logger was removed on August 31, 2009. The staff plate remains in place.

Table 3. Period of record for the NPS Gage, Gros Ventre River

Year	Period of Record	Comments
2006	August 10 to November 30	Datalogger started on August 9
2007	July 1 to November 30	Flows above 250 cfs July 1 through July 8
2008	August 6 to November 30	Flows above the rating July 1 through August 5; flows above 250 cfs August 6 through August 17 and September 2 and 3

Water Budget

A water budget was developed for the lower GVR between the Kelly and Zenith gages to provide a forecasting tool to manage flows for water use and fish passage. Water budgets are used to evaluate gains and losses on a river system and are determined using variations of the standard equation:

Outflow = Inflow + Gains - Losses

[4] Automated Data Processing System, ADAPS, version 4.7; the primary processing system used by the USGS for hydrologic data analysis.

[5] The rating was drawn to 6.10 feet since direct discharge measurements could not be collected at flows over 250 cfs. Indirect measurements were not performed.

Results

Year Type

Precipitation and discharge from nearby gages were used to categorize flow on the GVR during the study period into wetness categories or year types (Appendix C, Table 53–Table 56). Results of the year type analyses (Table 4–Precipitation, Table 5–Discharge) indicate that the study period included a range of hydrologic conditions from Dry (2007) to Moderately Wet (2008 and 2009). Year type and percent rank for the overlapping 44-year period (1966–2009) for discharge at the Cache Creek and Buffalo Fork Gages was used to categorize year types for the study period and are shown in Table 6.

Table 4. Precipitation year types for the study period (2006–2009)

Year	Precipitation
2006	Average Dry
2007	Moderately Dry
2008	Moderately Wet
2009	Average Wet

Table 5. Discharge year types for Kelly, Granite Creek, Cache Creek, and Buffalo Fork gaging stations (August through October 2006–2009)

Year	Kelly	Granite Creek	Cache Creek	Buffalo Fork
2006	Moderately Dry [a]	Moderately Dry	Average Dry	Average Dry
2007	Dry [a]	Moderately Dry	Moderately Dry	Moderately Dry
2008	Average Wet	Wet	Average Wet	Moderately Wet
2009	Moderately Wet	Average Wet	Average Wet	Average Wet

[a] Record estimated from the NPS Gage

Table 6. Year types based on the 44-year overlapping record for the Buffalo Fork and Cache Creek gages (August through October 2006–2009)

Year	Year Type
2006	Average Dry
2007	Moderately Dry
2008	Average Wet to Moderately Wet
2009	Average Wet

Diversion Inventory

The diversion inventory is presented in Appendix A. Twenty-four ditches historically existed along the lower GVR dating back to the 1890s (Appendix A: Table 18 and Figure **12**). Only eight ditches were diverting from the lower GVR during the study period due to non-use, changes in source and points of diversion, and ditch consolidation (Figure 7). Hot Springs and Hanrow Ditches convey spring sources adjacent to the GVR and are not discussed because they did not divert water from the GVR during 2006–2009.

Water Rights

A total of 221.41 cfs of adjudicated water rights (direct flow and supplemental supply) exist for the eight ditches on the lower GVR (Table 7). The United States owns 96.62 cfs, and 124.79 cfs are privately owned. Priority dates range from 1894 to 1966. This total is less than calculated by Hayden (1989), Campbell (1990), and HDR (2009) since Cedar Tree[6], Hot Springs, Hanrow, and Romeo ditches were not conveying GVR water during the study period.

Total adjudicated direct flow water rights for the eight ditches are 147.36 cfs—76.12 cfs owned by the United States (72.79 NPS and 3.33 cfs NER) and 71.24 cfs owned privately (WYSEO 1999 and HDR 2009). Total supplemental supply rights for these eight ditches are 74.05 cfs—20.50 cfs owned by the United States (NPS) and 53.55 cfs owned privately. Surplus and excess water rights could include an additional 147.36 cfs[7], when available. Unadjudicated water rights data are not included in this report.

Table 7. Water rights summary for lower Gros Ventre River (WYSEO 1999, HDR 2009)

	United States			Private			
Ditch Name	**Direct Flow**	**Supple-mental**	**Total**	**Direct Flow**	**Supple-mental**	**Total**	**Total (cfs)**
Savage	11.18	20.50	31.68	0.23	0.17	0.40	32.08
Newbold	45.85		45.85				45.85
South Park Supply	1.57		1.57	1.70	53.38	55.08	56.65
Enterprise	7.53		7.53	12.95		12.95	20.48
Wild Cherry	9.71		9.71	2.57		2.57	12.28
Price Lucas				5.22		5.22	5.22
May White	0.28		0.28	17.12		17.12	17.40
Spring Gulch				31.45		31.45	31.45
Totals:	**76.12**	**20.50**	**96.62**	**71.24**	**53.55**	**124.79**	**221.41**

cfs – cubic feet per second

[6] Cedar Tree and Romeo ditches are shown in Figure **12** as ditches 2 and 10, respectively.
[7] Surplus and excess water rights were determined from total direct flow water rights (United States 76.12 cfs and private 71.24 cfs), Table 7.

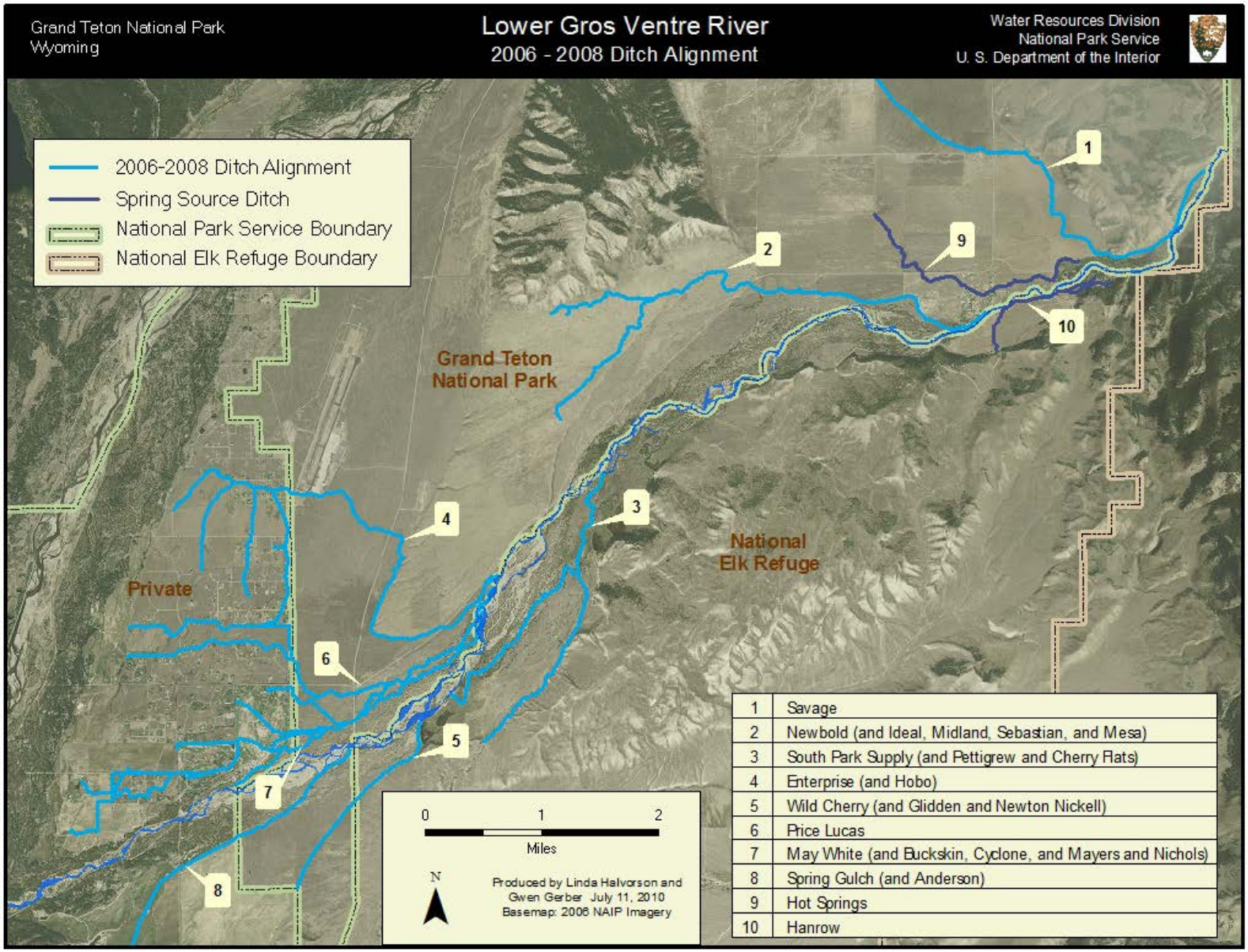


Figure 7. Ditch names and alignments on the lower Gros Ventre River, Teton County.

Hydrology

Discharge Measurements

Ditch Measurements

A total of 147 discharge measurements were made on the eight ditches during 2005–2009. Twenty-four measurements were taken in 2005 and 2006 on Wild Cherry and Spring Gulch Ditches by TSS for a study on the Spring Creek Watershed (Patterson 2007). The remaining 123 measurements were taken by NPS-WRD in 2006–2009. The number of measurements and minimum and maximum discharges for each ditch are displayed in Table 8. Individual measurements are summarized in Appendix A. Maximum discharge in South Park Supply, Price Lucas, May White, and Spring Gulch ditches were not measured due to concerns for crew safety; therefore, the maximum discharge observed in these ditches during the study period is greater than the measured discharges shown in Table 8. All ditch discharge measurements were rated as "good" (less than five percent error) with the exception of five measurements which were considered "fair" (less than eight percent error); see Appendix A.

Table 8. Summary of discharge measurements for eight lower Gros Ventre River ditches (2005–2009), Teton County

Ditch	Number of Measurements	Minimum Discharge (cfs)	Maximum Discharge (cfs)
Savage	7	0.587	8.83
Newbold	1	1.92	1.92
South Park Supply [a]	11	1.39	108 [b]
Enterprise [a]	27	1.43	28.5
Wild Cherry	12 (TSS) 3 (NPS)	0.10	22.3
Price Lucas [a]	22	0.802	30.3 [b]
May White [a]	20	6.23	126 [b]
Spring Gulch [a]	12 (TSS) 32 (NPS)	3.10	174 [b]
Totals	**147**	**15.6**	**> 500** [b]

[a] Staff plates were installed on these ditches in 2008 and rating curves developed

[b] Flows exceeded the maximum discharge displayed here but could not be measured safely

TSS – Measurements made by Teton Science School

NPS – Measurements made by NPS-WRD

Based on the maximum discharge measured, the eight GVR ditches listed in Table 8 have a combined conveyance capacity of greater than 500 cfs and three of the eight ditches have a capacity over 100 cfs each (South Park Supply, May White, and Spring Gulch). The Savage Ditch headgates were closed during most of the study period. The headgates were closed on Newbold Ditch during the study period, the discharge shown in Table 8 represents leakage under the headgate. The South Park Supply Ditch historically diverts water to Flat Creek via an aqueduct for supplemental supply until the end of July (Barney 2007). Wild Cherry Ditch was blocked off on several occasions during the study period for maintenance of an adjacent NER levee. Enterprise, Price Lucas, May White, and Spring Gulch ditches diverted water actively from May through October during the study period; therefore, most of the measurements were collected on these four ditches.

Monthly distribution of the 147 discharge measurements is shown in Table 9. Total combined maximum measured diversions ranged from 92.2 cfs in October to more than 471 cfs in May and June during spring runoff. Measurements were not performed on the May White Ditch in May or June since flows were too high to measure safely. Therefore, the highest measured discharge of 126 cfs in July was used (in place of a May/June May White Ditch measurement) to calculate the combined maximum discharge for the period of May/June.

Table 9. Monthly distribution of discharge measurements and maximum discharges measured for eight ditches on the lower Gros Ventre River (2005–2009)

Month	# of Discharge Measurements	Combined Maximum Discharge Measured for the 8 Ditches
May/June	21	> 471 [a]
July	30	> 429 [a]
August	46	> 269 [a]
September	29	129
October	21	92.2

[a] Flows exceeded the maximum discharge displayed here but could not be measured safely

Table 10 shows maximum measured discharges for 2005–2009 and the number of measurements and percent of measurements exceeding water rights for the eight ditches on the lower GVR. Maximum measured discharges exceeded direct and supplemental water rights for all ditches, except Savage and Newbold ditches. Maximum measured discharge exceeded direct, supplemental, excess, and surplus water rights for South Park Supply, Price Lucas, May White, and Spring Gulch ditches. Fifty-four percent of the measurements collected during 2005–2009 exceeded direct and supplemental water rights, and 28 percent exceed direct, supplemental, excess, and surplus water rights.

Table 10. Ditch discharge measurements versus water rights, Gros Ventre River (2005–2009)

		Direct and Supplemental			Direct, Supplemental, Excess and Surplus		
	Maximum Discharge Measured	Water Rights	Measurements Exceeding Water Rights		Water Rights	Measurements Exceeding Water Rights	
Ditch	(cfs)	(cfs)	Number	Percent	(cfs)	Number	Percent
Savage	8.83	32.08	0	0%	43.49	0	0%
Newbold	1.92	45.85	0	0%	91.70	0	0%
South Park Supply [a]	108	56.65	4	40%	59.92	4	36%
Enterprise	28.5	20.48	4	15%	40.96	0	0%
Wild Cherry	22.3	12.28	7	47%	24.56	0	0%
Price Lucas [a]	30.3	5.22	19	90%	10.44	12	55%
May White [a]	126	17.40	14	74%	34.80	6	30%
Spring Gulch [a]	174	31.45	29	67%	62.90	19	43%
Totals	**> 500**	**221.41**	**77**	**54%**	**368.77**	**41**	**28%**

[a] Flows exceeded the maximum discharge displayed but could not be measured safely

Seepage Run

A seepage run consisting of discharge measurements at eight locations (Figure 8) was conducted along the lower GVR on October 22, 2008, to determine natural gains and losses. Information regarding seepage run site coordinates, descriptions, methods, and measured discharges are described in Appendix B. Diversion headgates were closed for several weeks prior to the seepage run. All discharge measurements were rated "good" (less than five percent error) with the exception of Site 1, which was rated "fair" (within eight percent). Gains and losses likely differ seasonally or from year to year depending upon precipitation, antecedent moisture conditions, runoff, and channel changes.

Results of the seepage run indicate that the reaches between the NPS and Kelly gages and below the Zenith gage are gaining reaches and the reach between the Kelly and Zenith gages is a losing reach. Gains and losses between sites[8], distance between sites, and gains or losses per stream mile are shown in Table 11.

Table 11. October 22, 2008, seepage run results for the lower Gros Ventre River, Teton County

Seepage Run Site/Name [a]	Discharge at Seepage Run Site (cfs)	Change from Upstream Site (cfs)[b]	Distance Between Sites (miles)	Change Per Stream Mile (cfs)
1 NPS Gage	176	NA	NA	NA
2 Kelly Gage	219	43	2.9	15
3 GVR Campground	207	-12	2.2	-5
4 GVR Road Pullout	205	-2	2.8	-1
5 Just Above Highway Bridge	122	-83	3.0	-28
6 Middle of Seasonally Dry Reach	113	-9	1.1	-8
7 Just Below Zenith Gage	100	-13	1.2	-11
8 Snake River Confluence	142	42	1.7	25

[a] See Figure 8 for a map depicting site locations

[b] A negative number indicates a loss and a positive number indicates a gain

NA = not applicable, no upstream site for comparison.

Numbers in blue in Figure 8 represent gains, red numbers represent losses, and black numbers represent gains or losses per stream mile. Natural gains of 43 cfs (15 cfs per stream mile) occurred between the NPS and Kelly gages and 42 cfs (25 cfs per stream mile) below the Zenith Gage. Natural losses of up to 28 cfs per stream mile occurred between the Kelly and Zenith gages, with the largest loss occurring in the 3.25-mile reach upstream of the Highway 89/191 Bridge. Losses between the Kelly Gage (Site #2) and the Highway 89/19 Bridge (Site #5) were 97 cfs. Losses between the Highway 89/191 Bridge (Site #5) and the Zenith gage (Site #7) were 22 cfs throughout the seasonally dry reach. This reach remained wet during the 2008 irrigation season (and during the seepage run). Therefore, the loss of approximately 20 cfs in this reach is only applicable under these conditions. Total losses between the Kelly and Zenith gages were approximately 120 cfs on October 22, 2008.

[8] A negative number indicates a loss and a positive number indicates a gain

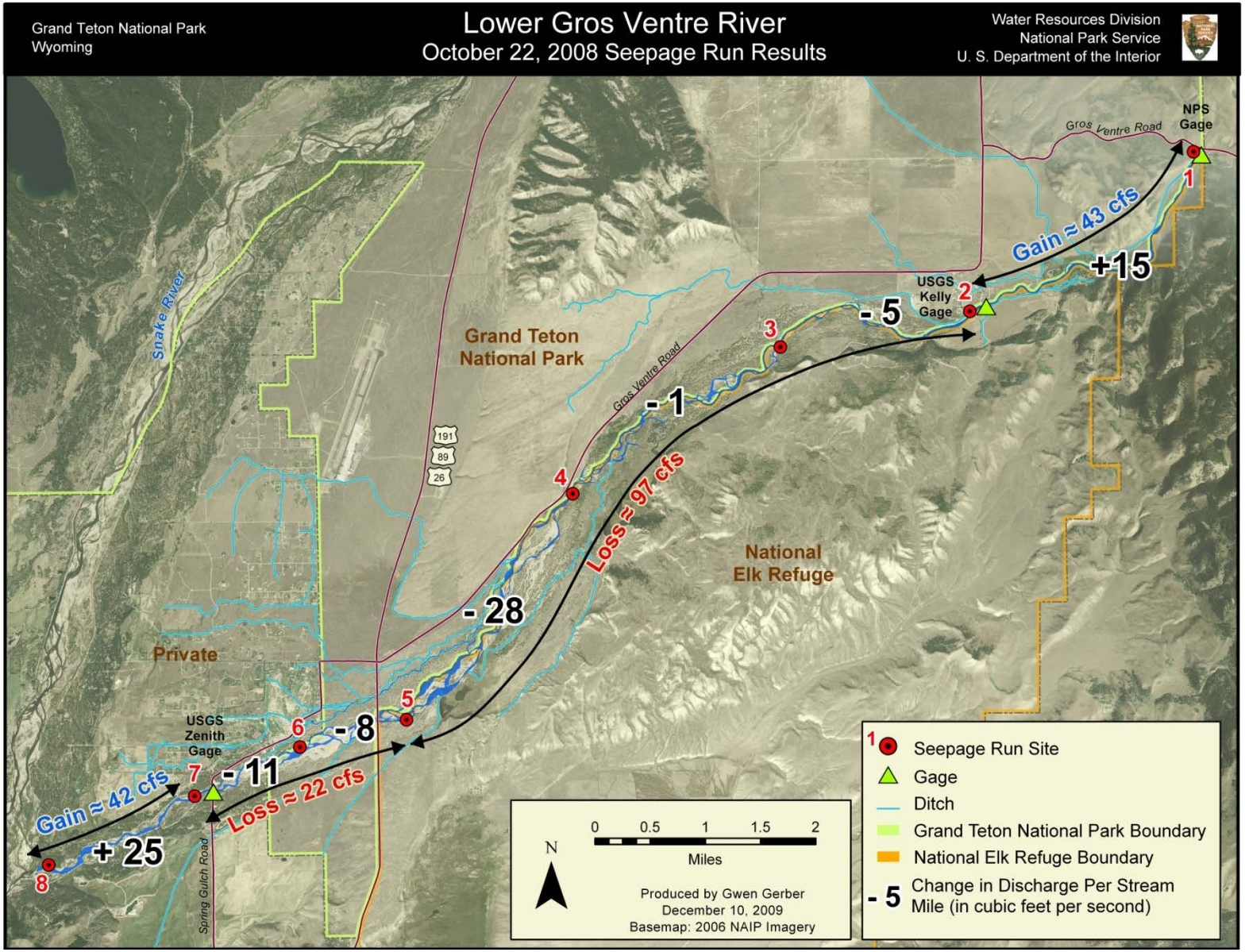


Figure 8. October 22, 2008, lower Gros Ventre River seepage run results, Teton County.

Additional GVR Discharge Measurements

In addition to the seepage run, 82 other discharge measurements were made during the 2006-2009 study period on the lower GVR; 38 by NPS-WRD and 44 by the USGS (Appendix C, Table 57). These measurements were evaluated to compare same day measurements to gains and losses measured during the 2008 seepage run. Appendix C, Table 58 shows the same day measurements for the GVR and ditches.

Table 12 shows eleven same-day measurements made at the NPS and Kelly gages during September 2006 through August 2007. Headgate losses on Savage Ditch were not measured on these 11 days. As a result, some of the fluctuation in gains could be caused by diversion or seepage to the Savage Ditch. Gains ranged from 17 to 41 cfs within this reach compared to the 43 cfs gain measured by the NPS on the October 22, 2008, seepage run. The average reach gain for the 11 same-day measurements and the seepage run measurement is 32 cfs (Table 12).

Table 12. Same-day discharge measurements (cfs) at the NPS and Kelly gages, Gros Ventre River, Teton County (2006–2008)

Date	NPS Gage	Kelly Gage	Gain
9/13/2006	130	163	33
10/4/2006	155	191	36
10/10/2006	220	260	40
10/18/2006	190	217	27
10/26/2006	172	194	22
10/31/2006	131	172	41
1/19/2007	96	131	35
3/22/2007	207	224	17
4/12/2007	159	190	31
7/20/2007	165	189	24
8/30/2007	103	135	32
10/22/2008 [a]	176	218	43
[a] Seepage Run			**Average = 32**

Table 13 and Table 14 show ten same-day measurements taken between the Kelly and Zenith gages during 2006–2009, and all indicate a loss in this reach. Since this reach includes six ditches[9], these losses represent both natural and ditch losses. Losses between Kelly and the Highway 89/191 Bridge ranged between 65 and 81 cfs, compared to the 97 cfs measured during the seepage run (Table 13). Losses between Kelly and Zenith ranged between 90 and 250 cfs, compared to the 119 cfs measured during the seepage run (Table 14).

Table 13. Same-day discharge measurements (cfs) between Kelly and the Highway 89/191 Bridge, Gros Ventre River, Teton County (2006–2008)

Date	Kelly	Highway 89/191 Bridge	Total Loss Between Kelly and the Highway 89/191 Bridge
11/2/2006	147	66.0	81
4/12/2007	190	125	65
10/22/2008 [a]	219 [a]	122 [a]	97 [a]

[a] Seepage Run

[9] South Park Supply, Enterprise, Price Lucas, May White, Wild Cherry, and Spring Gulch ditches

Table 14. Same-day discharge measurements (cfs) between Kelly and Zenith, Gros Ventre River, Teton County (2006–2009)

Date	Kelly	Zenith, WY	Total Loss Between Kelly and Zenith
10/10/2006	260	76.8	183
10/26/2006	194	58.5	136
10/31/2006	172	39.9	132
8/30/2007	135	2.02	133
5/21/2008	2880	2790	90
6/4/2008	1740	1640	100
10/7/2008	209	90.9	118
10/22/2008 [a]	219 [a]	100 [a]	119 [a]
8/26/2009	323	77.3	250

[a] Seepage Run
Discharge measurements shown in red were taken by the USGS

Gaging Station Data

Daily mean discharge for July 1 through October 30, 2006–2009, for the NPS, Kelly, and Zenith gaging stations are shown in Figure 9. The period of record for each gage is shown in Table 15, and tabular data can be found in Appendix C, Table 59 through Table 69. The Kelly Gage was not operated in 2006 and 2007; records were estimated by adding 32 cfs to the daily mean discharge for the NPS Gage (average gain calculated in Table 12). The NPS Gage was not operated in 2009; the record was estimated by subtracting 32 cfs from the daily mean discharge for the Kelly Gage.

Table 15. Period of record for lower Gros Ventre River gaging stations for 2006–2009

	2006	2007	2008	2009
NPS Gage	8/10–11/30	7/9–11/30	8/18–11/30 [a]	4/1–11/30 [b]
Kelly Gage	8/10–11/30 [c]	7/9–11/30 [c]	4/1–11/20	4/1–11/30
Zenith Gage	4/1–9/30	4/1–9/30	4/1–11/30 [d]	4/1–9/30

[a] except for 9/2/2008 and 9/3/2008 when flows exceeded 250 cfs
[b] record estimated from the Kelly Gage; shown as dashed line in Figure 9
[c] record estimated from the NPS Gage; shown as dashed line in Figure 9
[d] record provisional 9/30/2008 through 11/30/2008

The NPS and Kelly gages operated concurrently for 92 days in August through November 2008. Gains determined from daily mean discharge ranged from 26–46 cfs, with an average of 38 cfs. This is comparable to the gains of 17–43 cfs determined from the seepage run and 11 same-day discharge measurements (Table 12).

The Kelly and Zenith gages operated concurrently for 132 days during the 2008 and 2009 irrigation seasons. Losses determined from daily mean discharge ranged from 547 cfs in July to 96 cfs in October. The losses in July were greater than those measured during the seepage run and the seven other same-day measurements (Table 14). Differences are likely due to ditch diversions in July.

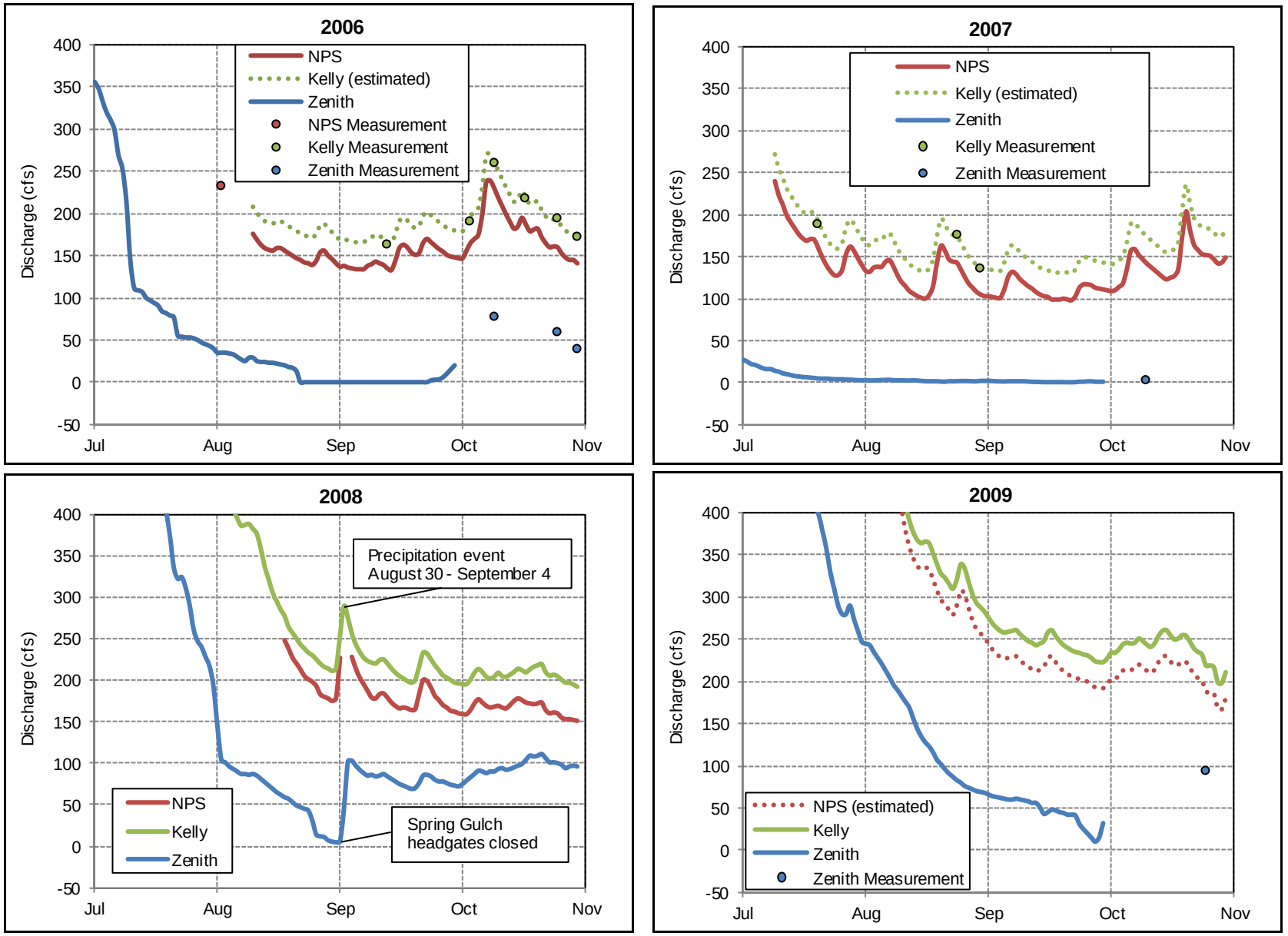


Figure 9. Comparison of daily mean discharge for the NPS, Kelly, and Zenith gages with related discharge measurements from **Table 57** for July through October 2006–2009, Gros Ventre River.

The NPS and Zenith gages operated concurrently for 136 days during the 2006 and 2007 irrigation seasons. Losses determined from daily mean discharge ranged from 226 cfs in July to 98 cfs in September. These losses are greater than the 76 cfs measured during the seepage run, likely due to unmeasured diversions. The shape of the hydrographs (Figure 9) for the Zenith Gage differs from the NPS and Kelly gages indicating the influence of diversions.

Seasonally Dry Reach

Historically, sections of the GVR between the Highway 89/191 Bridge and the Zenith Gage have been seasonally dry due to natural channel losses and diversions (Kiefling 1973). Kiefling's 1973 report documents the GVR being dry in 1969 and in 1972. The seasonally dry reach extends approximately 1.5 miles downstream of the Spring Gulch Ditch headgates to the Zenith Gage (Figure 10). Natural springs and/or GVR flows re-surface below the Zenith Gage, wetting the GVR to the confluence with the Snake River.

During some years the seasonally dry reach only extends from below the Spring Gulch Ditch to the May White Return Ditch, approximately one mile downstream (Figure 10). This reach is within the NPS boundary and is depicted as "Reach A" in Figure 10. "Reach B" is the reach between the May White Return Ditch and the Zenith Gage and is in private land (Figure 10). The May White Return Ditch returns GVR water from the May White Ditch complex[10] approximately 0.5 miles upstream of the Zenith Gage. Therefore, during some years, flows may resume in "Reach B" due to May White Return flows. Consequently, flows at the Zenith Gage cannot be used reliably to determine if or when the GVR is dry.

Streamflow records at the Zenith Gage (1988–2009) do indicate that flows dropped to zero in six of 22 years, primarily in August and September (Table 16). During the study period, the NPS-WRD documented zero flows in Reach A in 2006 as early as July 14 whereas flows at the Zenith Gage didn't drop to zero until August 22. Flows at the Zenith Gage never dropped to zero during 2007; however, according to Gregory and Yates (2009), Reach A was dry from June 23 through September 26. These data and observations confirm the Zenith Gage cannot always be used to estimate when Reach A is dry. Table 16 shows periods between 1988 and 2009[11] when the GVR was dry at the Zenith Gage or verified as dry by site visits. The GVR was dry seven of the 22 years between 1988 and 2009. It is not known if the GVR went dry in Reach A during the remaining 13 years.

In summary, the GVR has been seasonally dry from just downstream of the Highway 89/191 Bridge to the Zenith Gage or from the Highway 89/191 Bridge to the May White Return Ditch. Dry reaches have been documented in seven of the last 22 years and may have occurred in other years. The year types for all seven years ranged from Dry to Average Dry. The GVR has been documented as dry in Reach A as early as June 23 and in Reach B as early as August 2. These reaches have remained dry past September 30. During the study period, the GVR was dry for more than 70 days in 2006 and for more than 90 days in 2007. The GVR remained flowing from the Highway 89/191 Bridge to the Zenith Gage during 2008 and 2009.

[10] The point of diversion for the May White Complex is approximately two miles upstream of the Highway 89/191 Bridge. The May White "Complex" feeds four secondary ditches (May, Cyclone, White, and Buckskin) via headgates off of the main May White Ditch.

[11] 1988–2009 is the period in which irrigation season records are available from the Zenith Gage.

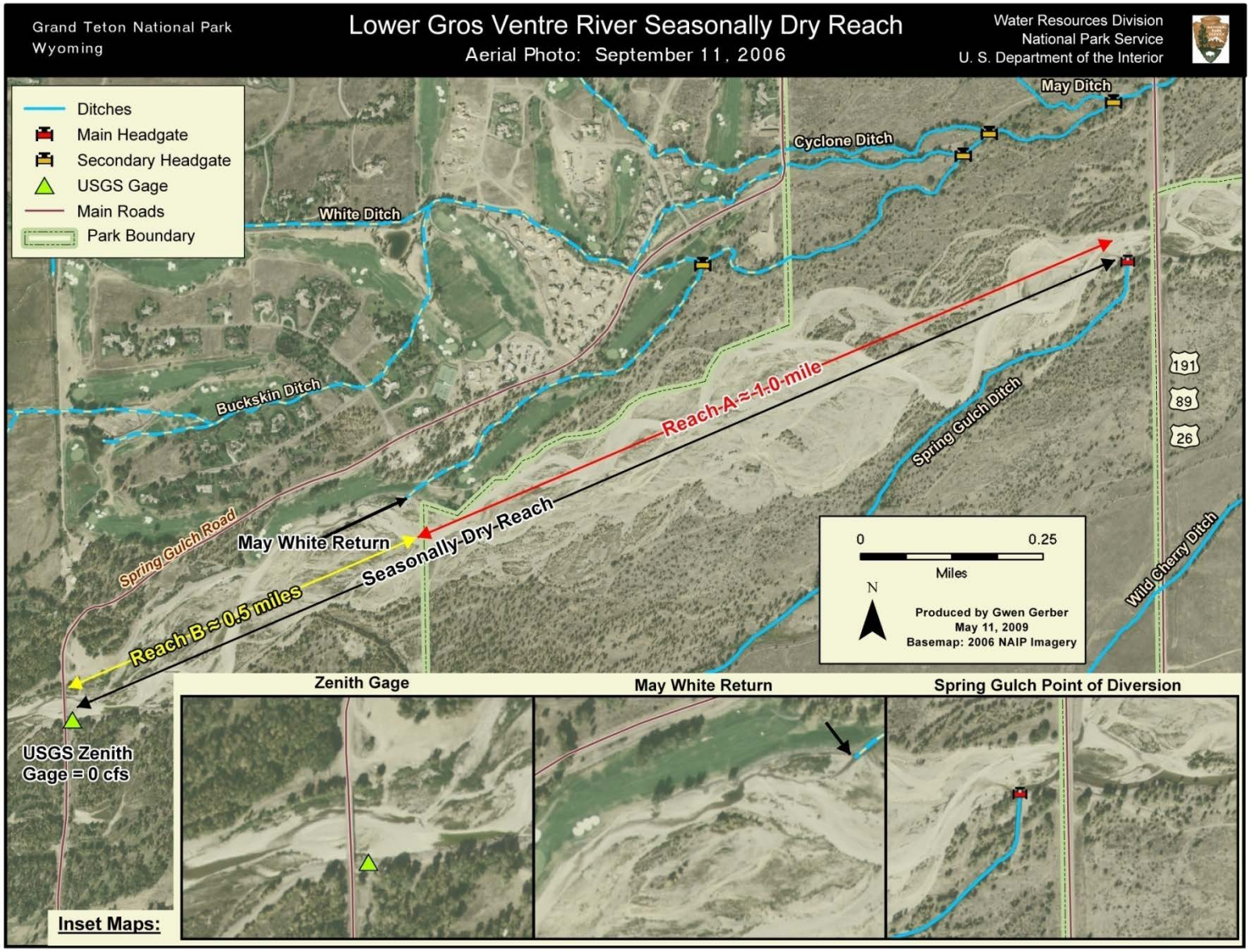


Figure 10. Aerial photograph of the seasonally dry reach of the Gros Ventre River from the Highway 89/191 Bridge downstream to the Zenith Gage.

Table 16. Documented seasonally dry periods, Gros Ventre River, Highway 89/191 Bridge to the USGS Zenith Gage, 1988–2009

Year [a]	Dates GVR Dry Below Highway 89/191 Bridge		Days Verified Dry	Source of Data	Zenith Gage (cfs)	Year Type [b]
	From	to				
1988	9/9/1988	9/17/1988	9	Zenith Gage	0	Dry to Moderately Dry
1992	9/1/1992	9/12/1992	12	Zenith Gage	0	Dry to Moderately Dry
1994	8/18/1994	9/30/1994	> 44	Zenith Gage	0	Dry
2001	8/2/2001	9/30/2001	> 60	Zenith Gage	0	Dry
2005	9/20/2005	9/25/2005	6	Zenith Gage	0	Average Dry
2006	7/14/2006	8/21/2006	72	Site Visit Observations	13 to 100	Average Dry
	8/22/2006	9/23/2006		Zenith Gage	0	
2007	6/23/2007	9/26/2007	>96	Gregory, 2009	1.4 to 49	Moderately Dry

">" the number of days shown is the minimum # of days the river was observed as dry

[a] Only years during the 1988–2009 period that were documented as dry are listed in this table

[b] Based on year types for August through October for Buffalo Fork and Cache Creek gages (Table 56)

Flows Necessary for Fish Passage

Gregory and Yates (2009) concluded that a minimum flow of 10 cfs is needed throughout Reaches A and B for fish passage. If natural losses of approximately 20 cfs occurs in Reaches A and B, as measured during the seepage run, approximately 30 cfs would need to pass the Spring Gulch Ditch headgates to maintain 10 cfs throughout the seasonally dry reach.

Zenith Gage data indicate that in 11 out of 22 years (50%) flows dropped below 10 cfs for five or more consecutive days (Table 17). Flows remained below 10 cfs for 19 days in 1990 and as many as 99 days in 2007 and occurred as early as June 23. It is not known how many years flows dropped below 10 cfs in Reach A. Consequently, fish passage may have been impeded for more than 11 of the last 22 years. Year types for these 11 years were Dry to Average Dry.

Table 17. Days flows less than 10 cfs at the Zenith Gage, Gros Ventre River (1988–2009)

Year [a]	Dates flows < 10 cfs at Zenith		Days < 10 cfs at Zenith	Source of Data	Year Type [b]
	From	to			
1988	7/25/1988	9/30/1988	68	Zenith Gage	Dry to Moderately Dry
1990	9/5/1990	9/23/1990	19	Zenith Gage	Moderately Dry to Average Dry
1992	8/4/1992	9/30/1992	58	Zenith Gage	Dry to Moderately Dry
1994	7/15/1994	9/30/1994	78	Zenith Gage	Dry
2000	8/23/2000	9/21/2000	26	Zenith Gage	Moderately Dry
2001	7/7/2001	9/30/2001	86	Zenith Gage	Dry
2002	8/5/2002	9/30/2002	51	Zenith Gage	Moderately Dry
2003	8/12/2003	9/30/2003	50	Zenith Gage	Moderately Dry
2005	9/4/2005	9/30/2005	23	Zenith Gage	Average Dry
2006	7/14/2006	8/21/2006	75	Site Visit Observations	Average Dry
	8/22/2006	9/27/2006		Zenith Gage	
2007	6/23/2007	7/12/2007	99	Gregory, 2009	Moderately Dry
	7/13/2007	9/30/2007		Zenith Gage	

[a] Only years during the 1988–2009 period that were documented as dry are listed in this table

[b] Based on year types for August through October for Buffalo Fork and Cache Creek gages (Table 56)

Results Summary

- The study period (2006–2009) included Dry to Moderately Wet year types.
- Eight ditches diverted water during the 2006–2009 study period.
- Total adjudicated water rights (direct and supplemental) for the eight ditches are about 220 cfs—74 cfs for supplemental supply.
- Over 500 cfs can be diverted to the eight ditches; the South Park Supply, May White, and Spring Gulch ditches each have conveyance capacities over 100 cfs.
- Of the 147 discharge measurements made on the eight ditches, 54 percent exceeded the total adjudicated direct and supplemental water rights and 28 percent exceeded direct, surplus, excess, and supplemental water rights.
- Natural channel gains of 43 cfs were measured between the NPS and Kelly gages and 42 cfs below the Zenith Gage during the October 22, 2008, seepage run.
- Natural channel losses of 120 cfs were measured between the Kelly and Zenith gages on October 22, 2008.
- Seasonal de-watering occurred in at least seven of the last 22 years between the Highway 89/191 Bridge and the Zenith Gage. De-watering occurred as early as June 23 in the reach between the bridge and the May White Return and as early as August 2 in the reach between the bridge and the Zenith Gage.
- De-watering of the seasonally dry reach occurs primarily during Dry to Average Dry runoff years.

Discussion

In order to evaluate management options to restore flows in the seasonally dry reach of the GVR, a water budget was developed. The water budget considers the minimum flow needed at the Kelly Gage to meet downstream water rights, account for natural losses, and maintain minimum flows required for fish passage. The water budget does not consider diverted flows exceeding direct, supplemental, surplus, and excess water rights or water use under the "free river" doctrine.

Water Budget

Specifically, the water budget (Figure 11) considers (A) diversions below the Kelly Gage from six ditches (South Park Supply, Enterprise, Wild Cherry, Price Lucas, May White, and Spring Gulch[12]) diverting water during the study period; (B) 120 cfs natural losses between the Kelly and Zenith gages measured on the October 22, 2008, seepage run; and (C) 10 cfs necessary for fish passage throughout the seasonally dry reach. Figure 11 equation 1 considers direct flow rights only, equation 2 considers direct, surplus, and excess water rights, and equation 3 considers direct, surplus, excess, and supplemental water rights.

	A) Diversions (water rights)		B) Measured Natural Losses		C) Minimum Flow Needed for Fish Passage (Gregory and Yates, 2011)		Minimum Flow Needed at Kelly Gage
1) Direct Flow Water Rights	90	+	120	+	10	=	220
2) Direct, Surplus, and Excess Water Rights	180	+	120	+	10	=	310
3) Direct, Surplus, Excess, and Supplemental Water Rights	234	+	120	+	10	=	364

Figure 11. Water budget equations for the lower GVR between the Kelly and Zenith gages, Teton County.

If 90 cfs is required to meet total direct water rights below Kelly, then 220 cfs is needed at Kelly to provide for fish passage. If 180 cfs is required to meet total direct, surplus, and excess water rights below Kelly and natural losses remain constant, then 310 cfs is needed at Kelly to provide for fish passage. If 234 cfs is required to meet total direct, surplus, excess, and supplemental water rights below Kelly and natural losses remain constant, then 364 cfs is needed at Kelly to provide for fish passage.

[12] The water budget does not include direct flow water rights from the Newbold Ditch (45.85 cfs) since the ditch was not diverting water during the study period.

Discharge from the Kelly Gage during the 2006–2009 study period was used to evaluate the water budget. In 2006, an Average Dry year (Table 6), flows at the Kelly Gage dropped below 220 cfs sometime between August 2 and August 10[13] and stayed below 220 cfs through October 31 (except for nine days in October during a rain event). The GVR was dry during this period until September 23 when flows resumed at the Zenith Gage, likely in response to precipitation events and/or ditch closures. Although flows did not drop below 220 cfs at the Kelly Gage until early August, the river was dry in the seasonally dry reach as early as July 14. Ditch measurements in July 2006 indicate diversions exceeded direct, surplus, and excess water.

In 2007, a Moderately Dry year (Table 6), flows at the Kelly Gage dropped below 220 cfs on July 14 and remained below 220 cfs through October 31 (except for one day in October during a rain event). The GVR was dry during this period through September 26. Flows dropped below 220 cfs at the Kelly Gage on July 14, but Reach A was dry as early as June 23. Only one ditch was measured in June 2007 (174 cfs) and was diverting water exceeding direct, surplus, and excess water rights.

In 2008, an Average Wet to Moderately Wet year (Table 6), flows remained above 220 cfs at the Kelly Gage until August 28 and then fluctuated between 192 cfs and 289 cfs through October 31. Direct, surplus, excess, and supplemental water rights were available up to August 11, 2008. The GVR did not go dry during 2008 and flows only dropped below 10 cfs for four days at the Zenith Gage. Since flows dropped below 220 cfs and the GVR did not go dry it is likely that irrigators were not diverting all direct flow water rights.

In 2009, an Average Wet year (Table 6), flows at the Kelly Gage remained above 220 cfs except for six days in October. Direct flow, surplus, excess, and supplemental water rights were available up to August 17. The GVR did not go dry in 2009, and flows were 10 cfs or above at the Zenith Gage for the entire period.

In summary, the water budget provides a management tool that can be used to initially assess flow levels necessary at the Kelly Gage to meet downstream water rights and allow for fish passage. In a Moderately Dry year (2007) there was not enough water available to supply all direct flow water rights to the ditches below Kelly and allow for fish passage as early as mid-July. In an Average Dry year (2006), the same was true after the first week in August. During Average Wet to Moderately Wet years (2008 and 2009) direct, supplemental, surplus, and excess water rights were available up to the second week of August and all direct flow water rights were generally available up through the end of September.

[13] A NPS Gage measurement of 232 cfs was taken on August 2, 2006, and the first estimated daily value from the Kelly Gage was 208 cfs on August 10, 2006.

Conclusions

- An initial water budget indicates flows of about 220 cfs at the Kelly Gage are necessary to meet total direct flow water rights and allow for fish passage: 310 cfs for direct, surplus, and excess; and 364 for direct, surplus, excess, and supplemental.
- Based on the study period, flows are not high enough to supply all adjudicated water rights and allow for fish passage during Dry to Average years but are high enough to supply all adjudicated water rights and allow for fish passage during above average years.

Recommendations

- Continue to operate the USGS Kelly Gage during April through October. The gage is key to forecasting and managing water use on the GVR.
- Continue to evaluate and refine the water budget model.
- Continue to refine the water budget by performing additional seepage runs.
- Use ditch staff gages to manage water use and quantify diversions on the GVR. Staff gages should be surveyed and rating tables verified regularly to ensure accuracy.
- Develop forecasting tools using Snotel sites and USGS gages to predict when water right and fish passage flow shortages may occur. These tools would primarily be needed during Dry to Average year types.
- Initiate discussions with stakeholders to develop management practices to maintain continuous flows for fish passage. Management practices that could be considered include using groundwater as an alternate source during low flow periods, re-engineering diversion headgates and ditches to minimize water losses, use of more efficient irrigation practices, and lease agreements to reduce irrigation during periods when flows are inadequate for fish passage.

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Appendix A. Lower Gros Ventre Diversion Inventory



Savage Ditch. Date: 5/10/2008. Source: Gerber

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Introduction

This appendix presents an inventory of diversions for the lower Gros Ventre River (GVR) along the Grand Teton National Park (GRTE)/National Elk Refuge (NER) boundary. Information is summarized for the 2006–2009 field seasons. All photographs, Global Positioning System (GPS) coordinates, field forms, field books, and discharge measurements notes are located in the data files at the National Park Service, Water Resources Division (NPS-WRD) office in Fort Collins, Colorado.

Methods

Diversions are described from upstream to downstream. The location, physical attributes, headgate condition, water rights data, and discharge data are described for each diversion. GVR ditches within GRTE and the NER were field verified and conditions assessed. The point of diversion in this report is the physical point that water is diverted from the GVR into the ditch or diversion channel and may or may not be the same as the point of diversion of record for a given water right in the Wyoming State records. Portions of Enterprise, May White, Wild Cherry, and Spring Gulch ditches on private land outside of the GRTE and NER boundaries were not field verified but were digitized from high resolution aerial photography (2002, 2005, and 2006) and compiled into a Project Geographical Information System (GIS).

A. PROJECT GIS

GPS coordinates and ditch attributes were recorded and mapped in the Project GIS. GPS data were collected using a Trimble® GeoXM™ in Universal Tranverse Mercator (UTM) North American Datum (NAD) 1983, Zone 12 North, geographic coordinate system. GPS data have a spatial accuracy of one to three meters and were processed, differentially corrected, (using either Kelly or Driggs, ID base station data) and exported to GIS shapefile format using Trimble PathFinder Office 3.10.

Additional GIS data layers used in the Project GIS were obtained from the United States Geological Survey (USGS), Wyoming Geographic Information Center (WYGIS), Wyoming Geographic Information Advisory Council (WGIAC), the National Agriculture Imagery Program (NAIP), and the Wyoming Natural Resources Data Clearinghouse.

B. WATER RIGHTS

Water rights data for the diversions on the lower GVR were obtained from the WYSEO (WYSEO 1999 and http://seo.state.wy.us/wrdb/PS_Permit.aspx), from past reports (Albright 1993, Campbell 1990, and Hayden 1989), and from HDR Engineering, Inc. (HDR 2009). Private and United States-owned water rights were tabulated and summarized based on ditch name and location of primary point of diversion from the GVR. Both direct flow and supplemental supply adjudicated water rights data were researched and compiled. Unadjudicated water rights data were not compiled.

C. DISCHARGE MEASUREMENTS

Discharge data were collected for the lower GVR ditches during the 2006–2009 field seasons. Standard USGS discharge measurement protocols were followed (Buchanan and Somers 1969). Discharge measurements were made with NPS-WRD Price AA and Pygmy vertical axis meters and standard wading rods marked in tenths. All NPS-WRD meters were calibrated by the USGS Hydrologic Instrumentation Facility according to USGS protocol (Smoot and Novak 1968). Velocity was recorded from JBS Instruments Aquacount. Standard NPS-WRD discharge measurement notes forms were used to record all data (NPS 2007). Discharge measurements were checked using HMST[14] spreadsheets (Loving 2002).

Discharge measurements were not taken during times of high flows in May, June, and July on the South Park Supply, Price Lucas, May White, and Spring Gulch ditches to assure crew safety. Indirect discharge measurements were not performed.

Uncertainties in discharge measurements were determined from Sauer and Meyer (1992). All discharge measurements were rated as "good" (less than five percent error) with the exception of the following which were considered "fair" (within eight percent error): Savage Ditch measurements on October 5, 2006, and October 21, 2008; Newbold Ditch measurement on October 5, 2006; Price Lucas Ditch on August 10, 2007; and the May White Return on August 17, 2007. Discharge data collected by Teton Science School (Patterson 2007) are not rated.

D. STAFF GAGES

USGS Type A staff gages were installed on South Park Supply, Enterprise, Price Lucas, May White, and Spring Gulch ditches in May 2008 in accordance with USGS protocol (Buchanan and Somers 1968). Reference marks were installed and levels surveys performed per Kennedy (1990). Stage-discharge relationships (rating tables) for each ditch were created with GRSAT[15] software using USGS methodology (Kennedy 1984).

[14] Hydrographer's Measurement Sheet Toolbox
[15] Graphical Rating and Shift Application Tool (Aquatic Informatics 2006)

Diversion Inventory

Up to 24 ditches (Table 18 and Figure **12**) existed along the lower GVR dating back to the 1890s (WYSEO ~1920). Due to a combination of abandonment, change in source, change in point of diversion, and ditch consolidation, only eight ditches conveyed water from the lower GVR during the 2006–2009 study period (Table 19, Figure **13**). Two additional ditches, Hot Springs Ditch and Hanrow Ditch, conveyed water via spring sources adjacent to the GVR.

Table 18. Historical ditches on the lower Gros Ventre River (WYSEO ~1920)

Ditch # (Figure 1)	Historical Ditch Name	Ditch Status
1	Savage	Active
1a	Mud Springs	Source is Kelly Warm Springs
1b	Mormon Row	Source is Kelly Warm Springs
1c	May Stock	Source is Kelly Warm Springs
2	Cedar Tree	Not found
3	Ideal	P.O.D. [1] changed to Newbold
4	Hot Springs	Spring source
5	Hanrow	Spring source
6	Newbold	Active
7	Sebastian	P.O.D. changed to Newbold
8	Midland	P.O.D. changed to Newbold
9	Mesa	P.O.D. changed to Newbold
10	Romeo	Not found
11	South Park Supply	Active
12	Pettigrew and Cherry Flats	P.O.D. same as South Park
12a	Pettigrew	P.O.D. same as South Park
13	Hobo	P.O.D. changed to Enterprise
14	Enterprise	Active
15	Mayers and Nichols	P.O.D. is same as May White
16	Wild Cherry	Active
17	Newton Nickell	P.O.D. same as Wild Cherry
18	Glidden	P.O.D. same as Wild Cherry
19	Price and Lucas	Active
20	Cyclone	P.O.D. is same as May White
21	Spring Gulch	Active
22	Anderson	P.O.D. is same as Spring Gulch
23	Buckskin	P.O.D. is same as May White
24	White	Active

[1] P.O.D. - Point of Diversion

Table 19. Existing ditches on the lower Gros Ventre River based on 2006–2009 field observations

Ditch # (Figure 2)	Gros Ventre River Source Existing Ditch Name (Consolidated Ditch Names)
1	Savage
2	Newbold (and Ideal, Midland, Sebastian, and Mesa)
3	South Park Supply (and Pettigrew and Cherry Flats)
4	Enterprise (and Hobo)
5	Wild Cherry (and Glidden and Newton Nickell)
6	Price Lucas
7	May White (and Buckskin, Cyclone, and Mayers and Nichols)
8	Spring Gulch (and Anderson)
Ditch # (Figure 2)	**Non Gros Ventre River Source Ditch Name**
9	Hot Springs
10	Hanrow

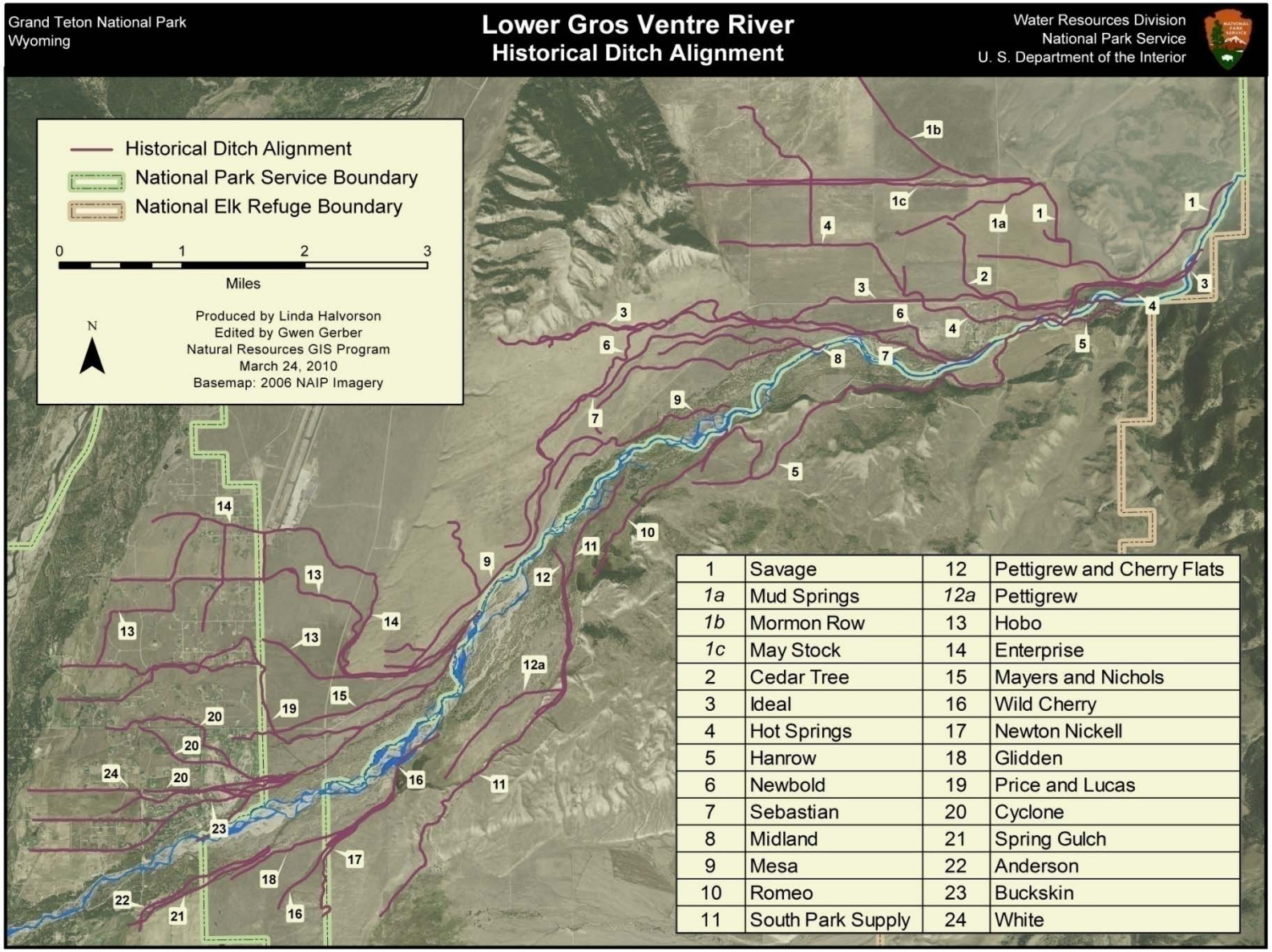


Figure 12. Map depicting historical ditch alignments on the lower Gros Ventre River (WYSEO ~1920), Teton County.

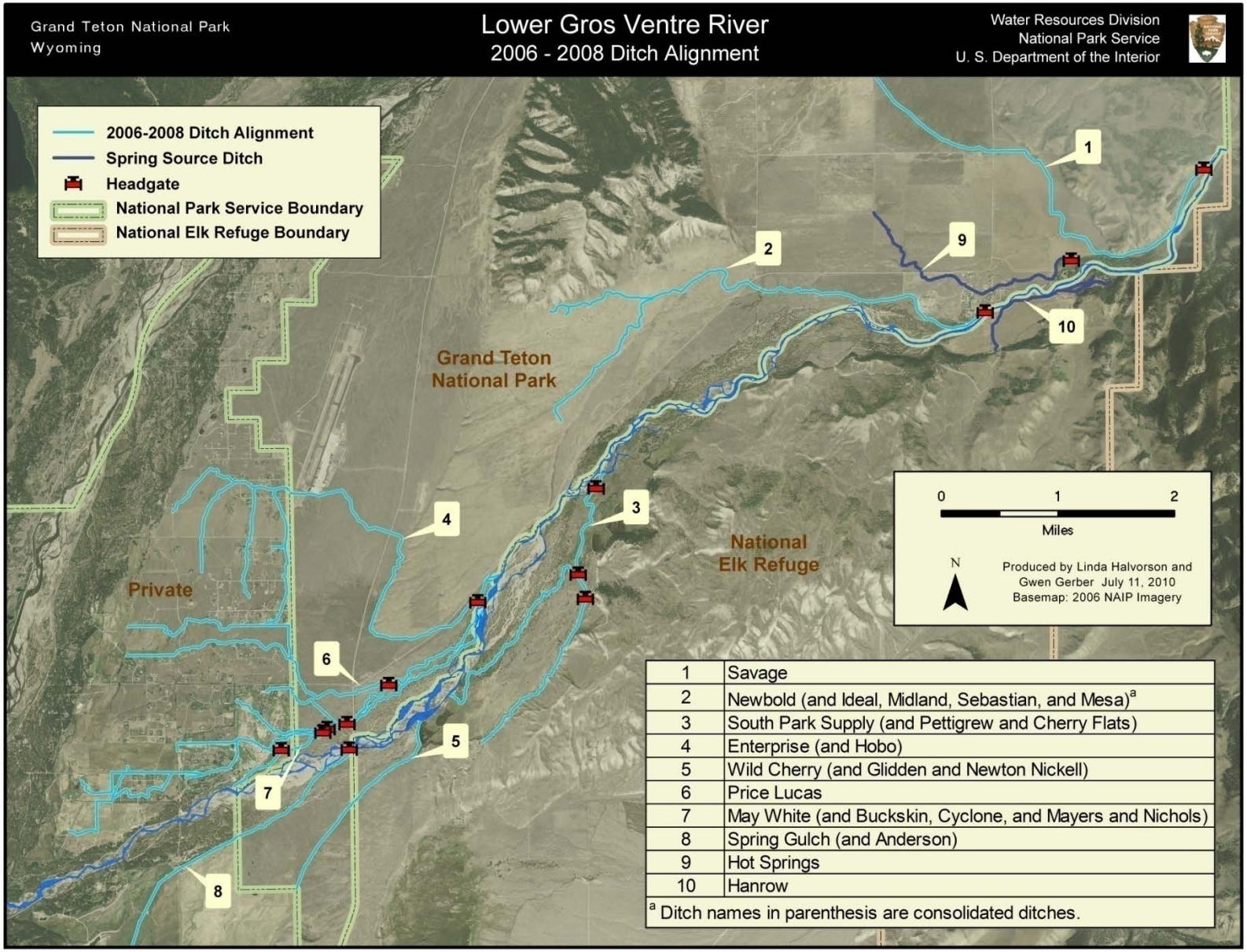


Figure 13. Map depicting ditch alignments on the lower Gros Ventre River during 2006–2009, Teton County.

A. EXISTING DITCHES

1. Savage Ditch

a. Description

The diversion point for the Savage Ditch is located just downstream of the GRTE boundary (Figure 14). The Savage Ditch begins at an elevation of approximately 6,720 feet and runs southwest parallel to the GVR for 1.3 miles then turns northward and travels 0.4 miles where a secondary ditch diverts flows to the west. This secondary ditch provides water to the Teton Valley Ranch (TVR) grazing lessee. The primary ditch continues to flow north 1.1 miles to Kelly Warm Springs where flow is augmented by the springs. The majority of the time during the study period GVR water was not conveyed to Kelly Warm Springs. Therefore, water in the ditch downstream of Kelly Warm Springs was solely from the springs.

The ditch splits at Kelly Warm Springs with two secondary ditches, one flowing west (formerly known as May Stock Ditch) and the other flowing southwest (formerly known as Mud Springs ditch). These ditches historically provided water to a network of flood irrigation channels for irrigation of the Kelly Hayfields. The Kelly Hayfields have not been irrigated since 1975 (Hayden 1989). The main ditch (formerly known as Mormon Row Ditch) flows northwesterly for another 2.5 miles to Ditch Creek. Along these 2.5 miles at least six secondary headgates exist which historically diverted water to the west to a network of flood irrigation canals irrigating the historic Kelly Hayfields.

At Ditch Creek the ditch splits with some water flowing into Ditch Creek and the remaining water is piped north over Ditch Creek. North of Ditch Creek the ditch provides water to GRTE horse pasture and to private inholdings near the terminus of the ditch. The private inholders use the water for lawns, trees, and shrubs.

b. Condition

Primary and secondary headgates and the ditch are in need of significant repair and maintenance. A double headgate controls flow from the GVR into the Savage Ditch (Figure 15). The headgates are marginally operational and there are significant cracks in the headwalls (Figure 16). On June 20, 2008, 8.8 cfs was measured leaking through the closed headgates during high flows.

Frequent dredging of the GVR due to channel aggradation is required for approximately 1,000 feet upstream of the headgate to keep water flowing into the ditch (Figure 17). High flows in May through July of 2008 were the only time during the 2006–2008 field seasons that there was sufficient flow in the ditch to convey water as far as Kelly Warm Springs.

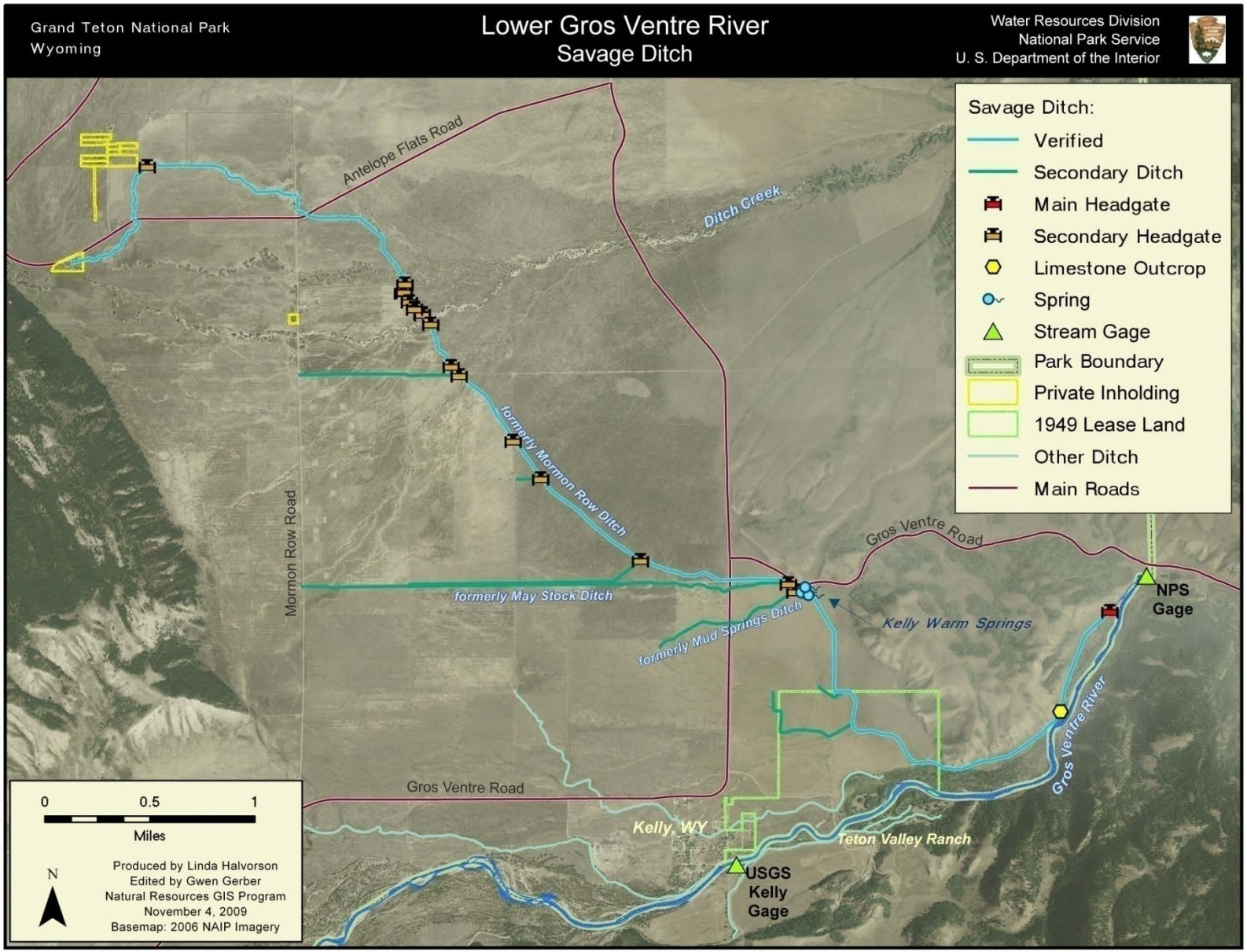


Figure 14. Savage Ditch location map, Gros Ventre River, Teton County.



Figure 15. Savage Ditch double headgate (looking downstream). Date: 7/25/2007. Source: Gerber



Figure 16. Cracks along right and left headwalls of headgate (looking upstream). Date: 4/11/2007. Source: Gerber



Figure 17. Excavated channel upstream of Savage Ditch headgates. Date: 4/11/2007. Source: Gerber

Starting approximately a half mile downstream of the headgate the ditch runs along the base of a steep eroding slope for about 0.7 miles. This slope is composed of fine to medium alluvium and outcrops of limestone. The ditch loses water to the permeable limestone (Figure 18) and is prone to small debris slides that inhibit flow (Figure 19).



Figure 18. Water loss to infiltration to limestone (looking upstream). Date: 8/31/2006. Source: Miller
Figure 19. Small debris slide from steeply sloped right bank (looking upstream). Date: 5/8/2008. Source: Gerber

The laterally shifting GVR channel with its characteristic cutbank erosion and point bar deposition are eroding the toe slope of the Savage Ditch embankment (Martin 1999). A photograph taken standing on the levee separating the GVR and the Savage Ditch is shown in Figure 20. Aerial photographs in Figure 21 show the progression of cut bank erosion from 1994–2006. Previous bank stabilization work is evident in the aerial photographs upstream of the current point of erosion. NPS-WRD assessed maintenance and repair issues of the Savage Ditch in 1998. Rehabilitation of the ditch, including rebuilding the headgate and stabilizing the eroding bank, was estimated to exceed $100,000 (Martin 1999).



Figure 20. Eroding levee between the Gros Ventre River and the Savage Ditch (looking downstream). Date: 5/8/2008. Source: Gerber

c. Water Rights

GRTE owns most of the water rights on the Savage Ditch, although the original appropriators are still identified in state files (WYSEO 1999). A small portion of the Savage Ditch water rights are appurtenant to inholdings near the terminus of the ditch (Lord 2006, see Figure 14). Water is used within these inholdings to irrigate lawns and shrubs (Hayden 1989). Priority dates for Savage Ditch water rights range from 1911–1934 (WYSEO 1999). There have been no changes in points of diversion nor consolidation with other diversions. The rights are adjudicated as set forth in Table 20.

In addition to the inholdings near the terminus of the ditch, the TVR operates a dude ranch on the north side of the GVR within GRTE by virtue of a 1949 life lease (via permits 10707 46-505 and 2855E 43-89). The leased lands have water rights through the Savage Ditch (permitted parcels are highlighted in Figure 14). The 1949 lease with GRTE terminates upon the death of the last surviving member of the Wilson family.

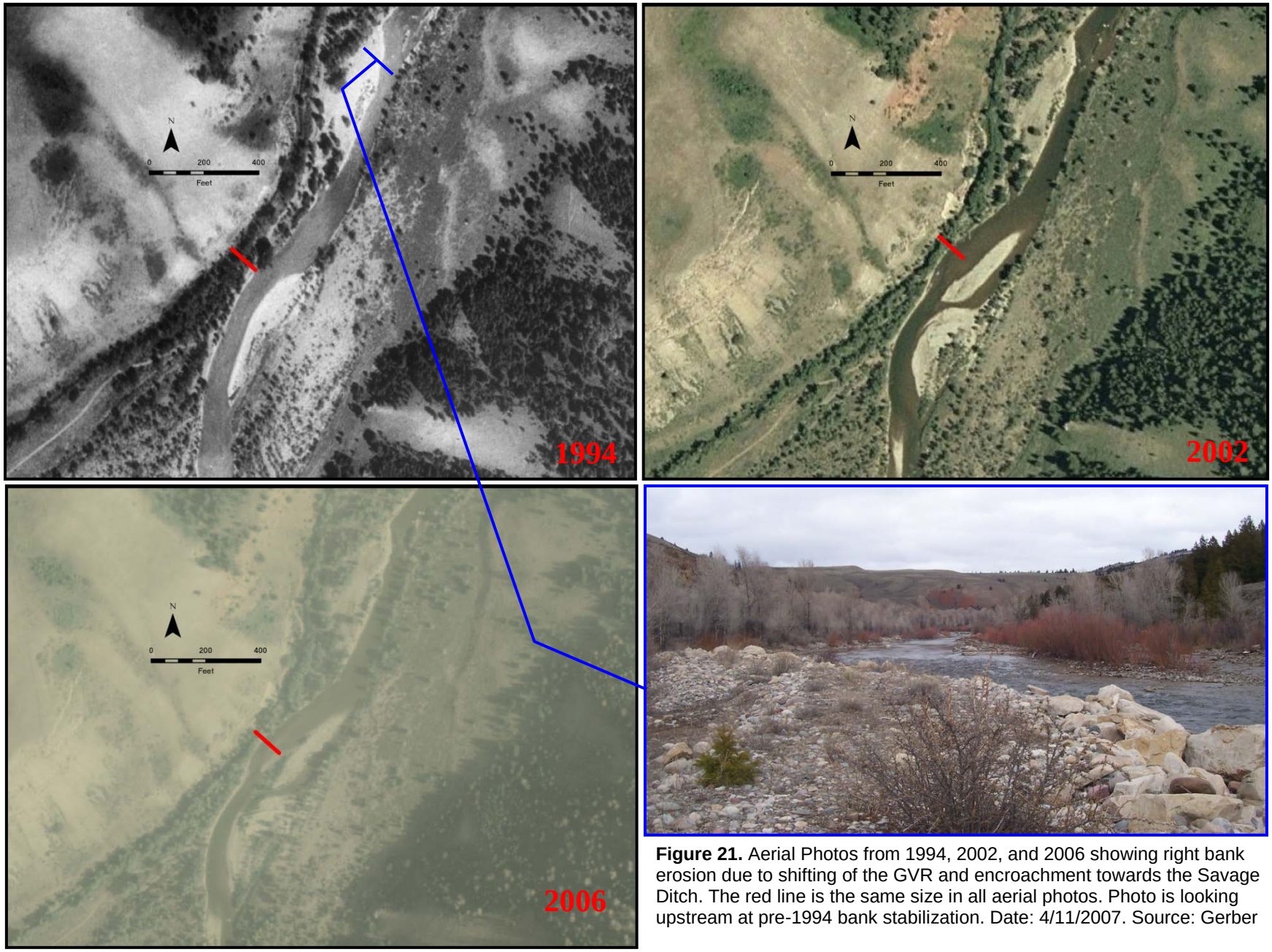


Figure 21. Aerial Photos from 1994, 2002, and 2006 showing right bank erosion due to shifting of the GVR and encroachment towards the Savage Ditch. The red line is the same size in all aerial photos. Photo is looking upstream at pre-1994 bank stabilization. Date: 4/11/2007. Source: Gerber

Table 20. Savage Ditch adjudicated water rights

Ditch	Ownership	Adjudicated Water Rights (WYSEO 1999)		
		Direct (cfs)	Supplemental (cfs)	Total (cfs)
Savage	GRTE	11.18	20.50	31.68
	Private	0.23	0.17	0.40
	Total	11.41	20.67	32.08

d. Discharge Measurements

Between 2006 and 2008 seven discharge measurements were taken on the Savage Ditch within 100 feet downstream of the primary headgate (Table 21). These discharge measurements ranged from 0.59 cfs to 8.83 cfs with an average of 3.76 cfs. None of these discharge measurements exceeded the total direct and supplemental water rights for the ditch.

Table 21. Savage Ditch discharge measurements (2006–2008)

Date	Discharge (cfs)	Comments
10/4/2006	0.59	Both headgates closed, leakage only
10/4/2006	4.31	Measured again after opening right headgate, left headgate remained closed
8/3/2007	1.67	Headgates open
5/30/2008	3.89	Headgates open
6/20/2008	8.83	Headgates closed (measurement 1 of 2 on this day, see also Table 22)
7/8/2008	6.40	Headgates closed (measurement 1 of 4 on this day, see also Table 22)
10/21/2008	0.657	Headgates closed, leakage
Average	**3.76**	

Four additional measurements were taken in 2008 further downstream of the primary headgates to determine gains and losses along the ditch (Table 22). This was the only year during the study period that Savage Ditch conveyed GVR water as far as Kelly Warm Springs. In June 2008, measurements were taken just below the primary headgates (8.83 cfs) and just upstream of Kelly Warms Springs (3.98 cfs). Therefore, 4.85 cfs was lost in this reach including an active secondary diversion (the TVR ditch).

Three weeks later field technicians took measurements on the Savage Ditch above (4.12 cfs) and below (3.30 cfs) the TVR ditch and determined that 0.82 cfs was being diverted to the ditch. Measurements taken just below the primary headgates (6.40 cfs) and just above Kelly Warm Springs (2.62 cfs) on that same day indicate that while 0.82 cfs was being diverted to the TVR ditch, 2.96 cfs was lost to seepage between the primary headgates at the GVR and Kelly Warm Springs.

Table 22. Additional downstream Savage Ditch discharge measurements (2008)

Date	Discharge (cfs)	Comments
6/20/2008	3.98	Measurement taken just upstream of Kelly Warm Springs
7/8/2008	4.12	Measurement taken above the TVR diversion (measurement 2 of 4 on this day)
7/8/2008	3.30	Measurement taken just downstream of the TVR diversion (measurement 3 of 4 on this day)
7/8/2008	2.62	Measurement taken just upstream of Kelly Warm Springs (measurement 4 of 4 on this day)

Four discharge measurements were taken downstream of Kelly Warm Springs to determine flow originating from the Springs. Measurements ranged from 2.99 to 7.41 cfs (Table 23). On May 30, 2008, Kelly Warm Springs flows were comingled with GVR flows via the Savage Ditch.

Table 23. Kelly Warm Springs discharge measurements (2007–2008)

Date	Discharge (cfs)	Comments
4/11/2007	4.95	Savage Ditch not running, flow measured only from Kelly Warm Springs
8/10/2007	3.35	Savage Ditch not running, flow measured only from Kelly Warm Springs
3/13/2008	2.99	Savage Ditch not running, flow measured only from Kelly Warm Springs
5/30/2008	7.41	11.3 cfs measured downstream of Kelly Warm Springs and includes Savage Ditch water, Savage Ditch measured at 3.89 cfs (Table 21) just upstream of Kelly Warm Springs; therefore, 7.41 cfs originated from the Warm Springs.



Figure 22. Kelly Warm Springs (looking towards outlet). Date: 5/10/2008. Source: Gerber

e. Summary

GRTE owns 31.68 cfs of direct and supplemental supply water rights on the Savage Ditch while private inholders own 0.40 cfs. State records for the federal water rights still reflect the original appropriator. A current 1949 life-lease authorizes TVR to use up to 3.64 cfs of GRTE water. GRTE used Savage Ditch water during the study period to irrigate horse pasture north of Ditch Creek. Both the ditch and headgates need significant maintenance and repair. Discharges were measured up to 8.83 cfs, none of the measurements exceeded the total direct and supplemental supply water rights for the ditch.

2. Newbold (and Ideal, Midland, Sebastian, and Mesa) Ditch

a. Description

The Newbold Ditch is the current point of diversion for the historical Ideal, Midland, Sebastain, and Mesa ditches. In this Appendix, the "Newbold Ditch" will include these ditches. Newbold Ditch begins on the north side of the GVR in Kelly, Wyoming, at an elevation of approximately 6,640 feet (Figure 23). A low head dam and double headgate is the primary diversion point (Figure 24, Figure 25). The ditch flows parallel to the GVR for about 0.3 miles and then turns northwesterly towards Blacktail Butte. Water is conveyed along this route for approximately 2.2 miles to a breach in the ditch levee where the water has created a riparian area within a sagebrush community just southeast of the Gros Ventre Road and just northwest of the Gros Ventre River Campground (Figure 26, Figure 27).

The ditch location was field verified to just beyond the riparian area where it crosses under Gros Ventre Road. Beyond the road the ditch location was determined from aerial photographs. Historically this ditch conveyed water along the southern edge of Blacktail Butte all the way across Highway 89/191.

b. Condition

During the study period the headgates remained closed at all times. Headgates are in good condition; however, approximately two cfs was measured seeping under the gates (Figure 28). The stability of the low head dam adjacent to the headgates is questionable. If the dam failed, water could no longer be diverted from the existing headgates. Low flow and standing water conditions have created wetland communities along the ditch adjacent to the GVR (Figure 29). Up to two feet of organic material has accumulated along the ditch bottom.

The ditch is in fair condition from the headgates to the breach in the ditch. The ditch would need to be repaired before any water could be conveyed past the breach. If the ditch were to convey more than two cfs, it is likely that additional repairs would be necessary in several areas to contain flows within ditch banks.

c. Water Rights

All water rights for Newbold Ditch, (including Ideal, Midland, Sebastain and Mesa ditches) were acquired by the U.S. in 1949 (Table 24, Hayden 1989). The water rights are still shown in state records as being held by the original appropriators. The WYSEO (1999) documents the change in point of diversion for all water rights from Ideal, Midland, Sebastian, and Mesa ditches to the Newbold Ditch. Priority dates for the Newbold Ditch range from 1899–1913.



Figure 23. Newbold (and Ideal, Midland, Sebastian, and Mesa) Ditch location map, Gros Ventre River, Teton County.



Figure 24. Newbold double headgates (looking downstream). Date: 5/30/2006. Source: Miller



Figure 25. Low-head dam on the Gros Ventre River in Kelly. Date: 8/15/2006. Source: Miller



Figure 26. Riparian area at terminus of Newbold Ditch. Date: 07/25/2007. Source: Gerber

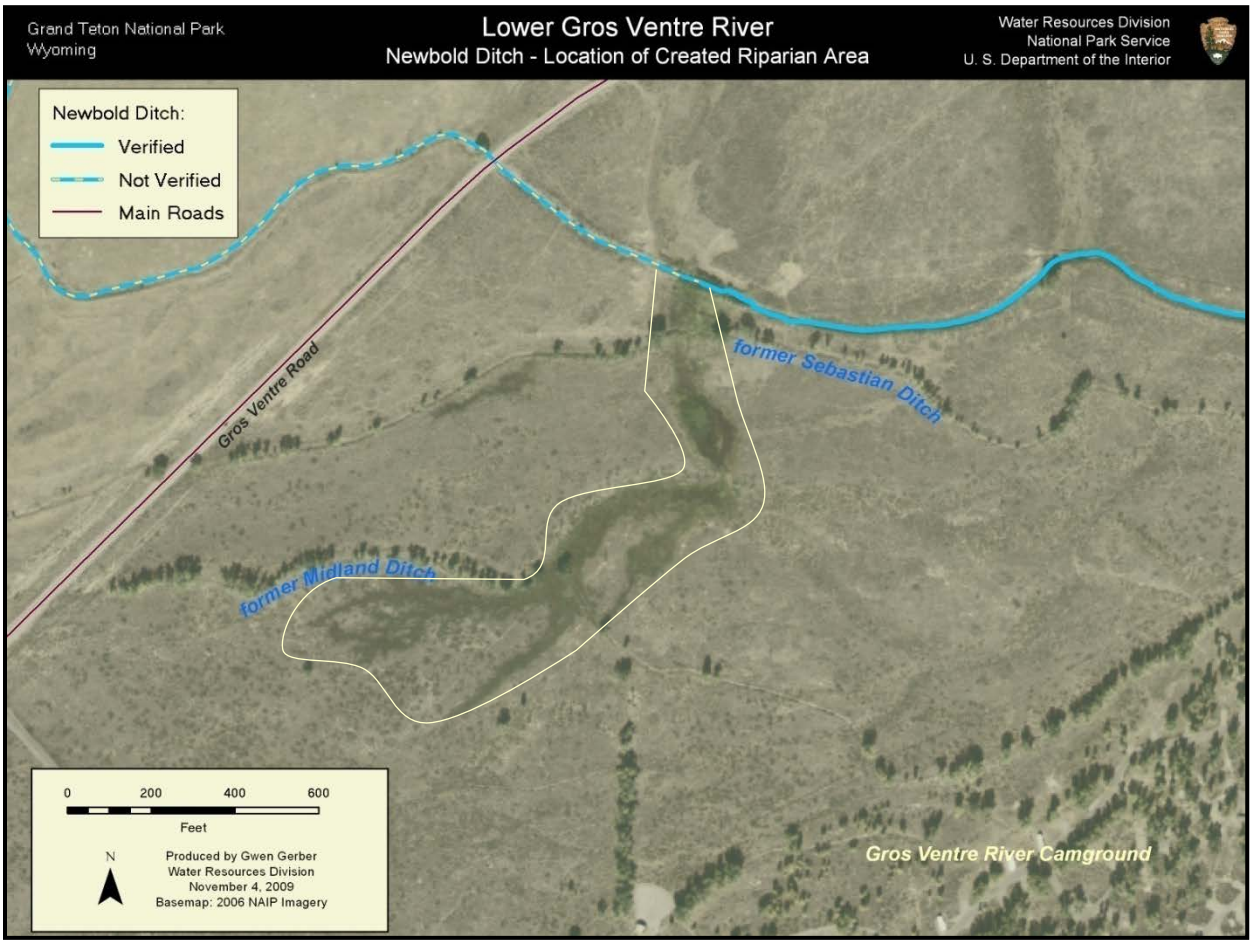


Figure 27. Location map of riparian area associated with Newbold Ditch.

Table 24. Newbold (and Ideal, Midland, Sebastian, and Mesa) Ditch adjudicated water rights

Ditch	Contributing Ditches	Adjudicated Water Rights (WYSEO 1999)			
		Direct (cfs)	Supplemental (cfs)	Total (cfs)	Total (cfs)
Newbold	Newbold	4.28	0	4.28	45.85
	Ideal	14.77	0	14.77	
	Midland	5.89	0	5.89	
	Sebastain	12.63	0	12.63	
	Mesa	8.28	0	8.28	

d. Discharge Measurements

Headgates remained closed during the study period. One discharge measurement of 1.92 cfs was made on October 5, 2006, to quantify leakage under the headgates (Table 25).

Table 25. Newbold Ditch discharge measurements and observations (2006–2008)

Date	Discharge (cfs)	Comments
10/5/2006	1.92	Both headgates closed
8/24/2007	No discharge measurement performed	Leakage below closed headgates lots of algae production
10/5/2007		Headgates closed, appreciable leakage ~2cfs
10/18/2007		Headgates closed, seepage below headgate ~1-2 cfs
11/15/2007		Headgates closed <1 cfs leakage
11/16/2007		Headgates closed <1 cfs leakage
9/16/2008		Headgates closed, leakage under headgates <1 cfs
9/17/2008		Headgates closed, <1 cfs leakage under headgates
10/21/2008		Headgates closed, one reading taken in center of ditch, was the only movement, estimated flow < 0.5 cfs

e. Summary

The 45.85 cfs of adjudicated water rights in the Newbold Ditch are owned solely by the NPS. State records for these water rights still reflect the original appropriator. The headgates were closed during the study period, and up to two cfs of leakage was common.



Figure 28. Newbold Ditch looking downstream from headgates. Date: 10/05/07. Source: Gerber



Figure 29. Newbold Ditch adjacent to the Gros Ventre River. Date: 7/25/07. Source: Gerber

3. South Park Supply (and Pettigrew and Cherry Flat) Ditch

a. Description

The South Park Supply Ditch begins at an elevation of 6480 ft on the south side of the GVR in the NER, just southwest of the Gros Ventre Campground in GRTE (Figure 30). Historical linen ditch plat maps (WYSEO ~1920) indicate that South Park Supply Ditch and the Pettigrew and Cherry Flats Ditch share the same point of diversion. There are no records of a change in point of diversion for either the South Park Supply or Pettigrew and Cherry Flats Ditch (WYSEO 1999). In this Appendix, the "South Park Supply Ditch" will include the Pettigrew and Cherry Flats Ditch.

The diversion point for the South Park Supply Ditch is a cobble mound (Figure 31). The primary headgate is located approximately 0.15 miles downstream of the cobble mound (Figure 32). A secondary headgate is located approximately 0.9 miles downstream from the primary headgate (Figure 33). Here the ditch splits, the primary ditch flows south and the secondary ditch flows west. The primary ditch flows south for approximately 1.8 miles before it is diverted into an aqueduct that delivers water to the Flat Creek watershed (Figure 34). Approximately 1,000 feet upstream of the aqueduct there is an old concrete weir which can be used to measure flows leaving the GVR watershed via the South Park Supply Ditch. NPS installed a staff plate on the weir on September 18, 2008 (Figure 36).

The secondary ditch travels 1.4 miles through the NER before returning to the GVR. The NER used this ditch during the study period to irrigate the Pederson Management Area. This area is approximately 651 acres, and about 330 acres are being irrigated annually (Reed 2009). Another secondary headgate approximately 1.1 miles downstream from the primary headgate was not used during the study period (Figure 35).

b. Condition

The primary headgates are in good condition, although the cobble bar determines the amount of flow in the ditch rather than the headgate. The ditch is in good condition and is capable of conveying over 100 cfs. The active secondary headgates are in good condition. The inactive secondary headgates appears to have been unused for some time and may need repairs to be operational.

c. Water Rights

The majority of the water rights (53.38 cfs) for the South Park Supply Ditch are supplemental and are attached to private lands southwest of Jackson, Wyoming. The priority dates of the private water rights range from 1932 to 1955. Water rights for South Park Supply Ditch are listed in Table 26. The NPS does not own any water rights on South Park Supply Ditch. The NER owns 1.57 cfs of direct supply from the Pettigrew and Cherry Flats Ditch (WYSEO 1999). Both the NER and private water rights holders used water during the study period from South Park Supply Ditch. Water is typically diverted by private land owners through the aqueduct up to the end of July for the first cut of hay (Barney 2007).

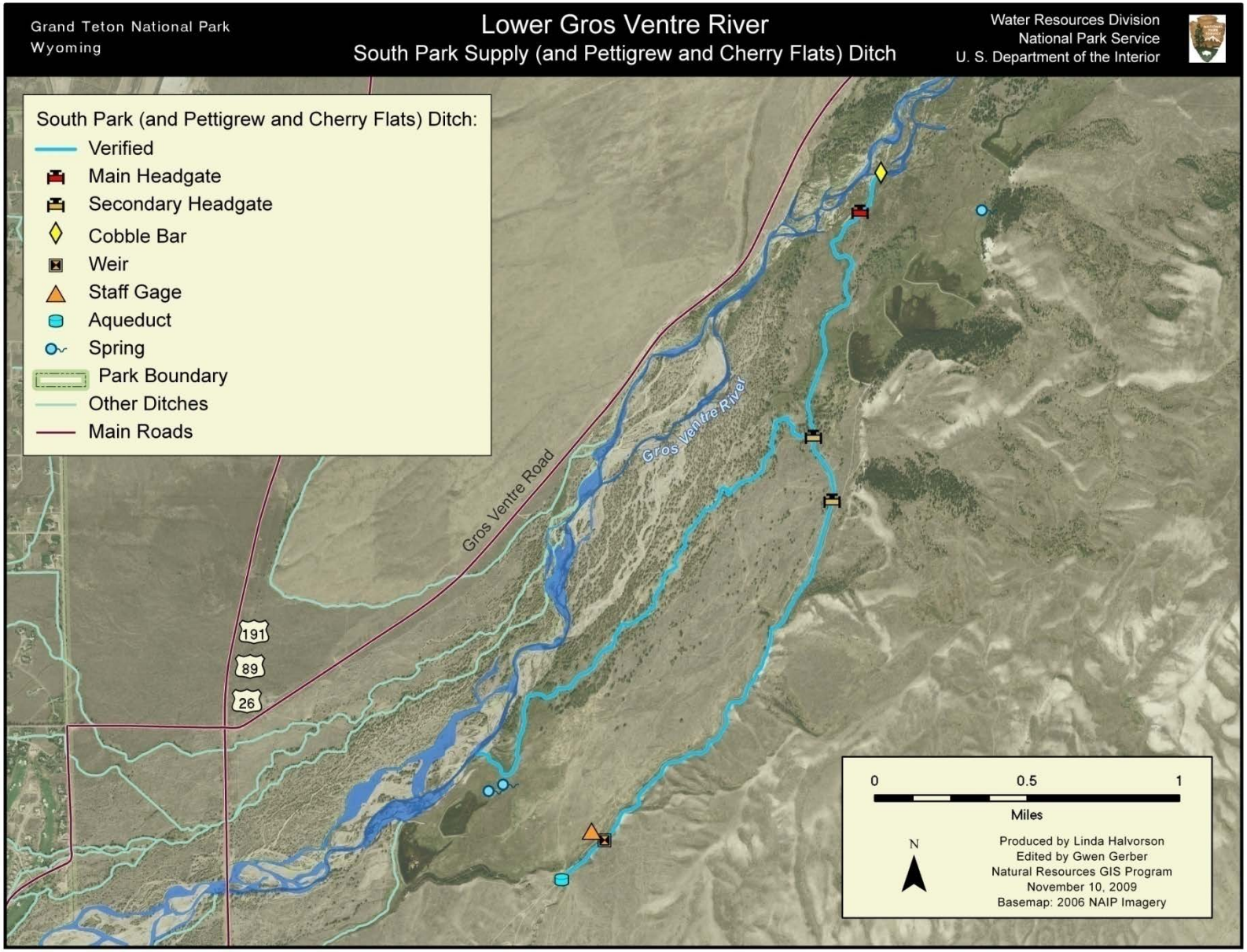


Figure 30: South Park Supply (and Pettigrew and Cherry Flats) Ditch location map, Gros Ventre River, Teton County.

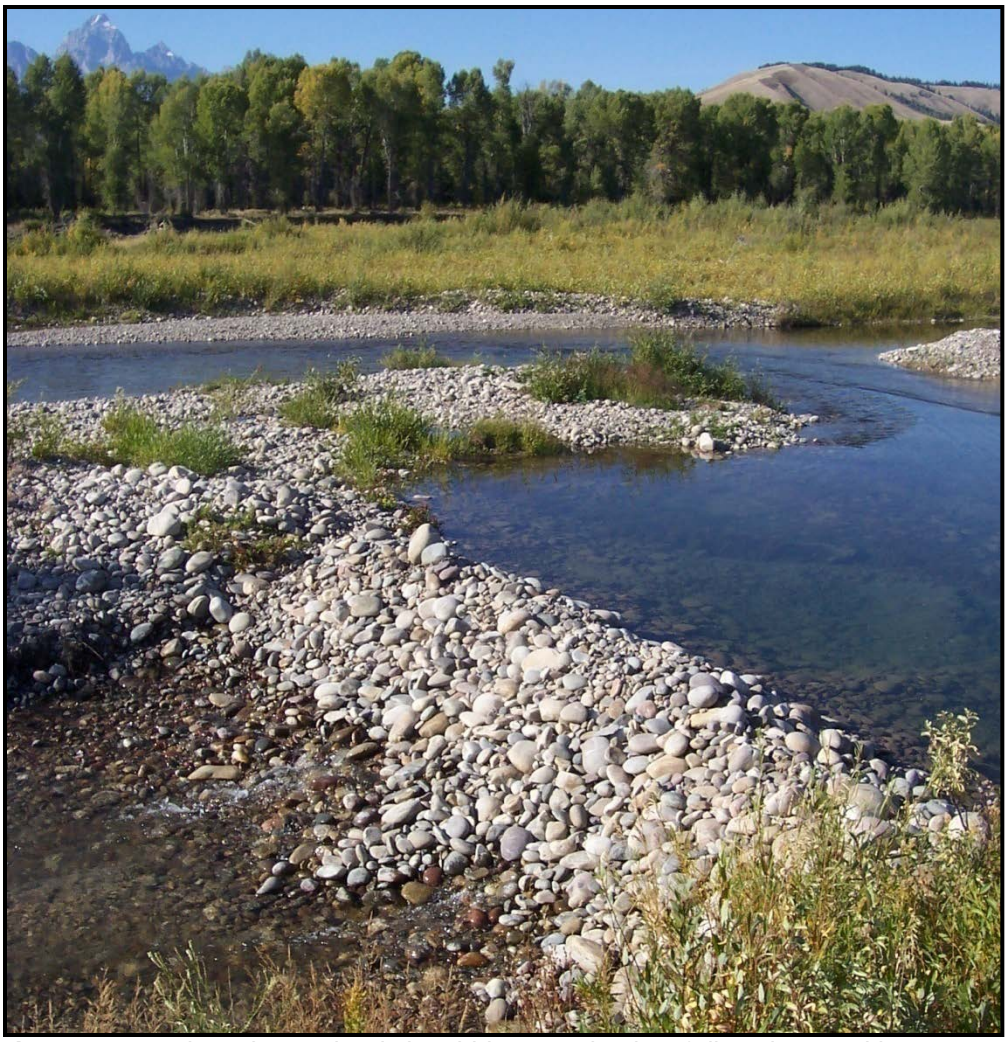


Figure 31. South Park Supply Ditch cobble mound point of diversion. Looking upstream. Date: 9/16/2008. Source: Gerber

Table 26. South Park Supply adjudicated water rights

Ditch	Ownership	Adjudicated Water Rights (WYSEO 1999 and HDR 2009)			
		Direct (cfs)	Supplemental (cfs)	Total (cfs)	Total (cfs)
South Park Supply	Private	1.7	53.38	55.08	56.65
Pettigrew and Cherry Flats	National Elk Refuge	1.57	0	1.57	
	Total:	3.27			

d. Discharge Measurements

No discharge measurements were taken in 2006 and 2007. Ten discharge measurements were collected during the 2008–2009 field seasons near the weir just upstream of the aqueduct (Table 27). Discharge measurements ranged from 1.39 cfs to 108 cfs with an average of 43.1 cfs. Four measurements exceeded the total direct and supplemental water rights. No discharge measurements were made on the active secondary ditch.

One discharge measurement was taken on October 21, 2008, just downstream of the cobble bar and upstream of the primary headgates to measure seepage through the cobble bar. A discharge of 2.03 cfs was measured leaking through the cobble bar.



Figure 32. Looking downstream at South Park Supply Ditch primary headgate. Date: 4/12/2007. Source: Gerber

Table 27. South Park Supply Ditch discharge measurements

Date	Discharge (cfs)	Comments
7/16/2007	0.00	No water in ditch
11/16/2007	0.00	No water in ditch
6/16/2008	83.8	
7/2/2008	108	Heavy equipment at aqueduct to remove debris
7/15/2008	74.3	Saw what we think are irrigators driving up towards diversion
7/23/2008	67.1	
8/1/2008	47.5	
8/7/2008	39.5	
8/13/2008	37.5	
8/28/2008	11.0	
9/4/2008	1.39	
9/17/2008	0.00	Ditch is dry
10/21/2008	2.03	Cobble bar up, measurement taken from leakage below cobble bar.
9/3/2009	2.38	No cobble bar, most water being diverted at first secondary headgate, 2.38 cfs leaking under secondary headgate measured at weir
Average[1]	**47.2**	

[1]Average of non-zero measurements

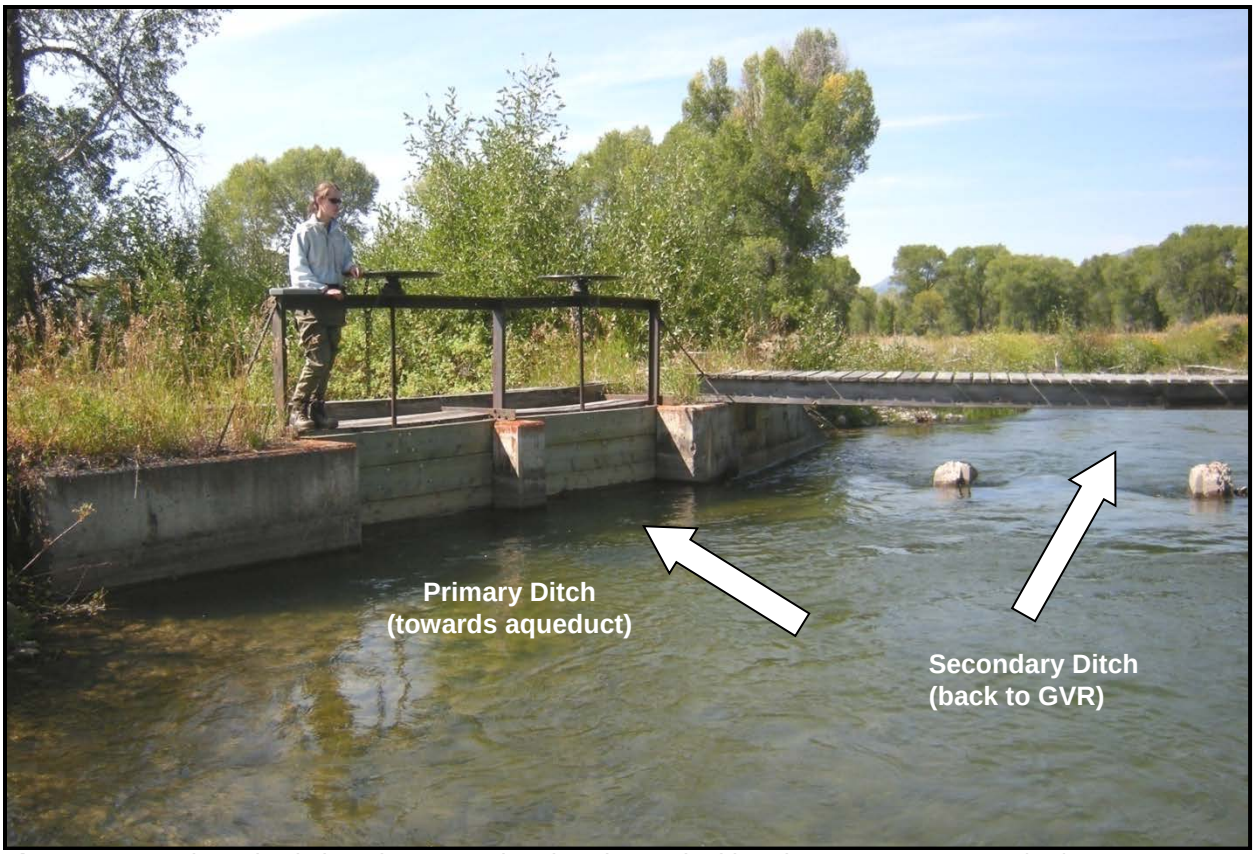


Figure 33. South Park Ditch active secondary headgates looking downstream. Date: 7/25/2007. Source: Gerber



Figure 34. South Park Ditch point of aqueduct entry. Looking downstream. Date: 7/25/2007. Source: Gerber



Figure 35. Looking upstream at inactive secondary diversion. Date: 7/25/2007. Source: Gerber



Figure 36. Looking downstream at the South Park Supply Ditch weir with staff plate. Inset: Tape down measurement from top of concrete on the right bank of weir. Date: 9/18/2008, inset: 9/4/2008. Source: Gerber, Fiumara

The NPS-WRD installed and surveyed a staff plate on South Park Supply Ditch on September 18, 2008 (Figure 36). Readings from the staff plate at corresponding measured discharges were used to establish a stage-discharge relationship and to develop a rating table (Table 28). The rating table is comparable to the rating provided by WYSEO (Barney 2007) for discharges collected between 1981 and 1985.

Prior to the installation of the staff plate, water levels were measured using a calibrated tape from the top of the right bank of the weir down to the water level (Figure 36 inset). These tape down measurements were converted to staff plate gage heights by subtracting the distance to water level from 3.54 feet (surveyed staff plate elevation of the top of the right bank of the weir).

Table 28. South Park Supply rating table

U.S. DEPARTMENT OF THE INTERIOR – NATIONAL PARK SERVICE - WATER RESOURCE DIVISION

STATION: Gros Ventre River - South Park Supply Ditch SOURCE AGENCY: USNPS
Date Processed: 10/26/2009 15:01:35 MST By ggerber
Rating for Discharge (cfs)
RATING ID: 0002 TYPE: Stage-Discharge

EXPANDED RATING TABLE

Stage (ft) →	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
↓					Discharge (cfs)					
0.10		1.24	1.43	1.62	1.83	2.04	2.27	2.50	2.74	2.99
0.20	3.25	3.52	3.79	4.07	4.36	4.66	4.96	5.28	5.59	5.92
0.30	6.25	6.59	6.94	7.29	7.65	8.02	8.39	8.77	9.16	9.55
0.40	9.95	10.3	10.8	11.2	11.6	12.0	12.5	12.9	13.3	13.8
0.50	14.3	14.7	15.2	15.7	16.1	16.6	17.1	17.6	18.1	18.6
0.60	19.1	19.6	20.2	20.7	21.2	21.8	22.3	22.8	23.4	24.0
0.70	24.5	25.1	25.7	26.2	26.8	27.4	28.0	28.6	29.2	29.8
0.80	30.4	31.0	31.6	32.3	32.9	33.5	34.2	34.8	35.5	36.1
0.90	36.8	37.4	38.1	38.8	39.4	40.1	40.8	41.5	42.2	42.9
1.00	43.6	44.3	45.0	45.7	46.4	47.2	47.9	48.6	49.3	50.1
1.10	50.8	51.6	52.3	53.1	53.8	54.6	55.4	56.1	56.9	57.7
1.20	58.5	59.3	60.1	60.9	61.7	62.5	63.3	64.1	64.9	65.7
1.30	66.5	67.4	68.2	69.0	69.9	70.7	71.6	72.4	73.3	74.1
1.40	75.0	75.9	76.7	77.6	78.5	79.4	80.2	81.1	82.0	82.9
1.50	83.8	84.7	85.6	86.5	87.5	88.4	89.3	90.2	91.1	92.1
1.60	93.0	94.0	94.9	95.8	96.8	97.7	98.7	99.7	101	102
1.70	103	104	105	106	106	107	108	109	110	111
1.80	112	113	114	116	117	118	119	120	121	122
1.90	123	124	125	126	127	128	129	130	131	132
2.00	133	134	135	137	138	139	140	141	142	143
2.10	144	145	146	148	149	150	151	152	153	154
2.20	155	157	158	159	160	161	162	164	165	166
2.30	167	168	169	171	172	173	174	175	176	178
2.40	179	180	181	182	184	185	186	187	189	190
2.50	191	192	194	195	196	197	198	200	201	202
2.60	204	205	206	207	209	210				

e. Summary

The South Park Supply Ditch is capable of diverting over 100 cfs and is one of the three largest ditches on the GVR. This ditch is used as a supplemental supply via Flat Creek to private landowners southwest of Jackson, Wyoming. It is also the direct supply to the NER. During the study period the NER diverted water through the South Park Supply Ditch to irrigate lands just south of the GVR on the floodplain; water used for this purpose does not leave the GVR watershed. The private diverters typically divert water through the end of July. The NPS does not own any water rights from the South Park Supply Ditch. Adjudicated water rights total 56.65 cfs, though diversions of up to 108 cfs have been measured. During 36 percent of the measurements, diversions exceeded total direct and supplemental water rights.

4. Enterprise (and Hobo)

a. Description

The Enterprise Ditch is located on the north side of the GVR downstream from the South Park Ditch (Figure 37). WYSEO (1999) indicates that all water appropriators that formerly diverted through the Hobo Ditch have changed their points of diversion to the Enterprise Ditch. In this Appendix, the "Enterprise Ditch" will include the Hobo Ditch. The point of diversion for the Enterprise Ditch is a series of cobble mounds (Figure 38) that direct water to a double headgate approximately 0.3 miles downstream from the first cobble mound (Figure 39). The ditch begins at an elevation of approximately 6,480 feet.

The ditch travels southwest for 0.4 miles where it crosses under Gros Ventre Road and runs around the perimeter of a terrace and crosses under Highway 89/191 after 1.7 miles. The ditch then travels for another mile within GRTE just south of the Jackson Hole Airport and crosses into private land. The ditch was not field verified beyond this point; aerial photography was used to digitize the location of the ditch within private lands.

b. Condition

The headgate is in fair condition and is located immediately downstream of a beaver pond (Figure 39). Debris from beaver activity frequently clogs the headgates (Figure 40). When headgates are clogged or closed, flows return to the GVR via a channel on the left bank just upstream of the headgates (Figure 41). The left bank headgate is canted and may not be completely operable. Leakage of nearly three cfs was measured when headgates were closed. The ditch appears to be in good condition and is capable of conveying up to 30 cfs.

c. Water Rights

Adjudicated water rights are owned by GRTE and private entities (Table 29). Priority dates for these water rights range from 1899–1914. The federally owned water rights acquired still identify the original appropriator in WYSEO files. GRTE did not divert from this ditch during the study period. From aerial photographs it appears that Enterprise Ditch water is being used for watering lawns, trees, and shrubs in the private subdivisions west of Highway 89/191.

Table 29. Enterprise Ditch adjudicated water rights

Ditch	Ownership	Adjudicated Water Rights (WYSEO 1999 and HDR 2009)			
		Direct (cfs)	Supplemental (cfs)	Total (cfs)	Total (cfs)
Enterprise and Hobo	Private	12.95	0	12.95	20.48
	GRTE	7.53	0	7.53	

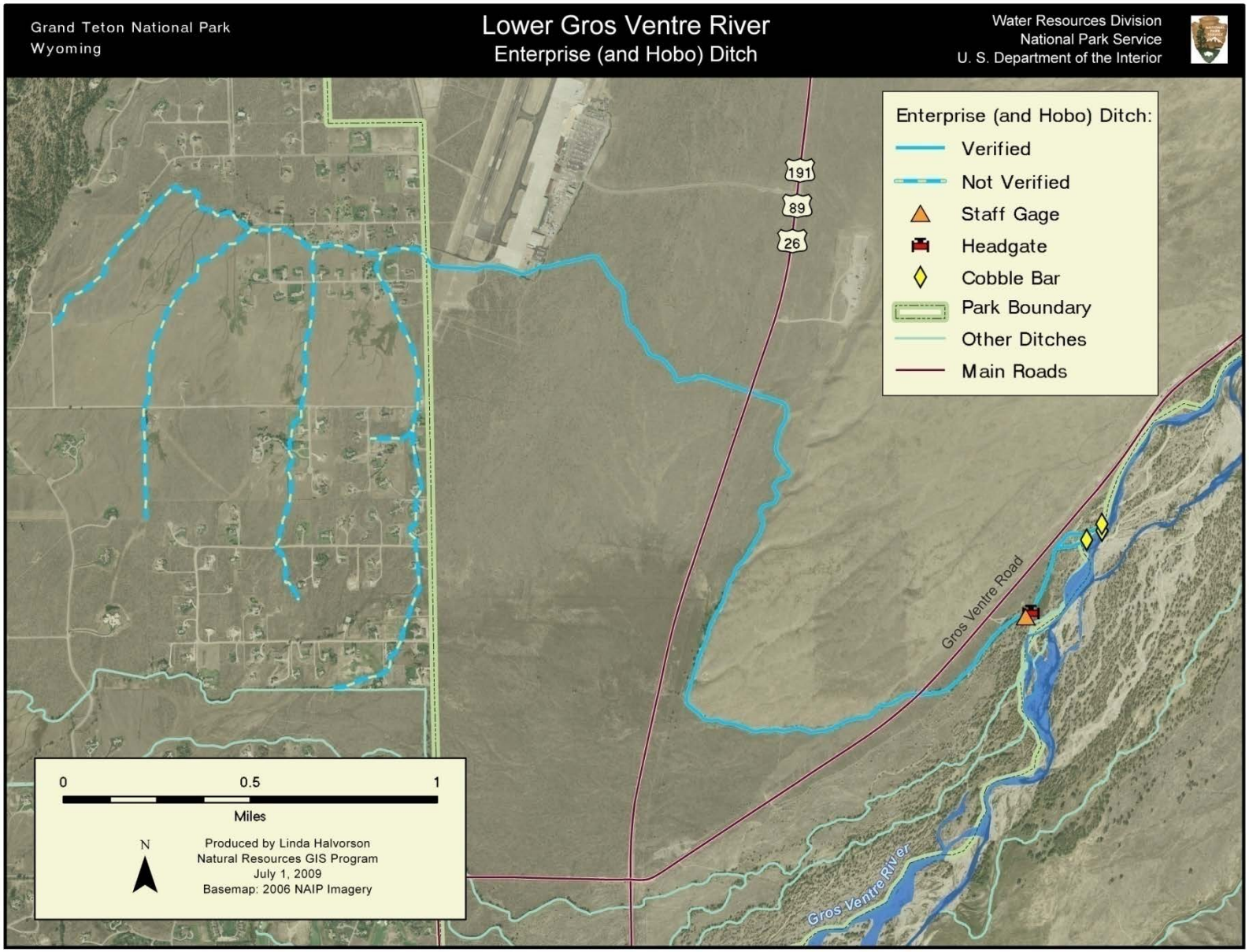


Figure 37. Enterprise (and Hobo) Ditch location map, Gros Ventre River, Teton County.



Figure 38. Looking downstream at the cobble bars at the Enterprise Ditch point of diversion. Date: 5/9/2008. Source: Miller



Figure 39. Looking downstream at debris in Enterprise Ditch headgates. Date: 6/29/2006. Source: Gerber



Figure 40. Looking upstream at beaver dam debris removed from Enterprise headgates. Date: 8/23/2006. Source: Miller

d. Discharge Measurements

Twenty-seven discharge measurements were collected on Enterprise Ditch during the 2006–2008 field seasons and are listed in Table 30. Discharge measurements ranged from 1.43 cfs to 28.5 cfs with an average of 9.44 cfs. Four measurements exceeded the total direct adjudicated water rights. The NPS-WRD installed and surveyed a staff plate on Enterprise Ditch on May 9, 2008 (Figure 42). Readings from the staff plate at corresponding measured discharges were used to establish a stage-discharge relationship and to develop a rating table (Table 31).

Table 30. Enterprise Ditch discharge measurements

Date	Discharge (cfs)	Comments
6/28/2006	9.27	
7/28/2006	24.9	
8/17/2006	2.44	Ben Haas, Water Manager for Enterprise Ditch, came out and opened headgate while we were doing measurement
8/17/2006	15.6	Measured second time because headgates opened while on site
8/23/2006	4.04	
9/14/2006	7.39	
7/24/2007	1.43	
8/3/2007	5.03	Left bank headgate may not be able to close completely open ~2.1 feet, right headgate open ~1.5 feet
8/10/2007	3.99	Headgates open
8/17/2007	4.13	Headgates open
8/24/2007	6.41	Headgates open
9/7/2007	5.44	Headgates open, leakage back to GVR on left about 5' upstream from headgate
10/25/2007	7.19	Headgates open
5/30/2008	5.41	Headgates open
6/16/2008	22.0	Headgates open, right headgate letting most of flow, left headgate down, irrigators sandbagged the overflow on left bank upstream of headgate, but still spilling over
6/30/2008	28.5	Headgates open
7/2/2008	28.0	Right headgate open
7/9/2008	18.2	Headgates open
7/16/2008	5.21	Right bank headgate open, sandbag on left bank upstream of headgate to prevent water flow away from diversion
8/1/2008	17.0	Headgates open
8/7/2008	9.95	Right headgate open
8/13/2008	7.77	Headgates open
8/28/2008	2.37	
9/4/2008	4.23	
9/20/2008	2.59	Headgates open
10/10/2008	3.19	Right bank headgate open, left bank headgate closed
10/21/2008	3.11	Headgates closed, but still leaking
Average	**9.44**	

e. Summary

The majority of the Enterprise Ditch water rights are privately held; the remainder are held by GRTE. State records for the federal water rights still reflect the original appropriator. GRTE was not diverting from this ditch during the study period. The privately held rights total 12.95 cfs, though diversions of up to 28.5 cfs have been measured. During 26 percent of the flow measurements, diversions exceeded private adjudicated water rights.



Figure 41. Looking downstream at Enterprise Ditch headgates. Date: 10/05/2007. Source: Gerber



Figure 42. Staff plate on Enterprise Ditch looking from right bank. Date: 5/9/2008. Source: Gerber

Table 31. Enterprise Ditch rating table

U.S. DEPARTMENT OF THE INTERIOR – NATIONAL PARK SERVICE - WATER RESOURCE DIVISION

STATION NAME: Gros Ventre River - Enterprise Ditch SOURCE AGENCY: USNPS
Date Processed: 10/26/2009 14:32:57 MST By ggerber
Rating for Discharge (cfs)
RATING ID: 0001 TYPE: Stage-Discharge

Offset1: 0.00 Offset2: 0.65
Breakpoint1: 0.68

EXPANDED RATING TABLE

Stage (ft)	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
					Discharge (cfs)					
0.20										2.37
0.30	2.43	2.51	2.59	2.69	2.80	2.94	3.13	3.36	3.62	3.96
0.40	4.34	4.78	5.20	5.60	5.97	6.33	6.67	7.02	7.37	7.73
0.50	8.09	8.46	8.84	9.22	9.62	10.0	10.4	10.9	11.3	11.7
0.60	12.2	12.6	13.1	13.6	14.1	14.6	15.1	15.7	16.3	16.9
0.70	17.6	18.3	19.0	19.6	20.1	20.6	21.0	21.4	21.8	22.2
0.80	22.5	22.8	23.1	23.4	23.7	24.0	24.2	24.5	24.7	24.9
0.90	25.2	25.4	25.6	25.8	26.0	26.2	26.4	26.6	26.7	26.9
1.00	27.1	27.2	27.4	27.6	27.7	27.9	28.0	28.2	28.3	28.5
1.10	28.6	28.7	28.9	29.0	29.1	29.3	29.4	29.5	29.6	29.7
1.20	29.9	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.8	

5. Wild Cherry (and Newton Nickell and Glidden) Ditch

a. Description

The Wild Cherry Ditch point of diversion is on the south side of the GVR about 0.6 miles east of Hwy 89/191 within the NER (Figure 43). Wild Cherry, Newton Nickell, and Glidden ditches share the same point of diversion (WYSEO ~1920, 1999). In this Appendix, the "Wild Cherry Ditch" will include the Newton Nickell and Glidden Ditches. The point of diversion for the Wild Cherry Ditch is a series of large cobble mounds directing GVR water into the ditch (Figure 44). No headgate was located. The point of diversion is directly downstream from a pond on the NER (Figure 45). An overflow culvert directs water from NER pond to the ditch and supplements ditch flow (Figure 46). The ditch is deep and narrow in most places and is not capable of carrying more than 25–30 cfs without flowing overbank. The ditch flows south and then southwest for about 1.0 mile and passes under the 89/191 Highway. The ditch enters GRTE and continues another 0.9 miles until it crosses onto private land. The ditch was not field verified beyond this point.

b. Condition

The NER pond levee directly upstream of the Wild Cherry Ditch point of diversion is eroding (Figure 47). Although some channel erosion is associated with the natural migration of the GVR, it is likely exacerbated by cobble bar construction in the active channel directing flow to the Wild Cherry Ditch point of diversion. NER staff were concerned about a possible levee breach, so the pond levee was repaired by the NER in 2007 (Figure 48). Aerial photographs from 1994, 2002, and 2006 indicate bank erosion of up to 40 feet per year (Figure 49).

c. Water Rights

Both federal and private water rights exist on Wild Cherry Ditch, the majority belonging to GRTE. Priority dates for these water rights range from 1900–1913 (WYSEO 1999). The federally owned water rights acquired still identify the original appropriator in WYSEO files. Federal lands were not irrigated during the study period, although the ditch still operated at full capacity. HDR's review of the aerial imagery found evidence of irrigation on private lands near the terminus of the ditch (HDR 2009).

Table 32. Wild Cherry (and Newton Nickell and Glidden) Ditch adjudicated water rights

Ditch	Ownership	Adjudicated Water Rights (WYSEO 1999, Hayden 1989, and HDR 2009)			
		Direct (cfs)	Supplemental (cfs)	Total (cfs)	Total (cfs)
Wild Cherry, Newton Nickell, and Glidden	Private	2.57	0	2.57	12.28
	NER	1.76	0	1.76	
	GRTE	7.95	0	7.95	

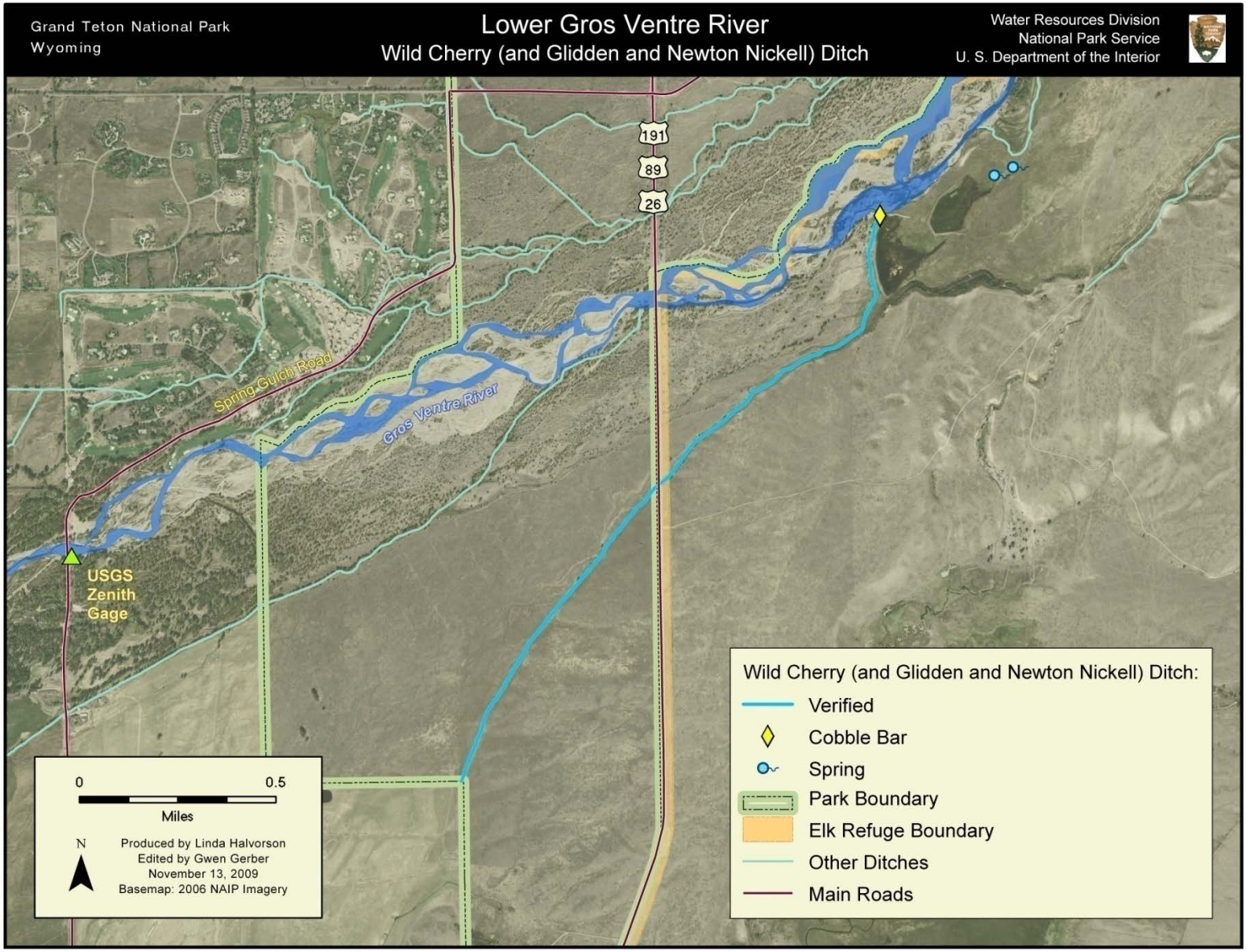


Figure 43. Wild Cherry (and Newton Nickell and Glidden Ditch) location map, Gros Ventre River, Teton County.



Figure 44. Looking downstream at cobble bars directing Gros Ventre River water to Wild Cherry point of diversion. Date: 10/19/2006. Source: Gerber



Figure 45. National Elk Refuge pond looking southwest from levee adjacent to Gros Ventre River. Date: 7/25/2007. Source: Gerber



Figure 46. Overflow culvert from National Elk Refuge pond. Date: 10/19/2006. Source: Miller

d. Discharge Measurements

Discharge data were collected in 2005 and 2006 by Teton Science School (Patterson 2007) and by NPS-WRD in 2008 (Table 33). Measured flows ranged between 0.1 and 22.3 cfs with an average of 9.17 cfs. Seven measurements exceeded the total direct adjudicated water rights. Since Wild Cherry Ditch was blocked off in November 2007 during levee work, no staff plate was installed on the ditch. Sometime between June 16, 2008, and July 2, 2008, irrigators re-opened the ditch.

Table 33. Wild Cherry Ditch discharge measurements

Date	Discharge (cfs)	Comments
7/19/2005	17.9	Data from Patterson 2007
8/4/2005	~0.1	
8/24/2005	~0.1	
9/22/2005	0.3	
5/18/2006	0.4	
6/9/2006	22.3	
6/20/2006	1.6	
7/3/2006	16.7	
7/14/2006	22.3	
7/21/2006	18.4	
7/28/2006	5.2	
8/9/2006	~0.1	
10/5/2007	No discharge measurement performed	Dry
10/18/2007		Dry
11/16/2007		Bulldozer parked at pond, worked on NER/pond levee, no water in ditch, blocked with bulldozer
5/9/08	0.00	Ditch completely blocked off by fall 2007 NER pond work, no staff plate installed
6/16/2008	4.54	Cobble bar still intact near pond, flow has eroded around west side of cobble bar to allow flow into ditch
7/2/2008	12.8	Lots of earth and cobble moved since last visit, backwater channel of GVR goes down newly opened ditch- spurs on the left bank also direct flow into ditch
7/15/2008	14.8	Massive cobble bar movement, dredging of depth also took place ~2 weeks ago
9/17/2008	No discharge measurement performed	Ditch blocked off, no flow
10/20/2008		Dry, Fuez Excavation (Pete Fuez) - contracted to stabilize levy - hired by Audobon Society, will not be working in river during seepage run
Average[1]	**9.17**	

[1]Average of non-zero measurements

e. Summary

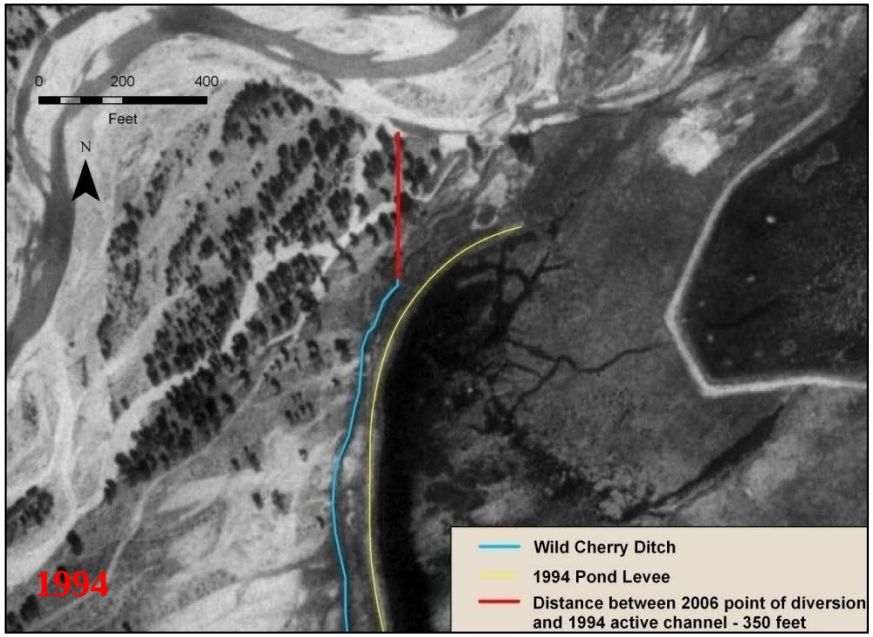
Both private and federal water rights are conveyed through the Wild Cherry Ditch. The privately held rights are still exercised through the Wild Cherry Ditch to irrigate lands at the ditch's terminus. State records for the federal water rights still reflect the original appropriator. Federal lands were not irrigated during the study period. Privately held rights total 2.57 cfs, though diversions of up to 22.3 cfs have been measured. During 60 percent of the flow measurements, diversions exceeded private adjudicated water rights.

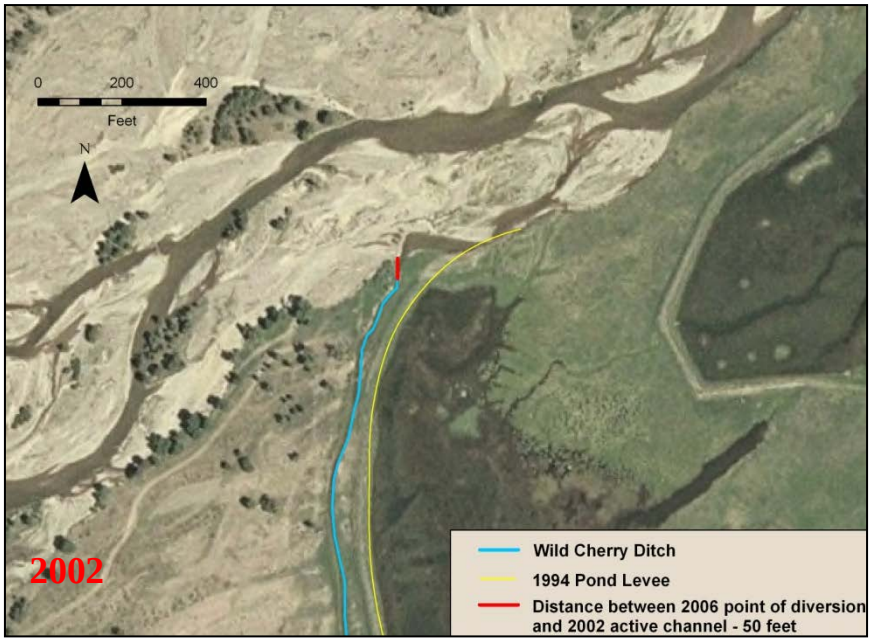


Figure 47. National Elk Refuge eroding pond levee, looking downstream. Date: 7/25/2007. Source: Gerber



Figure 48. National Elk Refuge repaired pond levee, looking upstream. Date: 5/9/2008. Source: Gerber





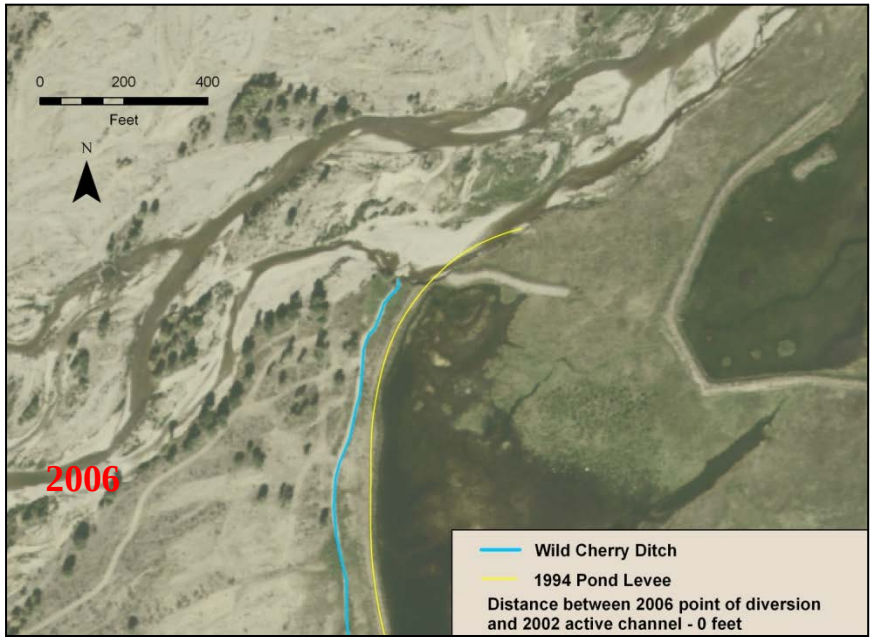


Figure 49. Aerial Photos from 1994, 2002, and 2006 showing left bank erosion and encroachment towards the National Elk Refuge pond.

6. Price and Lucas Ditch

a. Description

The Price and Lucas Ditch is located on the north side of the GVR about 0.3 miles east of Highway 89/191 (Figure 50). The point of diversion is a series of cobble mounds located approximately one mile upstream of the headgate. The headgate is a wooden "T" headgate which splits the ditch into two separate ditches (Figure 51). The ditch that flows west/northwest is the Price and Lucas Ditch. The ditch that flows southwest is a branch of the May White Ditch (Section 7). The Price and Lucas Ditch flows west/southwest for approximately 0.3 miles before it passes under Highway 89/191 through three culverts. The ditch continues another 0.5 miles before it turns north and passes underneath Spring Gulch Road. The ditch continues another 0.2 miles within GRTE where it passes underneath a road into private land. The ditch was not field verified beyond the GRTE boundary; aerial photography was used to digitize the location of the ditch within private lands.

b. Condition

Flow from the GVR into the headgates is controlled by cobble bars. Flow through the T-headgate is controlled by wooden slats (Figure 52). The headgate is in fair condition. When the headgate is closed there is significant leakage around the wooden slats and under the wood base of the headgate. Almost seven cfs was measured leaking through the headgates when closed. The ditch is in good condition and is capable of carrying up to 30 cfs (Figure 54).

c. Water Rights

Only private water rights exist for the Price and Lucas Ditch (Table 34). Priority dates for the 5.22 cfs of direct flow water rights range from 1900–1903. A direct flow appropriation with a priority date of 1991 for 14 cfs allows the filling of Teton Cascade Reservoirs, not to exceed 8.49 acre-feet in any one year (HDR 2009). According to HDR (2009) private landowners are currently using the Price and Lucas Ditch to irrigate lawns and landscapes surrounding individual homes and a small strip of agricultural lands.

Table 34. Price and Lucas Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999 and HDR 2009)			
Ditch	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**	**Reservoir Supply**
Price and Lucas	5.22	0	5.22	14 cfs (8.49 acre feet per year)

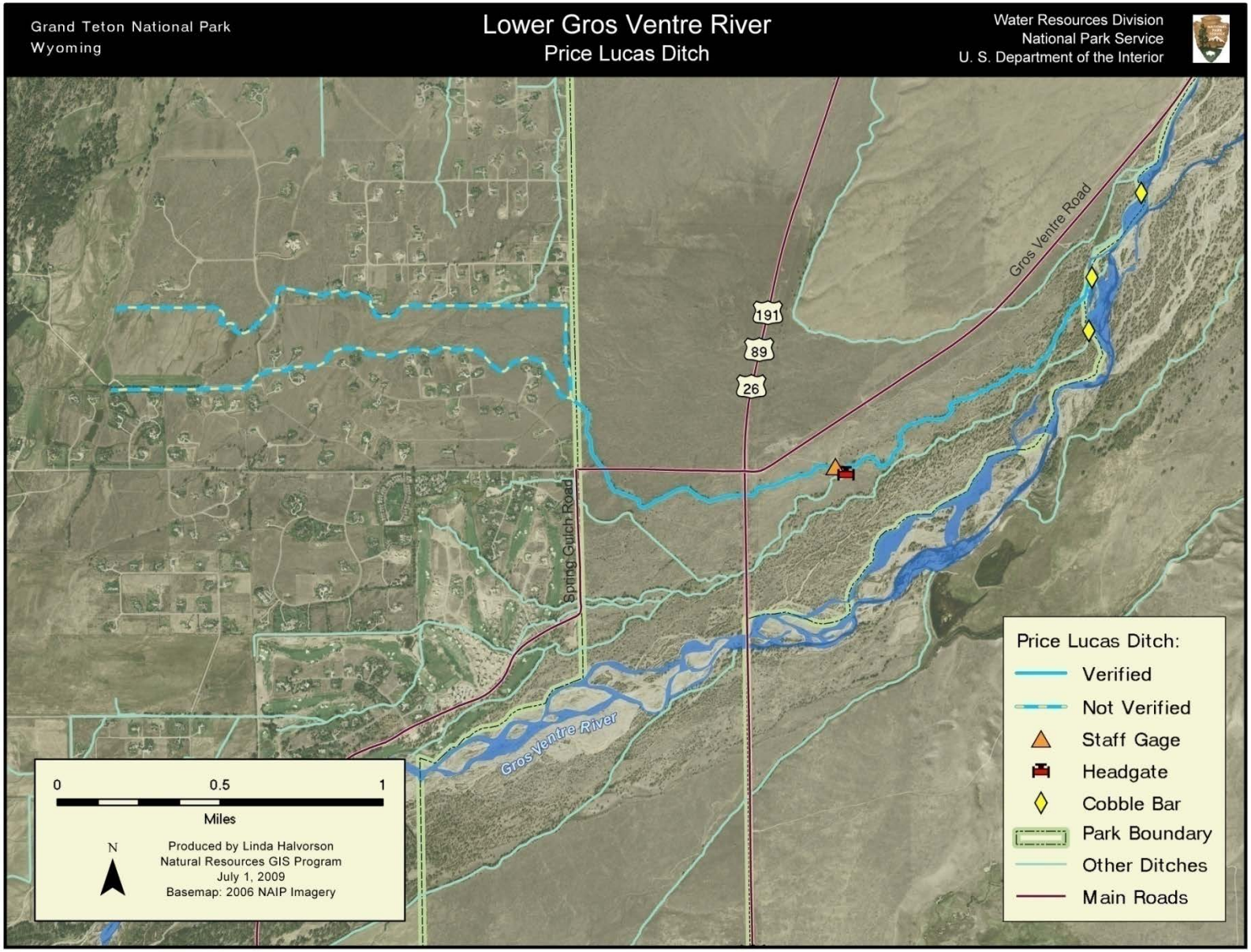


Figure 50. Price and Lucas Ditch location map, Gros Ventre River, Teton County.

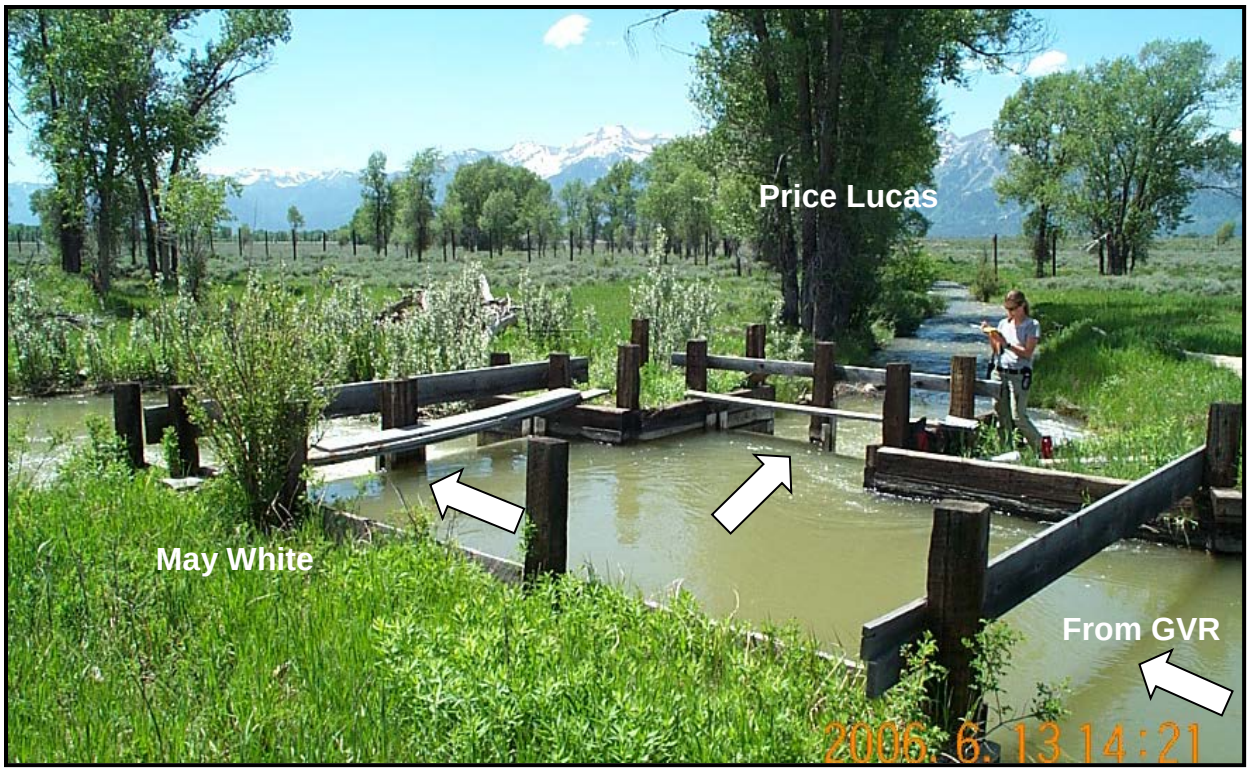


Figure 51. Price and Lucas Ditch T-headgates. Looking downstream at Price Lucas Ditch (center); May White Ditch on left. Date: 6/13/2006. Source: Miller



Figure 52. Price and Lucas Ditch headgates looking upstream. Date: 10/05/2007. Source: Patterson



Figure 53. Price and Lucas Ditch at 27.8 cfs looking upstream (near ditch capacity). Date: 06/04/2008 Source: Patterson



Figure 54. Price and Lucas Ditch staff plate. Date: 05/09/2008 Source: Gerber

d. Discharge Measurements

Twenty-one discharge measurements were collected during the 2006–2009 field seasons (Table 35). Discharges ranged from 0.802 to 30.3 cfs with an average of 13.3 cfs. Twenty of the measurements exceeded the total direct adjudicated water rights. The NPS-WRD installed and surveyed a staff plate on Price Lucas Ditch on May 9, 2008 (Figure 54). Readings from the staff plate at corresponding measured discharges were used to establish a stage-discharge relationship and to develop a rating table (Table 36).

Table 35. Price Lucas Ditch discharge measurements

Date	Discharge (cfs)	Comments
8/2/2006	9.54	
8/17/2006	30.3	
8/23/2006	21.3	
9/13/2006	20.3	
7/24/2007	5.35	
8/3/2007	0.00	No water flow
8/10/2007	0.802	Headgates open, had to find transect area deep enough to measure
8/17/2007	0.00	Dry - no water
8/24/2007	19.2	Headgates open
9/7/2007	25.3	Headgates open
10/25/2007	6.64	Headgates open
11/15/2007	< 1	No discharge measurement performed
6/4/2008	27.8	Headgates open
6/17/2008	20.6	Headgates open
7/2/2008	15.6	Headgates open
7/9/2008	13.2	Headgates open, no boards in headgate
7/16/2008	14.8	Headgates open, no boards in headgate
8/1/2008	12.0	Headgates open
8/7/2008	6.86	Both headgates open
8/13/2008	4.31	Headgates open, no boards in headgates
8/28/2008	9.59	Headgates status not noted
9/4/2008	6.18	One board up on both left and right sides of gate
9/20/2008	6.72	Headgates closed, only flow is from seepage/leakage under/around boards
10/10/2008	5.48	Headgates closed
10/20/2008	0.00	Dry, headgates closed
9/3/2009	11.4	
Average[1]	**13.33**	

[1]Average of non-zero measurements

e. Summary

The Price Lucas Ditch is being used by private landowners; GRTE does not own any water rights served by this ditch. A total of 5.22 cfs is adjudicated for this ditch and up to 30.3 cfs were measured by NPS. During 91 percent of the flow measurements, diversions exceeded total direct adjudicated water rights.

Table 36. Price Lucas Ditch rating table

U.S. DEPARTMENT OF THE INTERIOR – NATIONAL PARK SERVICE - WATER RESOURCE DIVISION

STATION: Gros Ventre River Price Lucas Ditch SOURCE AGENCY: USNPS
Date Processed: 10/26/2009 12:22:53 MST By ggerber
Rating for Discharge (cfs)
RATING ID: 0001 TYPE: Stage-Discharge

Offset1: 0.00 Offset2: 0.65
Breakpoint1: 0.91

EXPANDED RATING TABLE

Stage (ft) →	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
↓					**Discharge (cfs)**					
0.60									4.08	4.19
0.70	4.31	4.44	4.56	4.68	4.81	4.94	5.07	5.20	5.33	5.49
0.80	5.65	5.85	6.07	6.36	6.67	6.98	7.30	7.63	7.97	8.32
0.90	8.68	9.05	9.42	9.79	10.2	10.5	10.9	11.3	11.6	12.0
1.00	12.4	12.8	13.1	13.5	13.9	14.3	14.6	15.0	15.4	15.8
1.10	16.1	16.5	16.9	17.3	17.7	18.0	18.4	18.8	19.2	19.6
1.20	19.9	20.3	20.7	21.1	21.5	21.8	22.2	22.6	23.0	23.4
1.30	23.8	24.1	24.5	24.9	25.3	25.7	26.1	26.4	26.8	27.2
1.40	27.6	28.0	28.4	28.8	29.2	29.5	29.9	30.3	30.7	31.1
1.50	31.5	31.9	32.3	32.6	33.0	33.4	33.8	34.2	34.6	35.0
1.60	35.4	35.8	36.2	36.5	36.9	37.3	37.7	38.1	38.5	38.9
1.70	39.3	39.7	40.1	40.5	40.9	41.3				

7. May White (and Buckskin, Cyclone, and Mayers and Nichols) Ditch

a. Description

Field investigations in 2006–2008 indicate that the May, White, Buckskin, Cyclone, and Mayers and Nichols ditches share two points of diversion (Figure 55). In this Appendix, the "May White Ditch" will include the May, White, Buckskin, Cyclone, and Mayers and Nichols ditches. The first point of diversion is a series of cobble mounds that direct water through the southwest branch of the Price Lucas "T" headgate (as discussed in section 6). The second point of diversion is approximately 900 feet downstream from the first and directs water approximately 1.3 miles to its confluence with the southwest branch from the Price Lucas headgate (Figure 56, Figure 57). This second branch of the May White Ditch is depicted on historical linen plat maps as the "Star Ditch." The ditch is north of the GVR and is controlled by cobble bars. The two branches of the May White Ditch converge approximately 300 feet upstream from Highway 89/191 and is shown as the "May White Confluence" in Figure 56. After the ditch passes under Highway 89/191, four secondary ditches divert water from the main May White Ditch.

Each of the four secondary ditches are controlled by its own headgate. The first ditch, the May Ditch, is about 300 feet west of the highway (Figure 58). The second ditch, the Cyclone Ditch, splits from the main May White Ditch approximately 1,000 feet below the May Ditch (Figure 59). The third ditch, the Buckskin Ditch, splits from the main May White Ditch about 250 feet downstream of the Cyclone Ditch (Figure 60). The May, Cyclone, and Buckskin ditches travel through GRTE 0.6, 0.3, and 0.25 miles, respectively, before they pass underneath Spring Gulch Road and enter the developments surrounding Jackson Hole Golf and Tennis Club. The ditches were not field verified past this point. The last ditch, the White Ditch, splits from the main ditch within private property about 0.5 miles downstream from the Buckskin Ditch. Undirected flow remaining in the main May White Ditch re-enters the GVR at the Jackson Hole Golf and Country Club on the north side of the GVR, about 0.5 miles downstream from the White Ditch headgate via the "May White Return" (Figure 56, Figure 61). The White Ditch diversion and the portion of the main May White Ditch within private property were not field verified.

b. Condition

The May White ditches and headgates that were field verified are in good condition. The main May White Ditch is capable of carrying over 200 cfs. The secondary ditches (May, Cyclone, Buckskin, and White) are much smaller and may not be able to convey more than 10–15 cfs each.

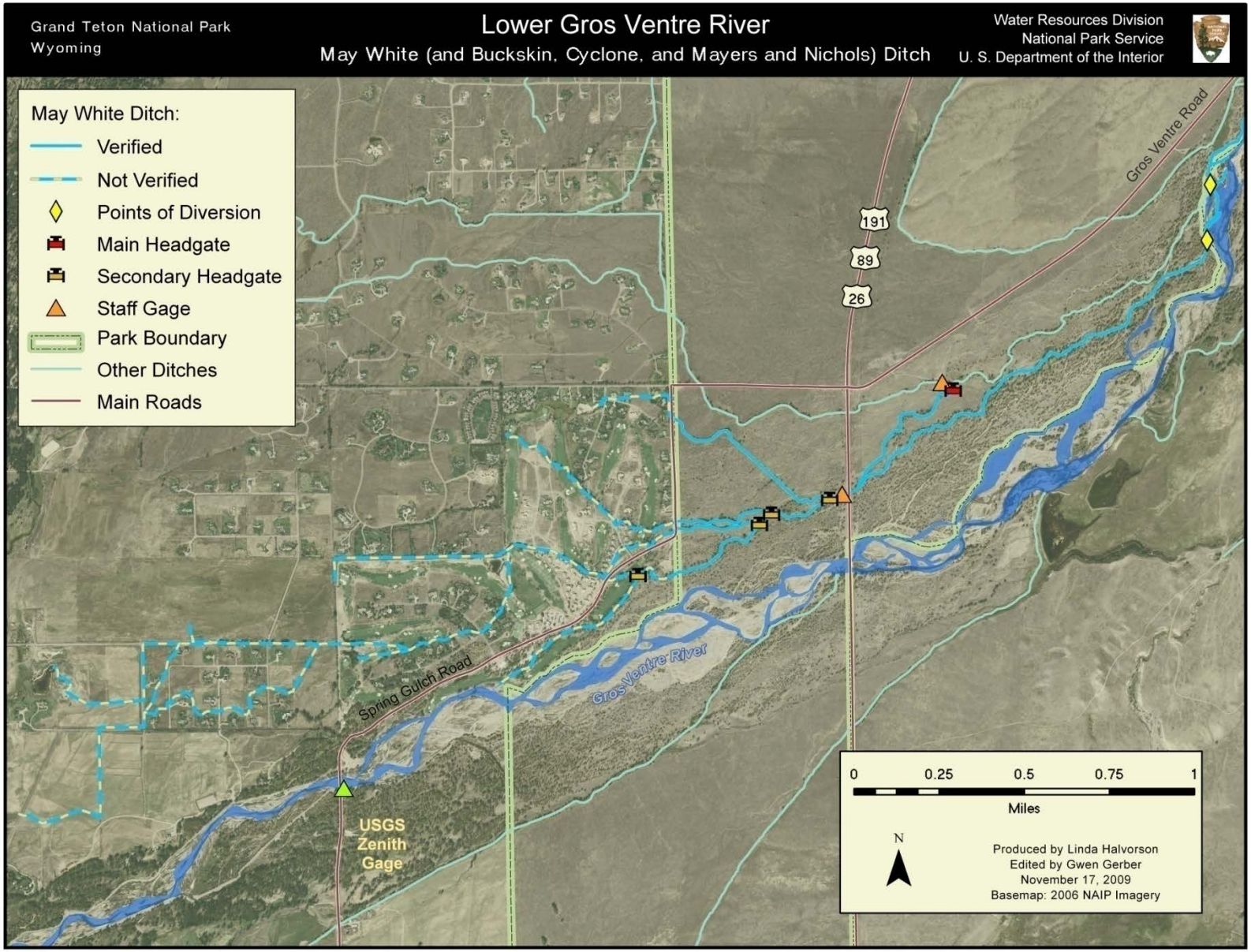


Figure 55. May White Ditch location map, Gros Ventre River, Teton County.

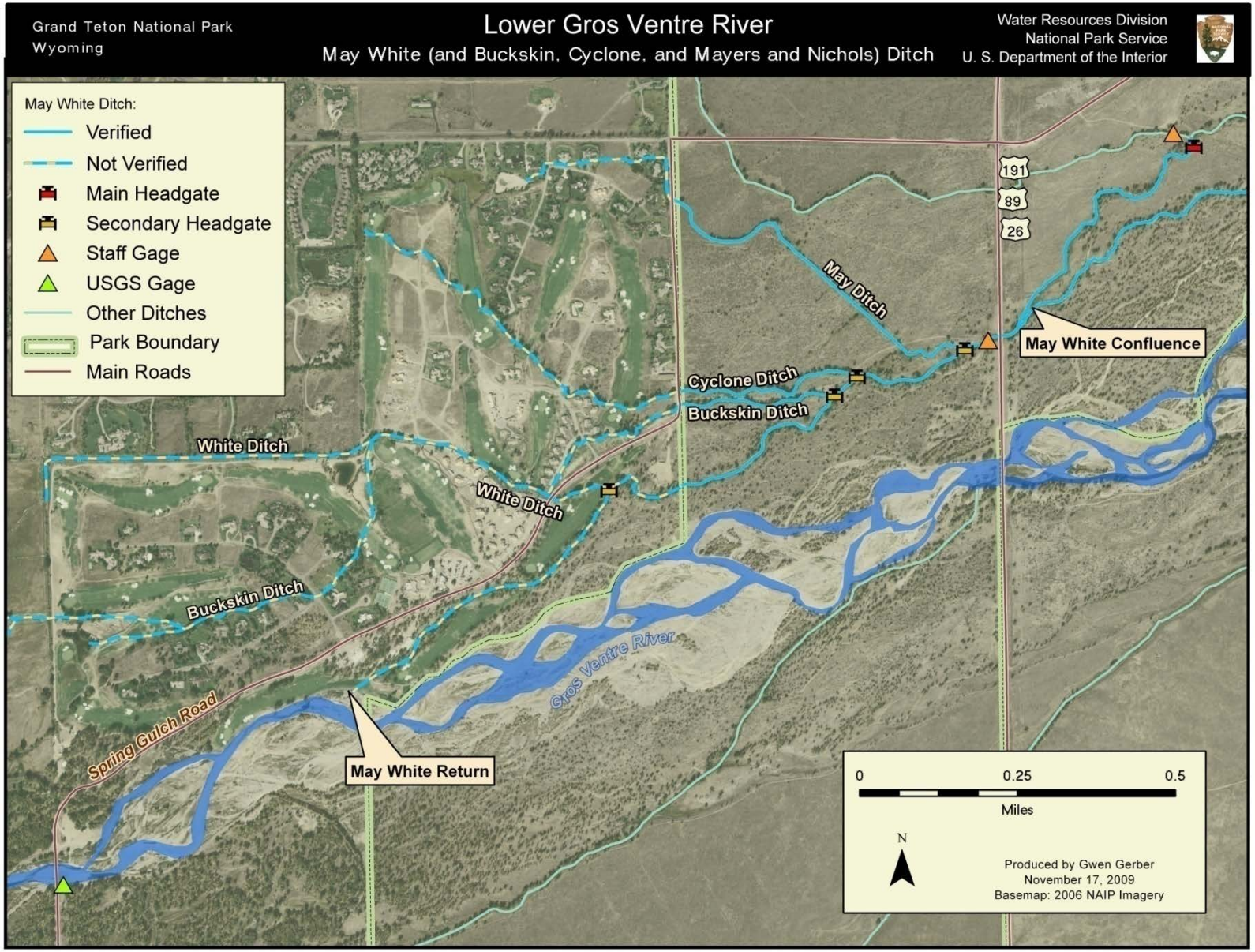


Figure 56. May, White, Buckskin, and Cyclone ditch location map, Gros Ventre River, Teton County.

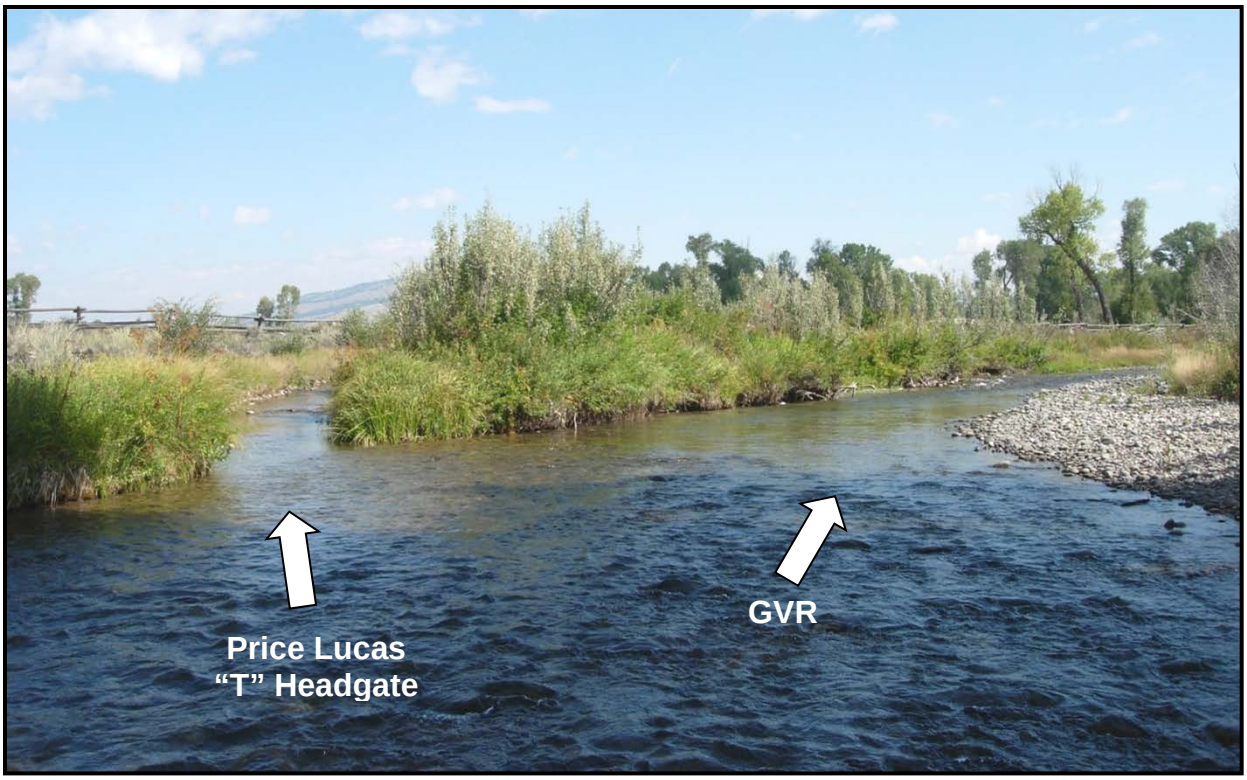


Figure 57. May White Ditch confluence looking upstream. Date: 9/7/2007. Source: Patterson



Figure 58. May Ditch headgate looking downstream. Date: 7/24/2007. Source: Gerber





Figure 59. Cyclone Ditch headgate (looking downstream). Date: 8/31/2004. Source: Corbin
Figure 60. Buckskin Ditch headgate (looking downstream). Date: 8/13/2004. Source: Corbin

c. Water Rights

Water rights for May White Ditch are listed in Table 37. Priority dates range from 1894–1945. All water rights from the May White Ditch are privately owned except for 0.28 cfs from the Mayers and Nichols Ditch which is owned by GRTE and the original appropriator is still identified in WYSEO files. The Mayers and Nichols Ditch no longer exists; private water rights attached to that ditch were changed to divert through the May Ditch. GRTE was not diverting water during the study period.

Table 37. White (and May, Buckskin, Cyclone, and Mayers-Nichols) Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999, HDR 2009)					
Ditch	**Ownership**	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**	**Total (cfs)**	**Reservoir Supply**
White	Private	9.25	0	9.25	17.40	20.28 acre feet
May		0.57	0	0.57		
Buckskin		3.12	0	3.12		
Cyclone		4.18	0	4.18		
Mayers and Nichols	GRTE	0.28	0	0.28		

Private water rights associated with the May White Ditch are used by the golf course and on the lawns and for landscaping around individual homes. Agricultural use exists near the terminus of the Buckskin and White ditches.

The May and Buckskin ditches also provide up to 20.28 annual acre feet to fill reservoirs within Jackson Hole Golf and Tennis Club (HDR 2009). Reservoir water is also supplemented by groundwater wells.



Figure 61. Return flow from May White Ditch to Gros Ventre River. Date: 7/18/2006. Source: Miller

d. Discharge Measurements

Nineteen discharge measurements ranging from 6.23 to 126 cfs with an average of 32.5 cfs were made on the May White Ditch in the 2006–2009 field seasons (Table 38). Fourteen measurements exceeded total direct adjudicated water rights. Discharge measurements were taken below the May White confluence and above May Ditch so that all the flow diverted from the GVR conveyed through the May White Ditch would be measured.

The NPS-WRD installed and surveyed a staff plate on May White Ditch on May 9, 2008 (Figure 62). Readings from the staff plate at corresponding measured discharges were used to establish a stage-discharge relationship and to develop a rating table, see Table 39. Although the highest discharge measured during the study period was 126 cfs, the ditch is capable of carrying almost double that flow. Field staff were unable to safely wade the ditch during higher flows but staff gage readings over three feet[16] were observed (see inset to Figure 62).

The May White Return Ditch returns diverted but unused water. Three discharge measurements were made on the May White Return ranging from 0.43 to 3.21 cfs (Table 38).

[16] The highest point on the rating estimates flows of 207 cfs at 2.67 feet (Table 39).

Table 38. May White Ditch discharge measurements

May White Ditch			May White Return
Date	**Discharge (cfs)**	**Comments**	**Comments**
8/25/2006			3.21 cfs measured
9/14/2006			1.63 cfs measured
10/18/2006	39		
7/24/2007	6.95		
8/3/2007	9.77		Not enough flow to perform measurement
8/10/2007	17.9		Not enough flow to perform measurement
8/17/2007	15.8		Barely measureable, discharge = 0.434
8/24/2007	18.6	Headgates open, May headgates being adjusted during site visit.	Inadequate flow for measurement - water goes subsurface before entering channel
9/7/2007	14.9		
10/25/2007	20.4	Headgates open	Flow estimate = 10-12 cfs
11/15/2007	0.00	Dry, ditch closed off on 11/3	Dry
6/17/2008	No measurement taken	Headgates open, too high to safely wade, overflowing banks	Very high, definitely returning to main GVR channel
7/2/2008		Headgates open, too high to wade safely	
7/15/2008	95.2	Headgates open	
7/23/2008	126	Headgates open	
8/1/2008	71.7	Headgates open	
8/7/2008	49.9	Headgates open	
8/13/2008	40.2	Headgates open	
8/28/2008	12.4	Headgate status not noted	Estimated return flow approximately 2 cfs.
9/4/2008	26.5	Headgate status not noted	Flow up since last visit - estimated 2-5 cfs returning to GVR
9/19/2008	18.4	Headgates open	
9/20/2008	18.2	Headgates open	approximately 2-3 cfs flowing to GVR
10/10/2008	18.5	Headgates open	Returning to GVR, ~5-10 cfs
10/16/2008	23.8	Headgates open	
10/20/2008	0.00	Dry, ditch closed on 10/18	Dry
9/3/2009	6.23		
Average[1]	**32.5**		

[1]Average of non-zero measurements

e. Summary

The May White Ditch was being used solely by private landowners during the study period. GRTE owns 0.28 cfs from this ditch but was not diverting during the study period. A total of 17.12 cfs of private water rights are adjudicated for this ditch and up to 126 cfs were measured. Diversions exceeding 200 cfs have been estimated for the May White Ditch when flows were too high to measure. During 70 percent of the measurements, diversions exceeded direct adjudicated water rights. Any water diverted to May White Ditch that goes unused by May, Cyclone, Buckskin, and White ditches returns to the GVR just above the Spring Gulch Road Bridge.



Figure 62. May White Ditch staff plate from left bank. Date: 5/9/2008. Source: Gerber. Inset: Staff Plate at high flows. Date 5/20/2008. Source: Patterson

Table 39. May White Ditch rating table

U.S. DEPARTMENT OF THE INTERIOR – NATIONAL PARK SERVICE - WATER RESOURCE DIVISION
STATION: Gros Ventre River - May White Ditch SOURCE AGENCY: USNPS
Date Processed: 10/26/2009 10:19:41 MST By ggerber
Rating for Discharge (cfs)
RATING ID: 0001 TYPE: Stage-Discharge

Offset1: 0.17 Offset2: 0.76
Breakpoint1: 0.93

EXPANDED RATING TABLE

Stage (ft) ⟶	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
					Discharge (cfs)					
0.50						5.28	5.57	5.87	6.18	6.50
0.60	6.82	7.15	7.49	7.84	8.20	8.56	8.94	9.32	9.71	10.1
0.70	10.5	10.9	11.3	11.8	12.2	12.7	13.1	13.6	14.0	14.5
0.80	15.0	15.5	16.0	16.5	17.0	17.6	18.1	18.7	19.2	19.8
0.90	20.3	21.0	21.7	22.4	23.4	24.3	25.3	26.5	27.6	28.8
1.00	30.0	31.2	32.4	33.5	34.7	35.8	37.0	38.2	39.3	40.5
1.10	41.6	42.8	43.9	45.0	46.2	47.3	48.5	49.6	50.7	51.9
1.20	53.0	54.1	55.2	56.4	57.5	58.6	59.7	60.8	61.9	63.1
1.30	64.2	65.3	66.4	67.5	68.6	69.7	70.8	71.9	73.0	74.1
1.40	75.2	76.3	77.4	78.5	79.6	80.7	81.8	82.9	83.9	85.0
1.50	86.1	87.2	88.3	89.4	90.4	91.5	92.6	93.7	94.8	95.8
1.60	96.9	98.0	99.1	100	101	102	103	104	106	107
1.70	108	109	110	111	112	113	114	115	116	117
1.80	118	119	120	121	123	124	125	126	127	128
1.90	129	130	131	132	133	134	135	136	137	138
2.00	139	140	141	142	144	145	146	147	148	149
2.10	150	151	152	153	154	155	156	157	158	159
2.20	160	161	162	163	164	165	166	167	168	169
2.30	170	172	173	174	175	176	177	178	179	180
2.40	181	182	183	184	185	186	187	188	189	190
2.50	191	192	193	194	195	196	197	198	199	200
2.60	201	202	203	204	205	206	207			

8. Spring Gulch (and Anderson) Ditch

a. Description

Spring Gulch Ditch is located on the south side of the GVR just west of Highway 89/191 (Figure 63). The Spring Gulch Ditch also serves as the point of diversion for Anderson Ditch. The point of diversion and means of conveyance for the Anderson Ditch were changed to the Spring Gulch Ditch (HDR 2009). In this Appendix, the "Spring Gulch Ditch" will include the Anderson Ditch.

Spring Gulch Ditch is one of the largest conveyors of GVR water. Cobble mounds direct flows from the GVR to a large concrete headgate (Figure 65, Figure 67). The ditch travels 1.3 miles in a southwesterly direction until it leaves GRTE. The ditch was not field verified past this point. Based on aerial photographs the ditch travels southwest another 0.6 miles before it passes under Spring Creek Road. The ditch continues for another three miles in a south-southwest direction delivering water to irrigate ranch lands within the Spring Creek watershed and to supplement Spring Creek. The GVR is often dry downstream of the Spring Gulch Ditch headgates during the late summer (Figure 66).

b. Condition

Spring Gulch Ditch and the headgates are in good condition although leakage of up to 10 cfs has been measured when headgates are closed (Figure 67). The ditch is capable of carrying upwards of 200 cfs. Large piles of excavated cobble line the ditch around the headgate adjacent to Highway 89/191.

c. Water Rights

Water rights for Spring Gulch and Anderson Ditches are privately owned (Table 40) and are currently being used to irrigate over 2,000 acres (HDR 2009). Priority dates range from 1898–1921.

Table 40. Spring Gulch and Anderson adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999 and HDR 2009)			
Ditch	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**	**Total (cfs)**
Spring Gulch	28.74	0	28.74	31.45
Anderson	2.71	0	2.71	

d. Discharge Measurements

Forty-four discharge measurements were made at Spring Gulch Ditch during 2005–2009. Discharge data were collected in 2005 and 2006 by Teton Science School (Patterson 2007) and by NPS-WRD in 2006–2009 (Table 41). Discharge measurements ranged from 3.10 to 174 cfs with an average of 60.0 cfs. Thirty measurements exceeded the total direct adjudicated water rights.

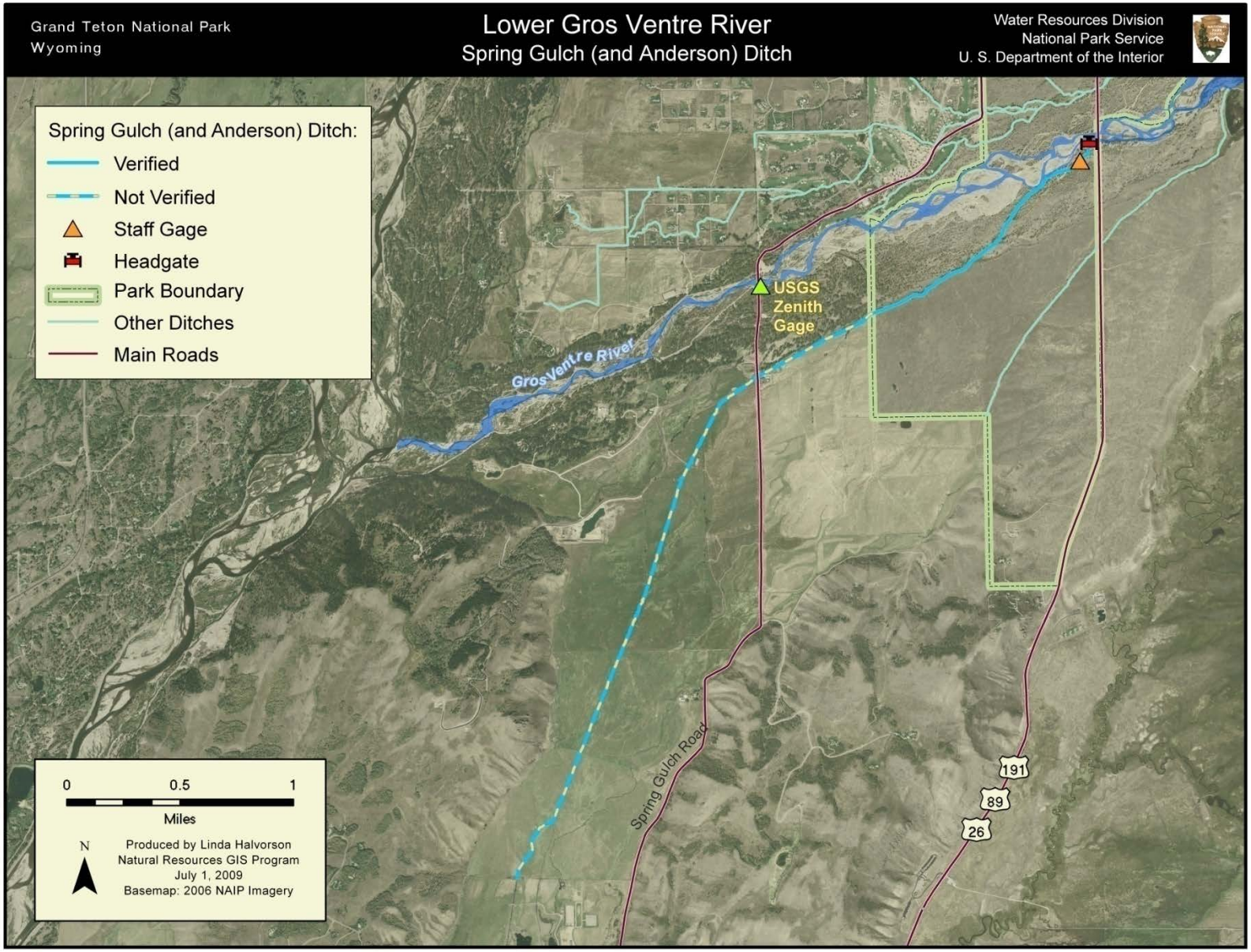


Figure 63. Spring Gulch/Anderson Ditch location map, Gros Ventre River, Teton County.

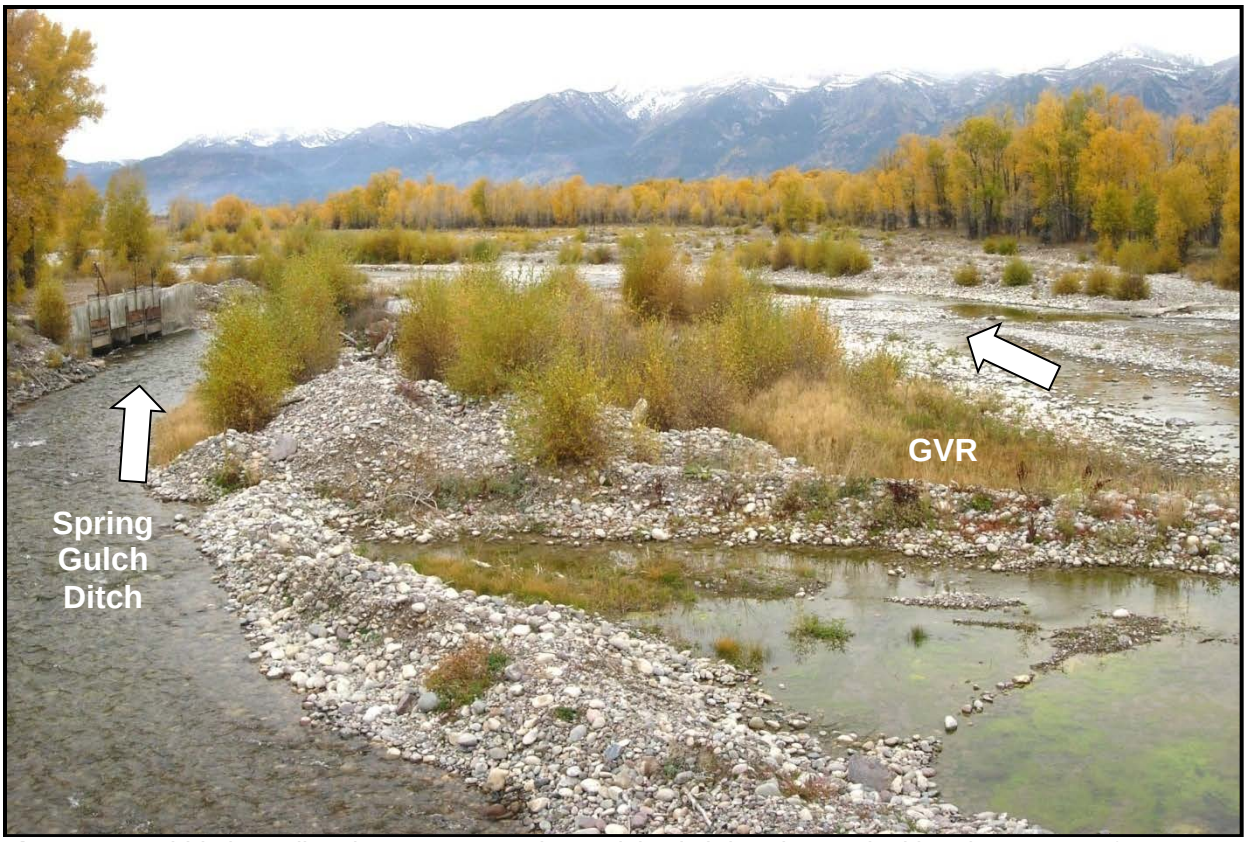


Figure 64. Cobble bars diverting water to Spring Gulch Ditch headgates, looking downstream from Highway 89/191 Bridge. Date: 10/05/2007. Source: Patterson



Figure 65. Spring Gulch Ditch headgates, looking upstream. Date: 6/29/2006. Source: Gerber

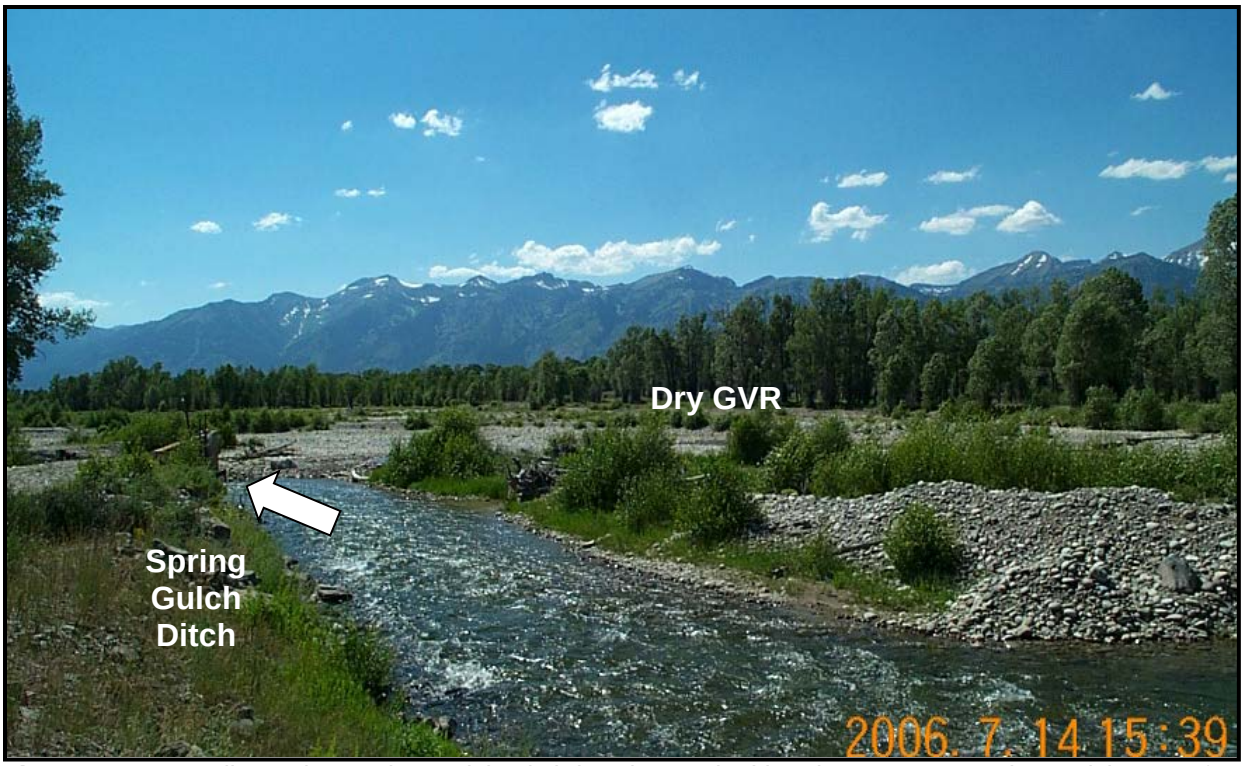


Figure 66. Water directed to Spring Gulch Ditch headgates, looking downstream. Spring Gulch=123 cfs, Gros Ventre River is dry. Date: 7/14/2006. Source: Miller



Figure 67. Spring Gulch headgates closed and leaking 10.3 cfs, looking upstream. Date: 9/19/2008. Source: Gerber

The NPS-WRD installed and surveyed a staff plate on Spring Gulch Ditch on May 9, 2008 (Figure 68). Readings from the staff plate at corresponding measured discharges were used to establish a stage-discharge relationship and to develop a rating table (Table 42).



Figure 68. Staff gage at Spring Gulch Ditch (from left bank). Date: 5/9/2008. Source: Gerber

e. Summary

All water rights from Spring Gulch Ditch are privately owned. Diversions are currently used to irrigate over 2,000 acres. A total of 31.45 cfs are adjudicated for this ditch and up to 174 cfs was measured by NPS. During 68% of the measurements, diversions exceeded direct adjudicated water rights.

Table 41. Spring Gulch Ditch discharge measurements

Date	Discharge (cfs)	Comments
6/9/2005	108	Data from Patterson 2007
7/19/2005	49.8	
8/4/2005	21.7	
8/24/2005	18.7	
9/22/2005	67.7	
9/30/2005	51	
5/18/2006	99.1	
6/9/2006	122	
6/20/2006	127	
7/3/2006	94.3	
7/14/2006	123	
7/21/2006	112	
7/28/2006	119	
8/17/2006	41.5	
8/24/2006	64.3	
8/31/2006	52.9	
9/6/2006	47.5	
9/14/2006	40.7	
9/26/2006	27.1	
10/5/2006	25.0	
10/10/2006	16.2	
10/18/2006	5.02	
11/1/2006	4.21	
5/16/2007	149	
6/15/2007	174	
7/20/2007	77.3	
8/3/2007	67.8	Headgates open
8/10/2007	48.7	Headgates open
8/17/2007	40.9	Headgates open
9/7/2007	38.3	Headgates open,
10/25/2007	31.1	Headgates open
11/16/2007	No discharge measurement	Headgates closed, some leakage approximately 5-15 cfs still flowing
6/4/2008	9.86	Headgates closed
6/17/2008	48.2	Headgates open a little, irrigators were out to open the headgate
6/17/2008	80.2	2nd measurement after headgates opened more
7/16/2008	79.8	Headgates open
8/7/2008	101	Headgates open
8/13/2008	84.6	Headgates open
8/28/2008	64.5	Headgate status not noted
9/4/2008	27.6	Two of three headgates open above gage
9/19/2008	10.3	Headgates completely closed, leaking around branches stuck under headgates
9/27/2008	5.50	Headgates closed, leakage
10/10/2008	3.10	Headgates closed, some leakage
10/21/2008	3.41	Headgates closed but still leakage
9/3/2009	55.8	Headgates open
Average	**60.0**	

Table 42. Spring Gulch Ditch rating table

U.S. DEPARTMENT OF THE INTERIOR – NATIONAL PARK SERVICE - WATER RESOURCE DIVISION

STATION NAME: Gros Ventre River - Spring Gulch Ditch SOURCE AGENCY: USNPS
Date Processed: 10/26/2009 08:11:49 MST By ggerber
Rating for Discharge (cfs)
RATING ID: 0001 TYPE: Stage-Discharge

Offset1: 3.64 Offset2: 3.44
Breakpoint1: 4.57

EXPANDED RATING TABLE

Stage (ft) ⟶	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
↓					Discharge (cfs)					
3.90									2.13	2.28
4.00	2.43	2.60	2.76	2.93	3.11	3.30	3.49	3.69	3.89	4.10
4.10	4.32	4.54	4.77	5.00	5.25	5.50	5.75	6.01	6.28	6.56
4.20	6.84	7.13	7.43	7.73	8.04	8.36	8.68	9.01	9.35	9.70
4.30	10.1	10.4	10.8	11.2	11.5	11.9	12.3	12.7	13.1	13.6
4.40	14.0	14.4	14.9	15.3	15.8	16.2	16.7	17.2	17.7	18.2
4.50	18.7	19.2	19.7	20.3	20.8	21.4	22.0	22.7	23.4	24.1
4.60	24.6	25.0	25.5	26.0	26.5	27.1	27.6	28.1	28.6	29.2
4.70	29.7	30.3	30.8	31.4	31.9	32.5	33.1	33.6	34.2	34.8
4.80	35.4	36.0	36.6	37.2	37.9	38.5	39.1	39.8	40.4	41.1
4.90	41.7	42.4	43.0	43.7	44.4	45.1	45.8	46.5	47.2	47.9
5.00	48.6	49.3	50.0	50.8	51.5	52.2	53.0	53.8	54.5	55.3
5.10	56.1	56.8	57.6	58.4	59.2	60.0	60.8	61.7	62.5	63.3
5.20	64.1	65.0	65.8	66.7	67.5	68.4	69.3	70.2	71.1	71.9
5.30	72.8	73.8	74.7	75.6	76.5	77.4	78.4	79.3	80.3	81.2
5.40	82.2	83.1	84.1	85.1	86.1	87.1	88.1	89.1	90.1	91.1
5.50	92.2	93.2	94.2	95.3	96.3	97.4	98.5	99.5	101	102
5.60	103	104	105	106	107	108	109	111	112	113
5.70	114	115	116	118	119	120	121	122	124	125
5.80	126	127	128	130	131	132	134	135	136	137
5.90	139	140	141	143	144	145	147	148	149	151
6.00	152	153	155	156	157	159	160	162	163	165
6.10	166	167	169	170	172	173	175	176	178	179
6.20	181	182	184	185	187	188	190	191	193	195
6.30	196	198								

B. SPRING SOURCE DITCHES

Location, condition, and water rights for the spring source ditches are discussed below. No discharge measurements were taken from these ditches during the study period. Observed flow rates were too low to measure with standard vertical axis meters.

1. Hot Springs Ditch

a. Description

Hot Springs Ditch is located on the north side of the GVR downstream of Savage Ditch and east of Kelly, Wyoming (Figure 69). The ditch begins at an elevation of approximately 6,680 feet in a wetland area on the north side of the GVR and flows west towards Kelly (Figure 70). After 0.8 miles the ditch crosses into residential lots in Kelly; the ditch was not field verified past this point. After 0.2 miles the ditch passes underneath Main Street in Kelly and travels west 0.3 miles through private lots. There was water in the ditch during the 2006–2009 field seasons at the Main Street crossing. Based on aerial photography the historical ditch extends west and then north passing underneath Gros Ventre Road. During 2006–2009 water was not observed at this point. The ditch then travels northwest and historically provided water to a system of flood irrigation laterals.

b. Condition

Double headgates are located in a wetland area adjacent to the GVR (Figure 71). The headgates appear to be in good condition. No cracks were noted in the headwalls of the headgates. Hot Springs Ditch is no longer connected to the GVR because of channel shifting and down-cutting. The headgates are separated from the active channel by approximately 500 feet (Figure 72). The water conveyed in the ditch is from a series of springs on the north bank of the GVR. Approximately 0.3 miles downstream of the headgates ditch water leaves the historical channel and creates a pond which at times drains back to the GVR (Figure 73).

c. Water Rights

All water rights for Hot Springs Ditch, which have priority dates ranging from 1899–1910, were acquired by the NPS between 1899 and 1910 (Table 43). No record of water rights abandonment or point of diversion transfer exist in the WYSEO records for Hot Springs Ditch (WYSEO 1999). GRTE was not diverting during the study period.

Table 43. Hot Springs Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999)		
Ditch	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**
Hot Springs	12.94	0	12.94

d. Summary

The 12.94 cfs water rights from Hot Springs Ditch are owned by the NPS. During the study period the ditch was not used by the NPS. About one cfs or less is being conveyed in the ditch from a number of springs occurring in the area. Water conveyed in the ditch either returns to the GVR via an overflow pond or is used by residents of Kelly, Wyoming, to irrigate lawns, trees, and shrubs.



Figure 69. Hot Springs Ditch location map, Gros Ventre River, Teton County.



Figure 70. Hot Springs Ditch wetlands, looking downstream. Date: 7/25/2007. Source: Gerber



Figure 71. Hot Springs Ditch headgate, looking downstream. Date: 6/23/2003. Source: Corbin

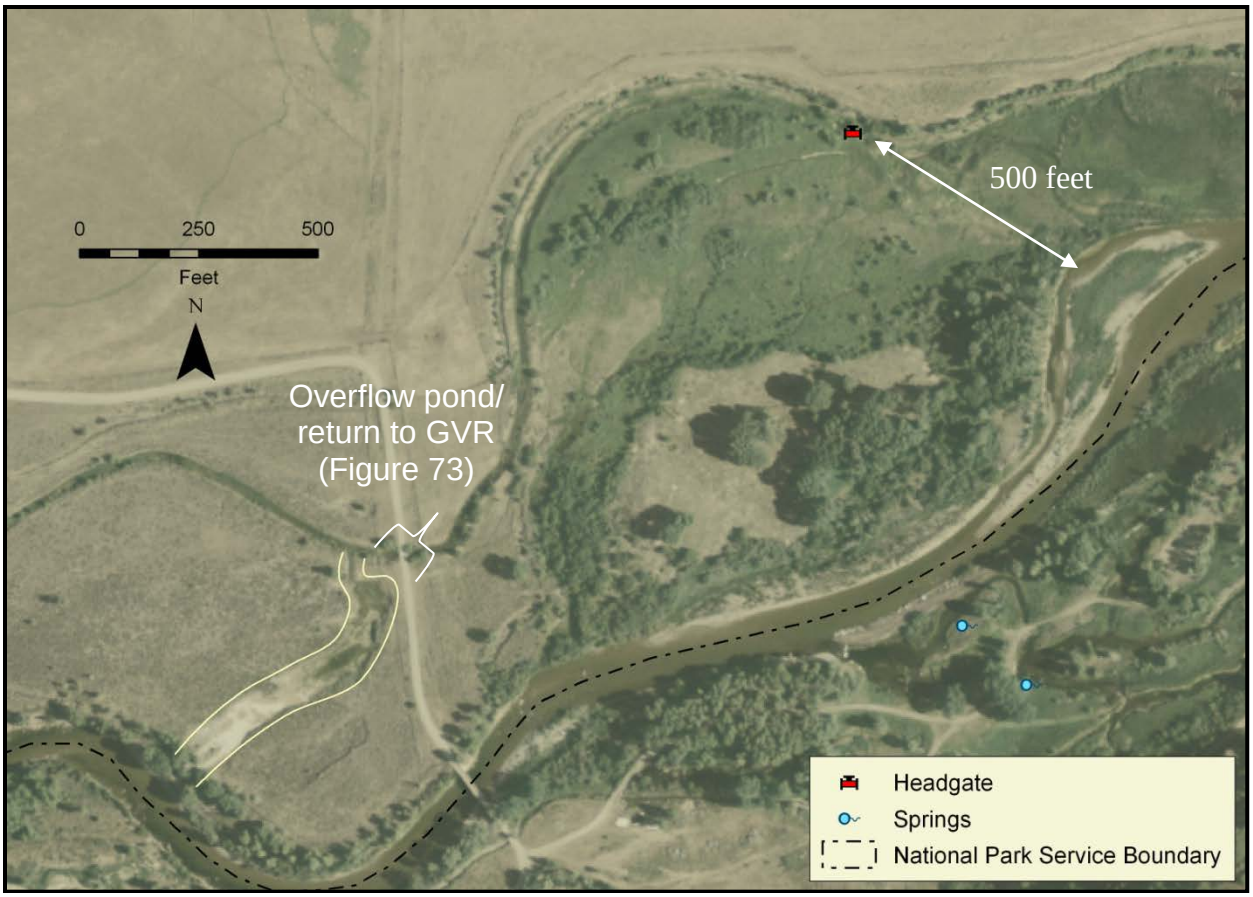


Figure 72. Hot Springs Ditch headgate disconnected from Gros Ventre River and location of ditch loss to pond and return flow to the Gros Ventre River (2006 aerial photo).



Figure 73: Overflow from Hot Springs Ditch and return to Gros Ventre River, looking southwest. Date: 10/23/2008. Source: Gerber.

2. Hanrow Ditch

a. Description

Hanrow Ditch is located on the south side of the GVR, and originates at multiple springs west of Kelly, Wyoming, within TVR (Figure 74). The ditch begins at an elevation of approximately 6,640 ft and flows southwesterly to the NER. The ditch was not field verified within TVR property. At the TVR/NER boundary, water surfaces from a culvert and flows into the ditch (Figure 74, Figure 75). The ditch flows west/southwest along the GVR for about 0.4 miles where it turns south away from the GVR and flows adjacent to a road within the NER. Historically, the ditch provided water to a series of flood irrigation canals on the west side of the road south of the GVR.

On October 23, 2008, NPS staff walked the left bank of the GVR upstream of Kelly to locate the Hanrow Ditch headgates. Over six spring tributaries to the GVR were located and mapped (Figure 74, Figure 76). No headgates or diversions from the GVR were located. During the study period the Hanrow Ditch did not withdraw water from the GVR. Water being conveyed in the ditch originated from the springs.

b. Condition

The condition of Hanrow Ditch was not evaluated. Less than one cfs was being conveyed in the ditch during the study period and was insufficient to measure. The majority of spring water returns to the GVR.

c. Water Rights

The 2.62 cfs of adjudicated direct supply is owned privately and by the NER (Table 44). According to WYSEO (1999), there was an "involuntary abandonment" of 145 acres in 1975 and a "change of point of diversion and source to Warm or Seebolm Warm Springs, tributary of GVR," on November 21, 1975.

Table 44. Hanrow Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999, HDR 2009)			
Ditch	**Ownership**	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**
Hanrow	Private / NER	2.62	0	2.62

An application filed on January 23, 2008, by TVR requests a new point of diversion on the GVR to supplement the spring source. This application proposes a direct flow right to irrigate 22 acres and a supplemental supply for irrigating 21 acres. Additionally, the application includes a 4.7 cfs direct flow right to fill four reservoirs annually (total of 52.6 acre feet) and a 0.73 cfs direct flow right for fish propagation (non-consumptive) through the four reservoirs in a 30-day period (water being returned to the GVR, WYSEO 2008, Table 45). The NER objected to this filing (Reed 2009).

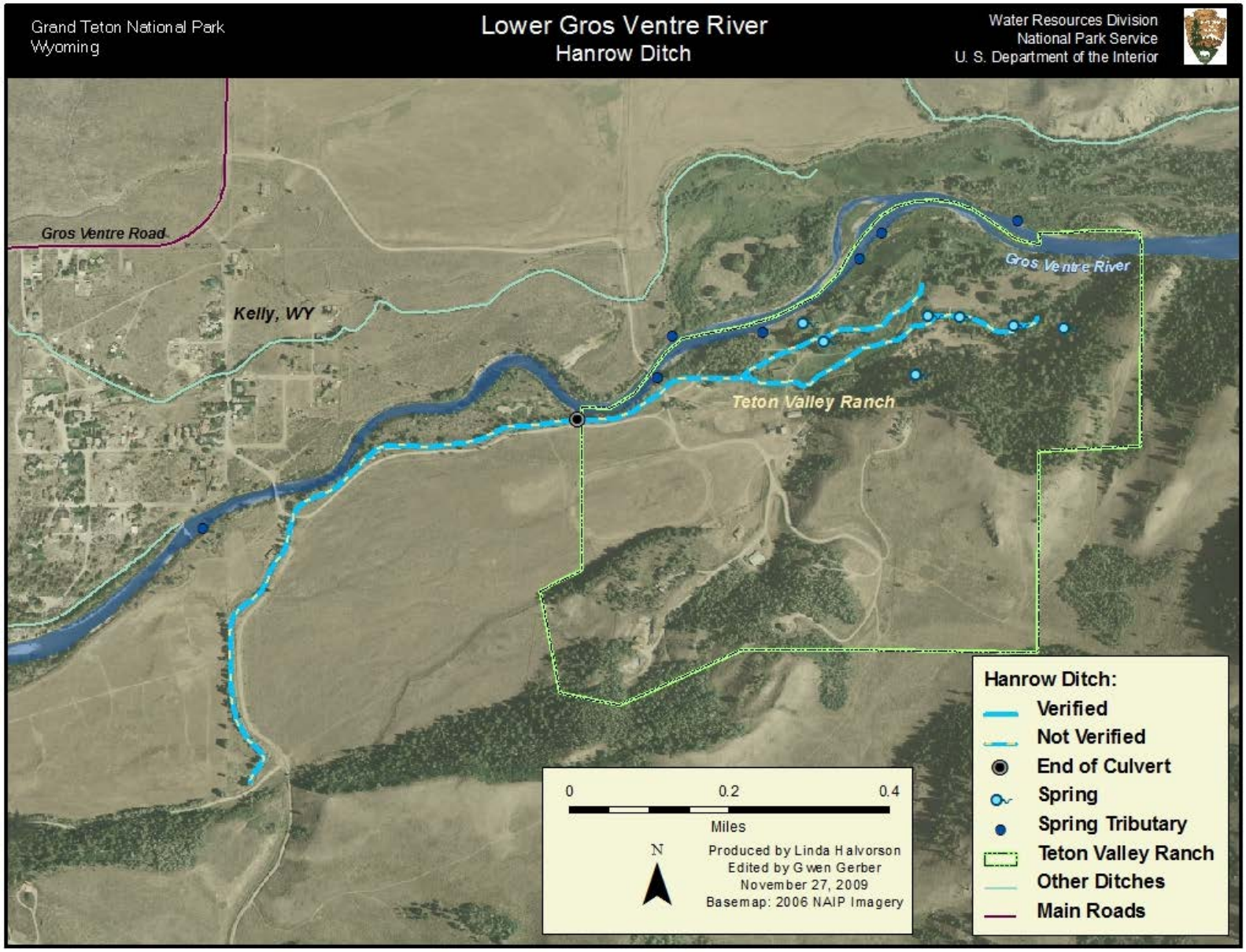


Figure 74. Hanrow Ditch location map, Gros Ventre River, Teton County.



Figure 75. Hanrow Ditch at Teton Valley Ranch and National Elk Refuge Boundary. Date: 10/23/2008. Source: Gerber

Table 45. Hanrow Ditch unadjudicated water rights

	Unadjudicated Water Rights (WYSEO 2008)				
Ditch	**Ownership**	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**	**Reservoir Supply**
Hanrow	Private	0.31	0.30	0.61	52.63 acre feet annually (4.7 cfs) and 0.73 cfs for non-consumptive flow through 4 reservoirs in a 30-day period

d. Summary

The 2.62 cfs adjudicated water rights from Hanrow Ditch are owned by private landowners and the NER. During the study period the ditch was not connected to the GVR. Water being conveyed in the ditch originated from a series of springs on the south side of the GVR. An additional application was filed in 2008 to divert water directly from the GVR for irrigation of 43 acres and for non-consumptive use to fill four reservoirs.



Figure 76. Warm or Seebolm Springs return to Gros Ventre River (also one of the source springs to Hanrow Ditch). Date: 8/15/2006. Source: Miller

C. OTHER DITCHES

During the study period these ditches were not conveying flow from the GVR and no headgates were located. No discharge measurements were made.

1. Cedar Tree Ditch

a. Description

According to historical linen plat maps (WYSEO ~1920) Cedar Tree Ditch formerly stemmed off the GVR 0.5 miles downstream of the Savage Ditch headgate. The ditch flowed parallel to Savage Ditch for 0.7 miles then traveled west for one mile before passing under Gros Ventre Road. Cedar Tree Ditch then turned northward, north of Kelly, Wyoming, ending just south of the old Mud Springs ditch (Figure 77). On July 25, 2007, NPS-WRD conducted a field survey to locate the Cedar Tree Ditch. Remnants of an old ditch were located in places, but no headgate was found. Figure 78 is a photo of a section of the old ditch that runs parallel to the present day Hot Springs Ditch. Since the historical Ideal Ditch (shown as a dashed line in Figure 77) ran parallel to the Cedar Tree Ditch it is not certain if the ditch remnants found are indeed Cedar Tree Ditch.

b. Water Rights

All water rights for Cedar Tree Ditch that have priority dates of 1898 were acquired by GRTE in 1949 (Table 46). State records for these water rights still reflect the original appropriator. No records of ditch abandonment or transfer of point of diversion exist in WYSEO records (WYSEO 1999). GRTE did not divert from this ditch during the study period.

Table 46. Cedar Tree Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999)		
Ditch	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**
Cedar Tree	4.57	0	4.57

c. Summary

The Cedar Tree Ditch water rights (4.57 cfs) are held by the NPS, although the original appropriators are still identified in state files. No headgates were found, and only remnants of the ditch were located in places. GRTE did not divert from this ditch during the study period.

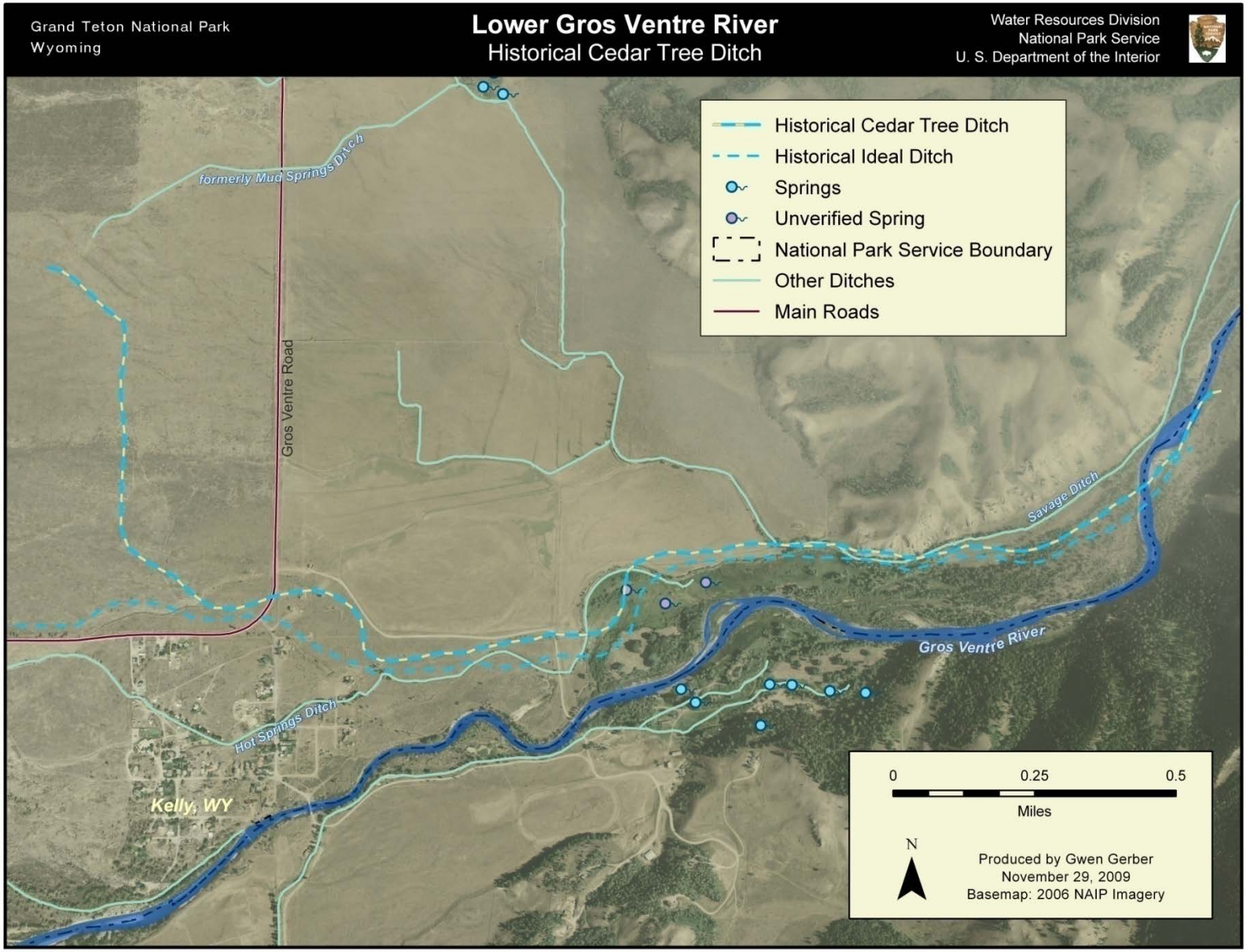


Figure 77. Historical Cedar Tree Ditch location map (WYSEO ~1920), Gros Ventre River, Teton County.



Figure 78. Remnant section of Cedar Tree Ditch. Date: 7/25/2007. Source: Gerber

2. Romeo Ditch / Romey Springs

a. Description

Romeo Ditch historically began on the south side of GVR just south of the current day GVR Campground in GRTE (Figure 79). The ditch began at an elevation of approximately 6,580 ft and flowed south along the buttes in the NER. From its origin at the GVR, the ditch traveled southwest for 1.7 miles. On September 18, 2008, NPS-WRD walked the left bank of the GVR to locate the Romeo Ditch point of diversion. No diversion from the GVR or headgate was located. Several ditches were located in the vicinity of Romeo ditch originating at a series of springs and are shown in Figure 79 as a dashed line. These ditches are listed in WYSEO (1999) as Romey Springs Ditch. These ditches flow into a series of NER reservoirs (Romney Reservoirs) south and east of the GVR (Figure 80). Overfill pipes, culverts, and ditches connect the three reservoirs in a series (Figure 81, Figure 82). The ditch draining the southwestern most reservoir terminates at the South Park Supply Ditch.

b. Water Rights

All water rights for Romeo Ditch are owned by the NER. Direct supply water rights listed in Table 47 were acquired by the NER in 1949 and have priority dates of 1900–1913. In addition to these water rights, water rights from 1993 for the Enlarged Romeo Ditch and the Enlarged Romey Springs Ditch supply the three Romney Reservoirs with 68.33 acre feet of water from all sources in any one year. This appropriation is limited to the amount of water beneficially used for wildlife and fish propagation (non-consumptive) at a rate not to exceed 1.0 cfs (WYSEO 1999).

Table 47. Romeo Ditch adjudicated water rights

	Adjudicated Water Rights (WYSEO 1999, HDR 2009)			
Ditch	**Direct (cfs)**	**Supplemental (cfs)**	**Total (cfs)**	**Reservoir Supply**
Romeo Ditch	1.95	0	1.95	68.33 acre feet 24.4 cfs from Romeo Ditch 8.56 cfs from Romey Spring Ditch
Romey Springs				

c. Summary

The water rights on Romeo and Romey Springs ditches are held by the NER. The direct supply from the GVR totals 1.95 cfs through Romeo Ditch. During the study period this ditch was not withdrawing water from the GVR. In addition, the NER holds a water right (68.33 acre feet) for beneficial use in 3 Romney Reservoirs for fish and wildlife propagation. Water for the reservoirs is either supplied through Romeo Ditch or Romey Springs. Romey Springs Ditch was the only ditch supplying water to the reservoirs during the study period.

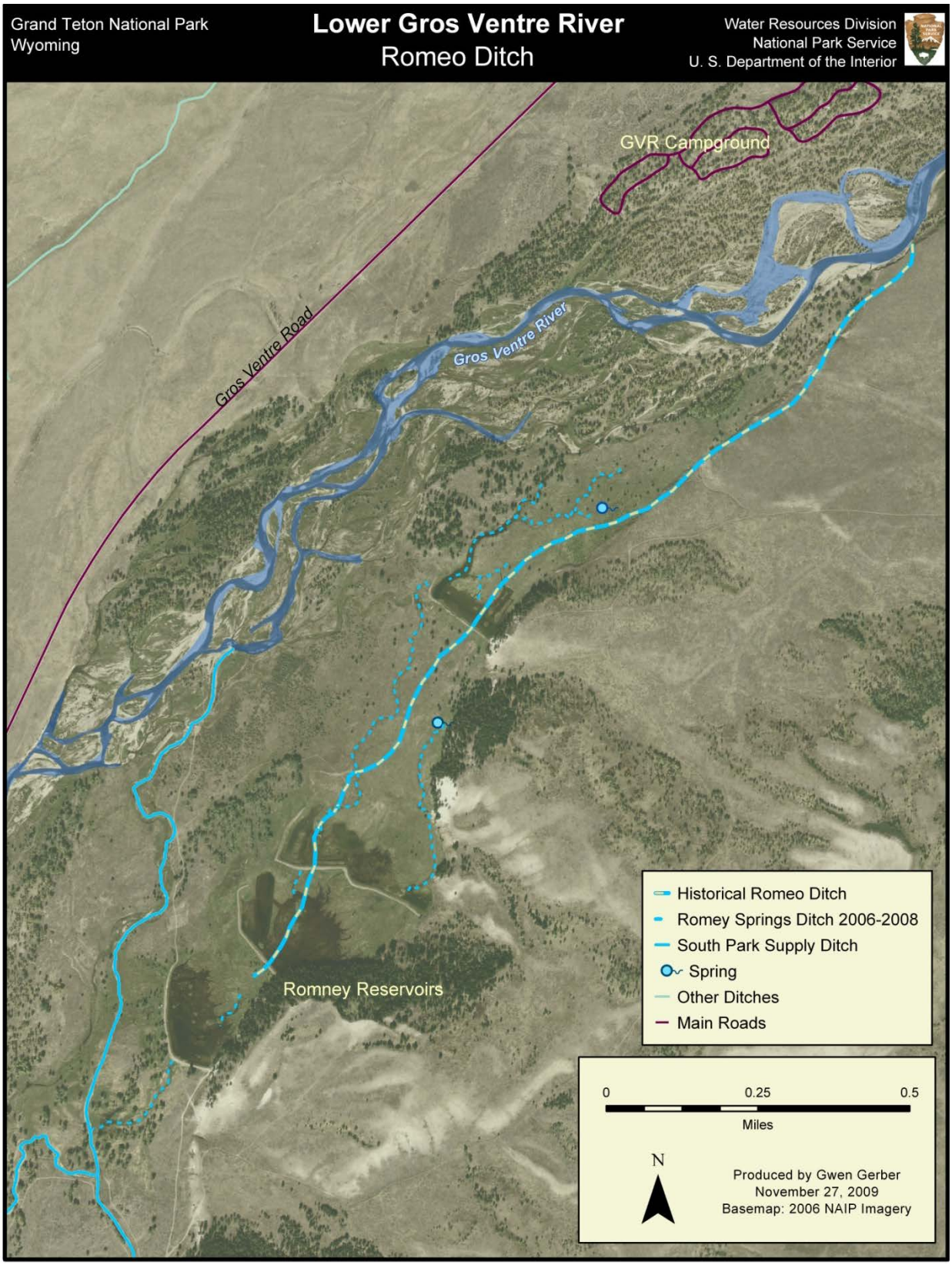


Figure 79. Romeo Ditch location map, Gros Ventre River, Teton County.



Figure 80. Spring fed ditch leading to National Elk Refuge reservoir. Date: 9/18/2008. Source: Gerber



Figure 81. Overfill culvert from National Elk Refuge reservoir. Date: 9/18/2008. Source: Gerber



Figure 82. Culvert from National Elk Refuge reservoir. Date: 9/18/2008. Source: Gerber

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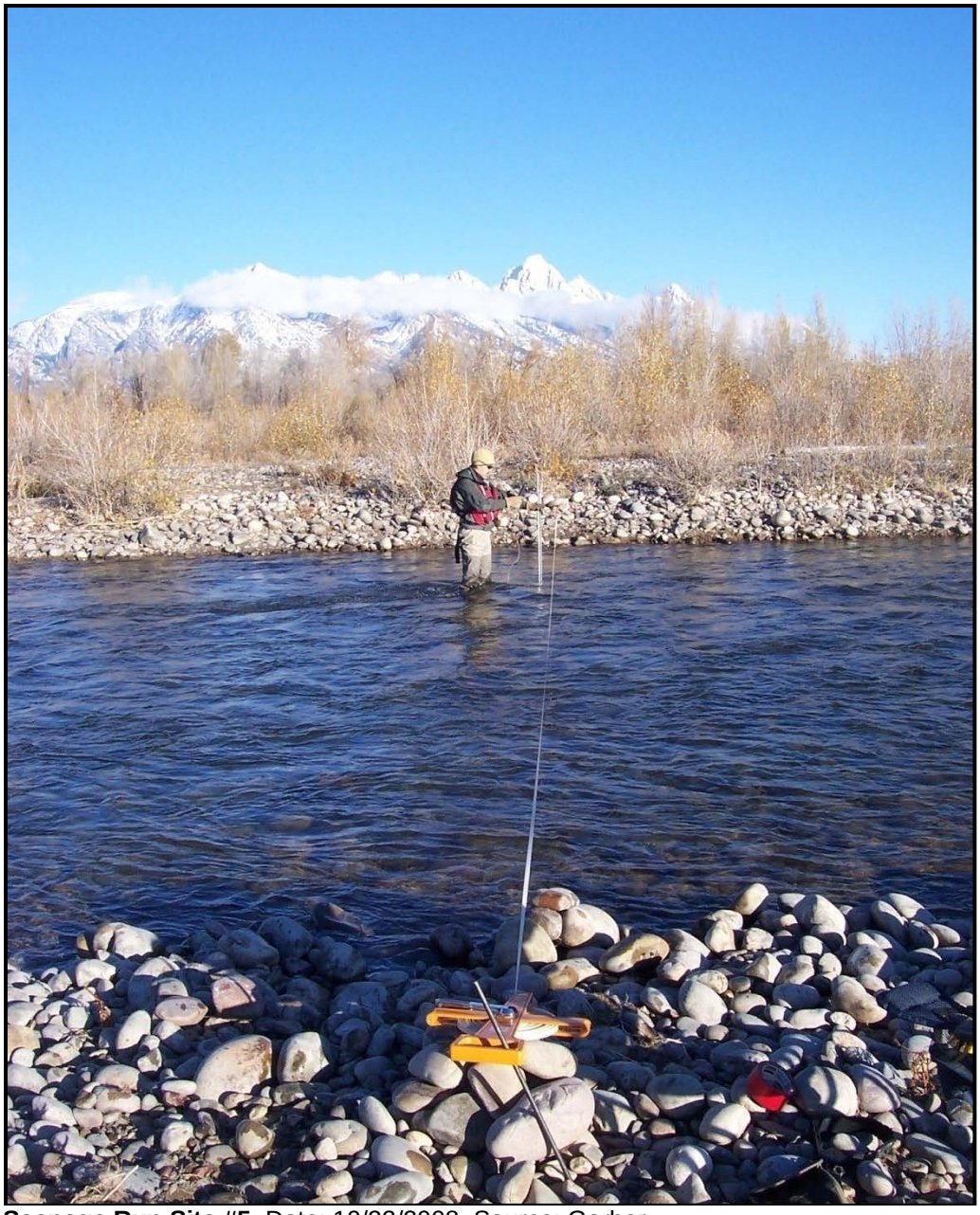
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Appendix B. Lower Gros Ventre River Seepage Run



Seepage Run Site #5. Date: 10/22/2008. Source: Gerber

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Introduction

This appendix summarizes the seepage run conducted by the National Park Service, Water Resources Division (NPS-WRD) on October 22, 2008, on the lower Gros Ventre River (GVR) from the Grand Teton National Park (GRTE) / Bridger-Teton National Forest (BTNF) boundary to the confluence of the Snake River. Copies of discharge measurements and photos of each of the eight seepage run sites are located in the data files at the NPS-WRD office in Fort Collins, Colorado.

Site Descriptions

Measurement cross sections were located prior to the seepage run. Eight sites were located along the 15-mile stretch of the lower GVR from the GRTE/BTNF boundary to its confluence with the Snake River. Sites were numbered 1 through 8 from upstream to downstream. Sites 1 through 6 were located on federal land (NPS and NER), and Sites 7 and 8 were on private property. Access was granted by private property owners through Scott Yates, Director of the Wyoming Water Project of Trout Unlimited. Sites were spaced from one to three miles apart and were located where the braided GVR was confined to one channel, with the exception of Site 8. Site 8 consisted of two separate cross sections—one on the main stem of the GVR and another on a side channel. Global Positioning System (GPS) coordinates were obtained for each of the eight sites. GPS data were mapped in a project GIS and depicted in Figure 83. Descriptions and GPS locations of each site are listed in Table 48.

Table 48. Locations of seepage run sites, lower Gros Ventre River, Teton County

Seepage Run Site #		Description	Coordinates (NAD 83 UTM Zone 12)	
			Northing	Easting
1		At the NPS Gage at the upstream GRTE/BTNF boundary	4832006.429	533568.531
2		Downstream of the USGS Gage at Kelly, WY and upstream of low head dam	4829753.762	530312.616
3		Approximately 700 feet southeast of loop 'C' in the Gros Ventre River Campground	4829204.252	527431.891
4		500 feet downstream of the Gros Ventre Road turnout 2.4 miles from the Highway 89/191 Junction	4827066.579	524403.879
5		0.25 miles upstream of the Highway 89/191 Bridge	4823766.532	521977.894
6		0.75 miles downstream of the Highway 89/191 Bridge	4823376.872	520422.794
7		Approximately 900 feet downstream of the Spring Gulch Road Bridge and the USGS Gage at Zenith	4822661.664	518889.280
8	Main Stem	Main stem of GVR, approximately 500 feet above confluence of Snake River	4821595.599	516727.036
	Side Channel	On side channel of GVR, approximately 1,500 feet above the confluence with the Snake River	4821410.014	516706.390

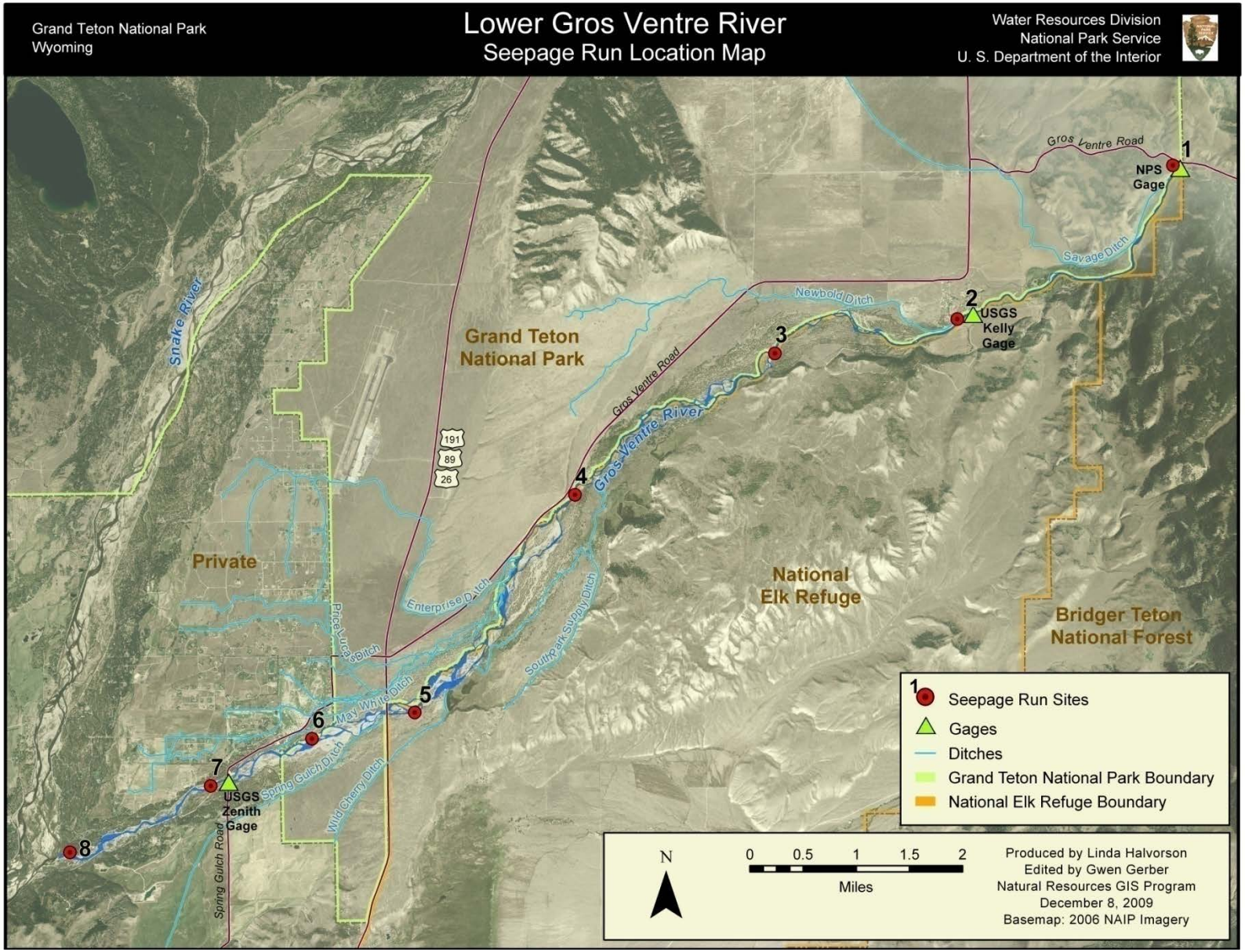


Figure 83. Location map for the National Park Service seepage run on October 22, 2008, Teton County.

Methods

On October 20 and 21, 2008, site visits were made to the eight ditches along the lower GVR (Figure 83). All ditches were closed and the only water conveyed in the ditches was water leaking through cobble bars and/or headgates. Wild Cherry, Price Lucas, and May White ditches were completely dry. Savage, South Park Supply, Enterprise, and Spring Gulch ditches had enough leakage to measure. Measurements were taken at these ditches on October 21, 2008; less than 10 cubic feet per second (cfs) was measured leaking to the eight ditches (Table 49). Newbold Ditch had insufficient flow to measure.

Table 49. Lower Gros Ventre River ditch measurements, October 21, 2008, Teton County

Diversion	Discharge (cfs)	Comments
Savage Ditch	0.657	Headgates closed, leakage around headgates
Newbold Ditch	< 0.5	Headgates closed, leakage under headgates, flow insufficient to measure
South Park Supply Ditch	2.03	Measurement taken above headgates and below cobble bar, represents cobble bar leakage
Enterprise Ditch	3.11	Headgates closed, leakage around headgates
Wild Cherry Ditch	0.00	Ditch dry
Price Lucas Ditch	0.00	Ditch dry
May White Ditch	0.00	Ditch dry
Spring Gulch Ditch	3.41	Headgates closed, leakage around headgates



Figure 84. Temporary staff plate installed at seepage run Site 8. Date: 10/20/2008 Source: Gerber

On October 20 and 21 temporary staff plates were installed at Sites 3 through 8 to determine if water levels were changing during the seepage run. Gage heights for Sites 1 and 2 were recorded from the staff plates at the NPS and Kelly gages. In addition, fifteen minute discharge values were obtained from the NPS, Kelly, and Zenith gages (Figure 83) to evaluate changes in discharge throughout the day.

On October 22 four teams made scheduled discharge measurements at two measurement sites. Two measurements were taken at each site. Discharge measurements were scheduled at 8:30 and 10:00 at the first site and 13:00 and 14:30 at the second site.

Standard USGS discharge measurement protocols were followed for the seepage run (Buchanan and Somers 1969 and Rantz et al. 1982). Discharge measurements were made with NPS-WRD Price AA and Pygmy vertical axis meters and standard wading rods marked in tenths. Meters were calibrated by the USGS Hydrologic Instrumentation Facility according to USGS protocol (Smoot and Novak 1968). NPS-WRD Discharge Measurement Notes forms (NPS 2007) were used to record all data. Discharge measurements were checked using Hydrographers Measurement Sheet Toolbox (HMST) spreadsheets (Loving 2002). Discharge measurement uncertainty was determined according to Sauer and Meyer (1992).

Results

Discharge, start and end time, and gage height for the measurements at the eight sites are shown in Table 50. All discharges are in cfs and reflect standard USGS rounding. All times recorded are in Mountain Daylight Time (MDT). The percent difference between the two measurements at each site was calculated. Differences ranged between 0.46 and 3.97 percent and are within acceptable USGS limits (Sauer and Meyer 1992). The final discharge for each site is the average of the two measurements. All discharge measurements were rated as "good" (less than five percent error) with the exception of the measurements at Site 1 and on the Savage Ditch (Table 49) which were considered "fair" (within eight percent error).

Table 50. Gros Ventre River seepage run results, October 22, 2008, Teton County

Site Number (Upstream to Downstream)		Discharge				Time		Gage Height		
		Measurement #	(cfs)	Percent Difference Between Measurements	Average (cfs)	Start (MDT)	End (MDT)	Start (feet)	End (feet)	Change (feet)
1		1	173	3.97%	176	08:22	09:36	5.54	5.54	0.00
		2	180			10:00	10:54	5.54	5.54	
2		1	218	0.46%	218	12:47	14:01	2.31	2.31	0.00
		2	219			14:28	15:30	2.31	2.31	
3		1	205	1.93%	207	08:30	10:00	0.95	0.95	0.00
		2	209			10:20	11:35	0.95	0.95	
4		1	202	0.99%	203	13:01	13:58	0.34	0.34	0.00
		2	204			14:30	15:20	0.34	0.34	
5		1	120	1.68%	119	08:30	09:35	0.66	0.66	0.01
		2	118			10:08	10:52	0.67	0.67	
6		1	112	2.71%	110	13:00	14:05	0.76	0.76	-0.01
		2	109			14:30	15:35	0.76	0.75	
7		1	98.7	3.29%	100	08:30	09:12	0.81	0.81	0.00
		2	102			09:38	10:29	0.81	0.81	
8	Main Stem	1	114	2.11%	142	13:00	13:50	0.73	0.73	-0.01
	Side Channel	1	29.8			13:54	15:20	Not Recorded		
	Total		144							
	Main Stem	2	111			15:27	16:21	0.73	0.72	
	Side Channel	2	30.1			16:39	17:28	Not Recorded		
	Total		141							

Actual start times for all measurements were within an hour of the designated start times. Water level changes were within 0.01 feet for all measurements at each site. Recorded changes in discharge at the NPS and Zenith gages were three and four cfs during the day. This fluctuation is within three percent of the discharges measured at those sites.

Total discharge for each reach was calculated by adding in the leakage measured on October 21, 2008, for ditches originating in that reach (Table 51). The change in discharge between reaches was calculated by subtracting the total discharge of each reach from the total discharge from the prior reach. Total change in discharge between sites ranged from a gain of 43 cfs to a loss of 83 cfs. In Table 51 and **Table 52**, a gain is depicted as a positive number and a loss is depicted as a negative number.

Table 51. Reach discharge and change in discharge for each reach for the seepage run on October 22, 2008, Gros Ventre River, Teton County

Reach #	Measurement Location	Discharge (cfs)	Change in Discharge (cfs)
1	Seepage Run Site 1	176	NA
2	Seepage Run Site 2	218	43
	Savage Ditch	0.657	
	Reach Total	**219**	
3	Seepage Run Site 3	207	-12
	Newbold Ditch	< 0.5	
	Reach Total	**207**	
4	Seepage Run Site 4	203	-2
	South Park Supply Ditch	2.03	
	Reach Total	**205**	
5	Seepage Run Site 5	119	-83
	Enterprise Ditch	3.11	
	Reach Total	**122**	
6	Seepage Run Site 6	110	-9
	Spring Gulch Ditch	3.41	
	Reach Total	**113**	
7	Seepage Run Site 7	100	-13
8	Seepage Run Site 8	**142**	42

NA = not applicable, no upstream site for comparison.

Total distances in stream miles between seepage run sites were determined from the Project GIS (**Table 52**). Change in discharge per stream mile was calculated by dividing the change in discharge by the distance between sites. The change in discharge per stream mile varied from a gain of 25 cfs to a loss of 28 cfs per stream mile (**Table 52**, Figure 85).

Gaining reaches occurred between Sites 1 and 2 and between Sites 7 and 8. Losing reaches occurred between all reaches from Site 2 through Site 7 with the greatest losses occurring between Sites 4 and 5 upstream of the Highway 89/191 Bridge (**Table 52**, Figure 85).

Table 52. Change in discharge per stream mile for the seepage run on October 22, 2008, Gros Ventre River, Teton County

Seepage Run Reach	Discharge (cfs) for Total Reach	Change from Upstream (cfs)	Distance Between Sites (miles)	Change Per Stream Mile (cfs)
1	176	NA	NA	NA
2	219	43	2.9	15
3	207	-12	2.2	-5
4	205	-2	2.8	-1
5	122	-83	3.0	-28
6	113	-9	1.1	-8
7	100	-13	1.2	-11
8	142	42	1.7	25

NA = not applicable, no upstream site for comparison.

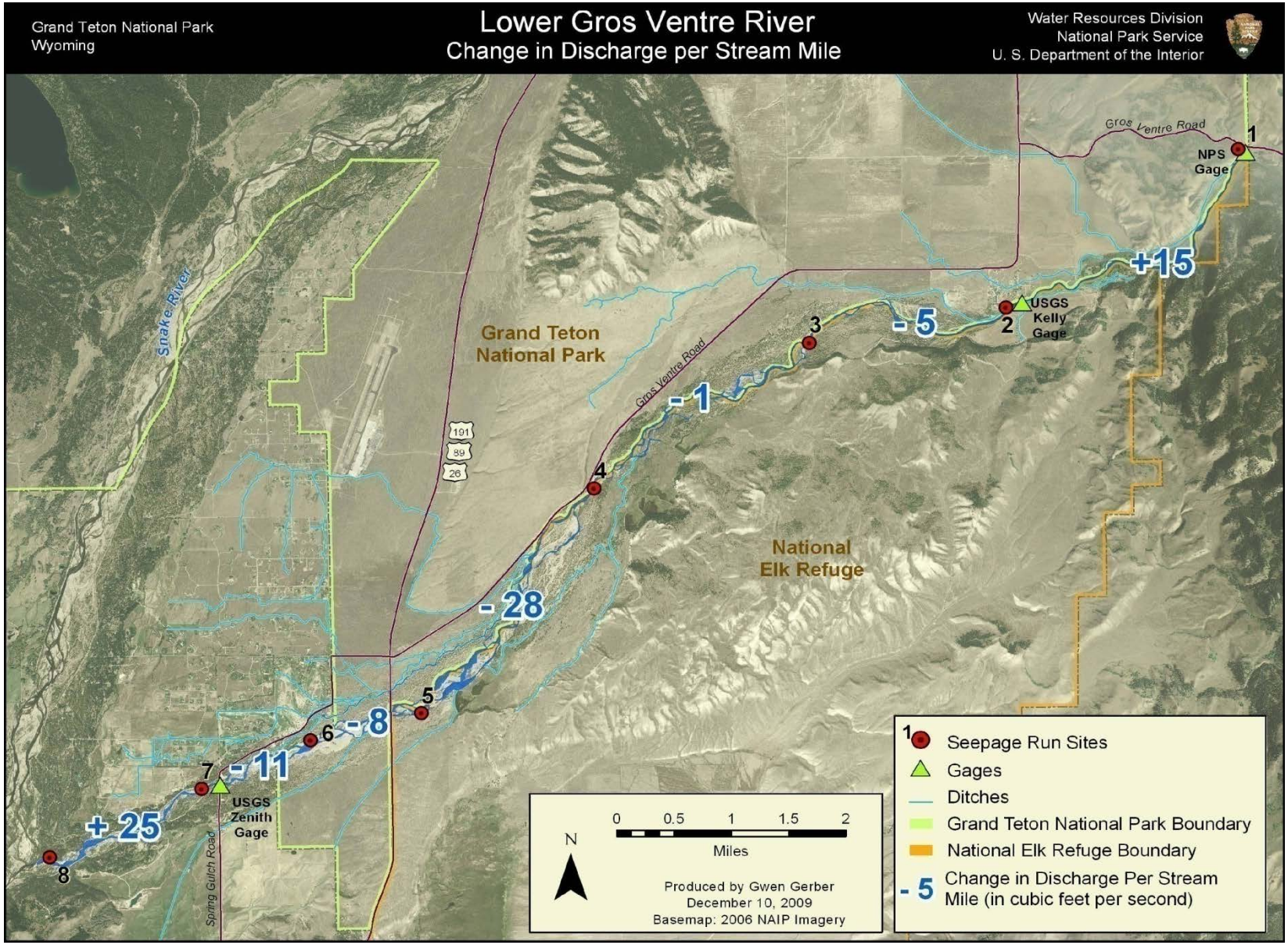


Figure 85. Change in discharge per stream mile for seepage run on October 22, 2008, Gros Ventre River, Teton County.

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Appendix C. Supplemental Data



Winter Discharge Measurement at the NPS Gage. Date: 1/19/2007. Source: Gerber

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Introduction

This appendix presents additional figures and tables not included in the main body of the report. Copies of all NPS discharge measurements are located in the data files at the NPS office in Fort Collins, Colorado. All USGS discharge measurements and gaging station data were obtained from the *USGS National Water Information System: Web Interface* (NWIS) unless otherwise noted.

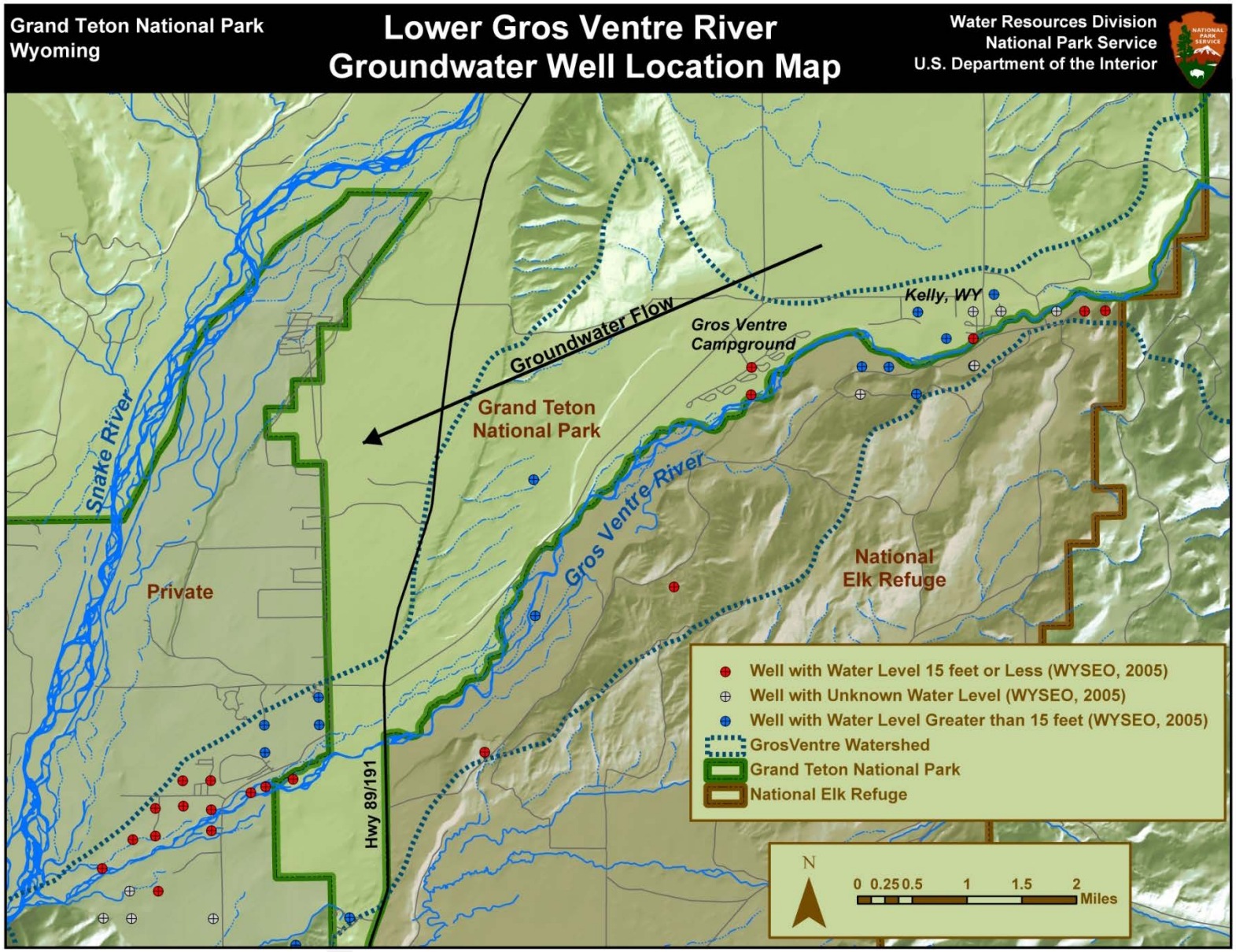


Figure 86. Location of groundwater wells in the study area, Gros Ventre River.

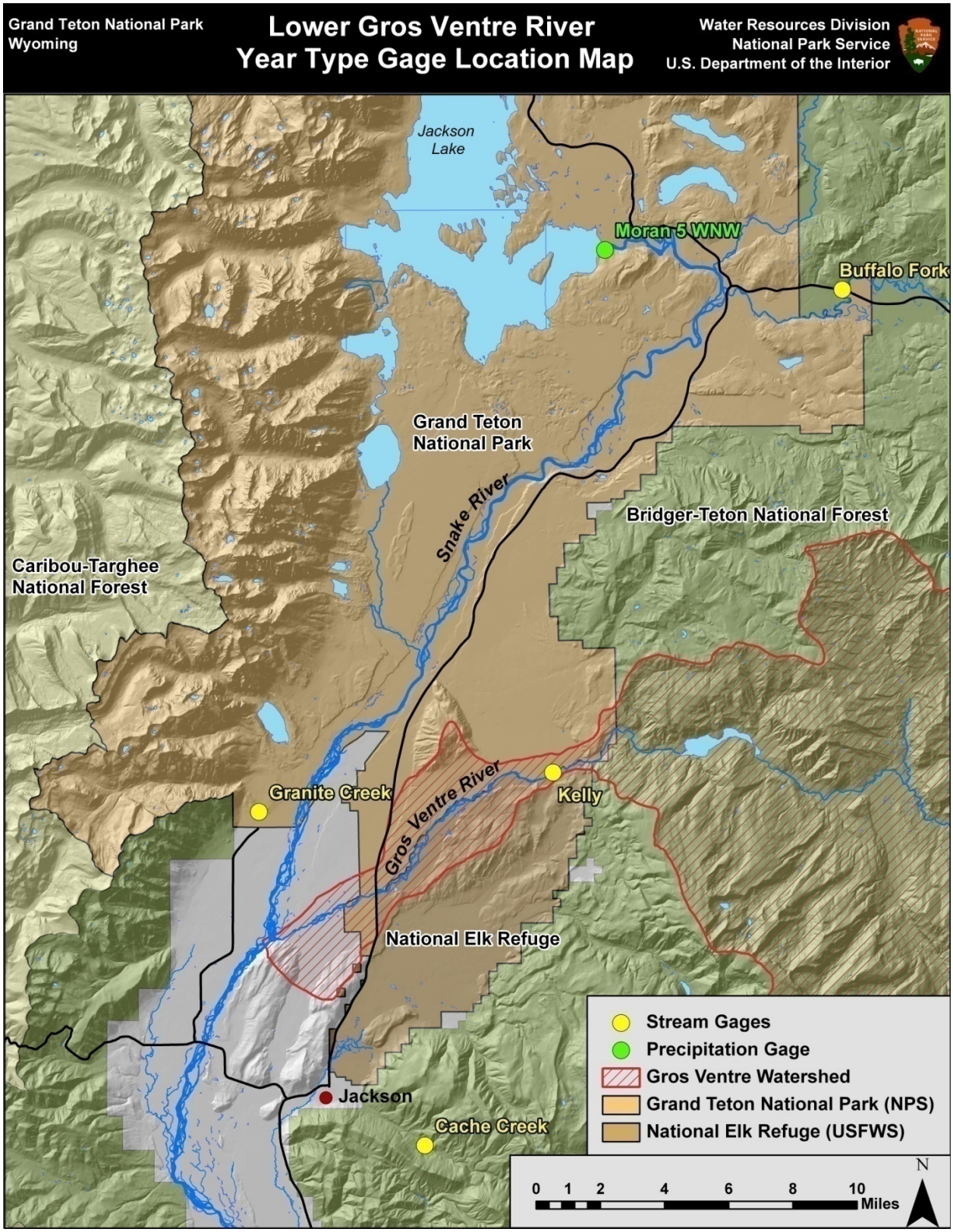


Figure 87. Locations of precipitation and gaging stations used for the year type analysis, Teton County.

Table 53. Total annual precipitation ranking (1897–2009), Moran, Wyoming (U.S. HCN 2010)

Year	Annual Precip in Inches	Rank	Rank Percent	Rank Category	Year	Annual Precip in Inches	Rank	Rank Percent	Rank Category
1897	19.3	24	21	MOD DRY	1954	18.75	19	17	MOD DRY
1898	18.53	15	13	MOD DRY	1955	27.66	98	87	MOD WET
1899	23	65	58	AVE WET	1956	20.73	37	33	AVE DRY
1900	17.02	6	5	DRY	1957	25.74	85	75	MOD WET
1901	22.01	51	45	AVE DRY	1958	20.69	36	32	AVE DRY
1902	17.26	9	8	DRY	1959	19.3	25	22	MOD DRY
1903	18.75	18	16	MOD DRY	1960	21.22	40	35	AVE DRY
1904	22.53	57	50	AVE WET	1961	26.52	90	80	MOD WET
1905	17.05	7	6	DRY	1962	19.27	23	20	MOD DRY
1906	22.93	63	56	AVE WET	1963	25.69	84	74	MOD WET
1907	22.71	59	52	AVE WET	1964	29.31	104	92	WET
1908	21.83	48	42	AVE DRY	1965	21.56	47	42	AVE DRY
1909	25.4	82	73	MOD WET	1966	20.6	33	29	MOD DRY
1910	18.26	13	12	MOD DRY	1967	25.81	87	77	MOD WET
1911	19.94	26	23	MOD DRY	1968	24.35	75	66	AVE WET
1912	24.83	78	69	AVE WET	1969	21.02	38	34	AVE DRY
1913	20.25	28	25	MOD DRY	1970	29.26	103	91	WET
1914	20.24	27	24	MOD DRY	1971	29.14	102	90	WET
1915	21.53	46	41	AVE DRY	1972	27.97	99	88	MOD WET
1916	22.78	60	53	AVE WET	1973	23.72	69	61	AVE WET
1917	28.29	101	89	MOD WET	1974	23.09	68	60	AVE WET
1918	21.5	44	39	AVE DRY	1975	31.14	108	96	WET
1919	14.61	3	3	DRY	1976	21.43	43	38	AVE DRY
1920	26.75	92	81	MOD WET	1977	25.15	80	71	MOD WET
1921	23.94	70	62	AVE WET	1978	23.01	66	58	AVE WET
1922	22	50	44	AVE DRY	1979	13.91	2	2	DRY
1923	31.37	109	96	WET	1980	25.68	83	73	MOD WET
1924	20.34	29	26	MOD DRY	1981	24.2	73	65	AVE WET
1925	28.25	100	88	MOD WET	1982	27.53	97	86	MOD WET
1926	27.4	96	85	MOD WET	1983	29.4	106	94	WET
1927	38.55	113	100	WET	1984	23.04	67	59	AVE WET
1928	22.5	56	50	AVE DRY	1985	22.89	62	55	AVE WET
1929	24.63	77	68	AVE WET	1986	29.37	105	93	WET
1930	21.05	39	35	AVE DRY	1987	17.29	10	9	DRY
1931	15.27	4	4	DRY	1988	18.6	17	15	MOD DRY
1932	20.5	32	28	MOD DRY	1989	26.92	94	83	MOD WET
1933	17.22	8	7	DRY	1990	22.28	52	46	AVE DRY
1934	22.31	53	47	AVE DRY	1991	24.24	74	65	AVE WET
1935	17.01	5	4	DRY	1992	19.17	21	19	MOD DRY
1936	26.34	88	78	MOD WET	1993	26.4	89	79	MOD WET
1937	24.99	79	70	AVE WET	1994	21.85	49	43	AVE DRY
1938	25.31	81	72	MOD WET	1995	33.19	111	98	WET
1939	17.85	12	11	MOD DRY	1996	37.03	112	99	WET
1940	24.2	72	64	AVE WET	1997	32.36	110	97	WET
1941	25.76	86	76	MOD WET	1998	29.8	107	95	WET
1942	21.51	45	40	AVE DRY	1999	27.02	95	84	MOD WET
1943	17.54	11	10	DRY	2000	21.25	41	36	AVE DRY
1944	20.42	30	27	MOD DRY	2001	18.34	14	12	MOD DRY
1945	26.78	93	82	MOD WET	2002	22.42	54	48	AVE DRY
1946	20.48	31	27	MOD DRY	2003	24.13	71	63	AVE WET
1947	20.68	35	31	AVE DRY	2004	19.24	22	19	MOD DRY
1948	21.27	42	37	AVE DRY	2005	22.88	61	54	AVE WET
1949	18.55	16	14	MOD DRY	2006	22.42	55	49	AVE DRY
1950	24.4	76	67	AVE WET	2007	20.67	34	30	MOD DRY
1951	22.53	58	51	AVE WET	2008	26.67	91	81	MOD WET
1952	13.51	1	1	DRY	2009	22.98	64	57	AVE WET
1953	18.76	20	18	MOD DRY					

Study period shown in red

Table 54. Total mean flow ranking for April through October and August through October (1945–2009) for the Kelly Gage (USGS 2010)

Kelly									
Year	Mean Flow Apr - Oct	Rank	Rank Percent	Rank Category	Year	Mean Flow Aug - Oct	Rank	Rank Percent	Rank Category
1945	619	4	27	MOD DRY	1945	275	13	76	MOD WET
1946	669	7	47	AVE DRY	1946	213	7	41	AVE DRY
1947	758	11	73	MOD WET	1947	291	15	88	MOD WET
1948	589	3	20	MOD DRY	1948	170	2	12	MOD DRY
1949	634	5	33	AVE DRY	1949	204	6	35	AVE DRY
1950	915	13	87	MOD WET	1950	344	16	94	WET
1951	1002	15	100	WET	1951	396	17	100	WET
1952	647	6	40	AVE DRY	1952	217	8	47	AVE DRY
1953	536	2	13	MOD DRY	1953	181	3	18	MOD DRY
1954	719	9	60	AVE WET	1954	230	9	53	AVE WET
1955	495	1	7	DRY	1955	182	4	24	MOD DRY
1956	981	14	93	WET	1956	265	12	71	MOD WET
1957	741	10	67	AVE WET	1957	250	11	65	AVE WET
2006		No data			2006[a]	195	5	29	MOD DRY
2007		No data			2007[a]	161	1	6	DRY
2008	712	8	53	AVE WET	2008	248	10	59	AVE WET
2009	835	12	80	MOD WET	2009	290	14	82	MOD WET

Flow in cfs, study period in red

No data for April through July for 2006 and 2007

[a] 2006 and 2007 August through October data estimated from the NPS Gage

Table 55. Total mean flow ranking for April through October and August through October (1996–2009) for the Granite Creek Gage (USGS 2009c)

Granite Creek									
Year	Mean Flow Apr - Oct	Rank	Rank Percent	Rank Category	Year	Mean Flow Aug - Oct	Rank	Rank Percent	Rank Category
1996	77.4	13	93	WET	1996	17.9	11	79	MOD WET
1997	104.4	14	100	WET	1997	29.1	14	100	WET
1998	69.4	10	71	MOD WET	1998	17.3	10	71	MOD WET
1999	53.4	5	36	AVE DRY	1999	19.2	12	86	MOD WET
2000	52.1	3	21	MOD DRY	2000	9.9	2	14	MOD DRY
2001	43.0	1	7	DRY	2001	8.3	1	7	DRY
2002	57.5	7	50	AVE DRY	2002	12.6	7	50	AVE DRY
2003	60.1	8	57	AVE WET	2003	11.5	5	36	AVE DRY
2004	56.0	6	43	AVE DRY	2004	14.5	8	57	AVE WET
2005	52.6	4	29	MOD DRY	2005	11.8	6	43	AVE DRY
2006	61.0	9	64	AVE WET	2006	11.1	4	29	MOD DRY
2007	46.6	2	14	MOD DRY	2007	10.3	3	21	MOD DRY
2008	71.3	11	79	MOD WET	2008	19.5	13	93	WET
2009	72.7	12	86	MOD WET	2009	15.6	9	64	AVE WET

Flow in cfs, study period in red

Table 56. Total mean flow ranking for April through October and August through October for the Cache Creek (1966–2009) and Buffalo Fork (1963–2009) gages (USGS 2009a and 2009b)

	Cache Creek								Buffalo Fork							
Year	Mean Flow Apr-Oct	Rank	Rank Percent	Rank Category	Mean Flow Aug-Oct	Rank	Rank Percent	Rank Category	Mean Flow Apr-Oct	Rank	Rank Percent	Rank Category	Mean Flow Aug-Oct	Rank	Rank Percent	Rank Category
1963	14.8	19	40	AVE DRY	18	7.3	38	AVE DRY								
1964	19.8	28	60	AVE WET	29	9.9	62	AVE WET								
1965	28.7	43	91	WET	41	11.7	87	MOD WET								
1966	14.5	14	30	MOD DRY	10	6.7	21	MOD DRY	682	14	32	AVE DRY	202	7	16	MOD DRY
1967	21.6	32	68	AVE WET	34	10.5	72	MOD WET	886	30	68	AVE WET	296	25	57	AVE WET
1968	18.5	27	57	AVE WET	32	10.3	68	AVE WET	935	31	70	AVE WET	442	42	95	WET
1969	18.4	26	55	AVE WET	22	7.8	47	AVE DRY	774	21	48	AVE DRY	250	19	43	AVE DRY
1970	20.7	29	62	AVE WET	27	9.7	57	AVE WET	866	28	64	AVE WET	281	24	55	AVE WET
1971	31.7	47	100	WET	47	13.4	100	WET	1157	41	93	WET	429	41	93	WET
1972	29.2	44	94	WET	42	11.9	89	MOD WET	1113	40	91	WET	416	40	91	WET
1973	12.9	11	23	MOD DRY	11	6.7	23	MOD DRY	623	10	23	MOD DRY	204	9	20	MOD DRY
1974	24.7	41	87	MOD WET	38	11.0	81	MOD WET	1201	43	98	WET	357	34	77	MOD WET
1975	18.4	25	53	AVE WET	36	10.6	77	MOD WET	946	32	73	MOD WET	392	38	86	MOD WET
1976	21.3	31	66	AVE WET	28	9.8	60	AVE WET	1014	36	82	MOD WET	366	35	80	MOD WET
1977	6.0	1	2	DRY	3	4.7	6	DRY	387	1	2	DRY	147	1	2	DRY
1978	23.6	39	83	MOD WET	33	10.3	70	AVE WET	1002	34	77	MOD WET	413	39	89	MOD WET
1979	16.1	20	43	AVE DRY	19	7.5	40	AVE DRY	701	16	36	AVE DRY	230	16	36	AVE DRY
1980	17.5	23	49	AVE DRY	25	9.2	53	AVE WET	710	17	39	AVE DRY	256	22	50	AVE DRY
1981	14.5	17	36	AVE DRY	17	7.3	36	AVE DRY	678	13	30	MOD DRY	199	6	14	MOD DRY
1982	24.7	40	85	MOD WET	44	12.3	94	WET	1179	42	95	WET	554	44	100	WET
1983	21.8	33	70	AVE WET	39	11.1	83	MOD WET	816	24	55	AVE WET	345	31	70	AVE WET
1984	21.8	34	72	MOD WET	31	10.2	66	AVE WET	876	29	66	AVE WET	349	32	73	MOD WET
1985	12.7	9	19	MOD DRY	9	6.5	19	MOD DRY	656	12	27	MOD DRY	227	14	32	AVE DRY
1986	30.8	45	96	WET	46	12.6	98	WET	999	33	75	MOD WET	328	27	61	AVE WET
1987	14.5	16	34	AVE DRY	21	7.7	45	AVE DRY	518	5	11	MOD DRY	181	5	11	MOD DRY
1988	13.6	13	28	MOD DRY	8	6.0	17	MOD DRY	600	9	20	MOD DRY	172	4	9	DRY
1989	18.0	24	51	AVE WET	23	8.3	49	AVE DRY	756	20	45	AVE DRY	250	21	48	AVE DRY
1990	12.5	8	17	MOD DRY	13	7.0	28	MOD DRY	701	15	34	AVE DRY	246	18	41	AVE DRY
1991	14.5	15	32	AVE DRY	15	7.1	32	AVE DRY	792	23	52	AVE WET	269	23	52	AVE WET
1992	7.1	2	4	DRY	1	4.0	2	DRY	514	4	9	DRY	202	8	18	MOD DRY
1993	16.8	22	47	AVE DRY	26	9.6	55	AVE WET	832	25	57	AVE WET	350	33	75	MOD WET
1994	12.0	7	15	MOD DRY	4	5.4	9	DRY	502	3	7	DRY	151	2	5	DRY
1995	22.2	35	74	MOD WET	43	12.2	91	WET	859	27	61	AVE WET	344	30	68	AVE WET
1996	27.6	42	89	MOD WET	40	11.5	85	MOD WET	1074	39	89	MOD WET	341	29	66	AVE WET
1997	31.1	46	98	WET	45	12.5	96	WET	1419	44	100	WET	485	43	98	WET
1998	23.1	38	81	MOD WET	37	10.8	79	MOD WET	839	26	59	AVE WET	299	26	59	AVE WET
1999	22.4	36	77	MOD WET	35	10.5	74	MOD WET	1063	38	86	MOD WET	377	37	84	MOD WET
2000	12.8	10	21	MOD DRY	12	6.8	26	MOD DRY	735	19	43	AVE DRY	215	12	27	MOD DRY
2001	8.2	3	6	DRY	2	4.3	4	DRY	413	2	5	DRY	156	3	7	DRY
2002	10.8	5	11	MOD DRY	7	5.6	15	MOD DRY	632	11	25	MOD DRY	222	13	30	MOD DRY
2003	11.5	6	13	MOD DRY	6	5.6	13	MOD DRY	728	18	41	AVE DRY	212	11	25	MOD DRY
2004	13.2	12	26	MOD DRY	16	7.2	34	AVE DRY	569	7	16	MOD DRY	250	20	45	AVE DRY
2005	14.8	18	38	AVE DRY	14	7.0	30	MOD DRY	596	8	18	MOD DRY	229	15	34	AVE DRY
2006	16.7	21	45	AVE DRY	20	7.6	43	AVE DRY	779	22	50	AVE DRY	238	17	39	AVE DRY
2007	9.1	4	9	DRY	5	5.5	11	MOD DRY	519	6	14	MOD DRY	210	10	23	MOD DRY
2008	22.9	37	79	MOD WET	30	10.1	64	AVE WET	1010	35	80	MOD WET	371	36	82	MOD WET
2009	21.1	30	64	AVE WET	24	9.1	51	AVE WET	1036	37	84	MOD WET	334	28	64	AVE WET

Flow in cfs, study period in red

Table 57. Gros Ventre River discharge measurements 2006–2009

Site Description	NPS Gage	Kelly, WY	Highway 89/191 Bridge	Zenith, WY
Date	Discharge (cfs)			
8/2/2006	232			
8/21/2006				16.5
8/23/2006	133			
8/29/2006	163			
9/6/2006	136			
9/8/2006	149			
9/13/2006	130	163 (good)		
9/20/2006	138			
9/26/2006	149			
10/4/2006	155	191 (good)		
10/10/2006	221	260 (good)		76.8
10/18/2006	190	217 (good)		
10/26/2006	174	194 (good)		58.5 (good)
10/31/2006	131	172 (good)		39.9 (good)
11/2/2006		147 (good)	66.0 (good)	
1/19/2007	96.4 (poor)	131 (good)		
3/22/2007	207	224 (good)		
3/23/2007				109
4/12/2007	159	190 (good)	125 (good)	
4/23/2007				93.5
5/2/2007				676
5/31/2007				67.8
6/15/2007		685 (good)		
7/16/2007				6.68 (good)
7/20/2007	165	189 (good)		
8/24/2007		176 (good)		
8/30/2007	103	135 (good)		2.02
9/14/2007				0.650 (poor)
10/11/2007				2.91
3/24/2008				23.4
3/31/2008		106		
4/21/2008				82.6
4/22/2008		186		
5/9/2008		634		
5/21/2008		2880		2790
6/4/2008		1740		1640
6/23/2008				2370
7/16/2008				585
7/30/2008		536		
8/5/2008				88.6
8/25/2008				20.8
8/29/2008		215		
10/7/2008		209		90.9
10/22/2008[a]	176	218		100 (good)
11/20/2008		184		
12/1/2008				74.8
3/17/2009		150		
3/30/2009				51.2
4/23/2009				438
5/8/2009		482		
5/28/2009		2400 (poor)		
6/2/2009				2960

Site Description	NPS Gage	Kelly, WY	Highway 89/191 Bridge	Zenith, WY
Date	Discharge (cfs)			
6/17/2009				1890 (poor)
7/16/2009		911		
7/22/2009				376
8/26/2009		328		77.3
9/23/2009		235		
10/26/2009				94.4
10/29/2009		202		

Discharge measurements shown in red were taken by the USGS

Discharge measurement uncertainty was rated according to Sauer and Meyer (1992); all measurements were rated “fair” (less than 8 percent error) unless otherwise noted. “Good” is less than 5 percent error and “poor” is greater than 8 percent error.

Table 58. Same-day discharge measurements, Gros Ventre River (2006–2009)

GVR Site Name and # or Ditch Name	NPS Gage 1	Savage Ditch	Kelly Gage 2	Newbold Ditch	South Park Supply Ditch	Enterprise Ditch	Price Lucas Ditch	May White Ditch	Wild Cherry Ditch	Highway 89/191 Bridge 5	Spring Gulch Ditch	Zenith Gage 7
Date	**Discharge (cfs)**											
9/13/2006	130		163				20.3					
10/4/2006	155		191									
10/10/2006	221		260								16.2	76.8
10/18/2006	190		217					39.0			5.02	
10/26/2006	174		194									58.5
10/31/2006	131		172									39.9
11/2/2006			147							66.0		
1/19/2007	96.4		131									
3/22/2007	207	**GAIN**	224			**LOSS**						
4/12/2007	159		190							125		
7/20/2007	165		189								77.3	
8/30/2007	103		135									2.02
5/21/2008			2880									2790
6/4/2008			1740				27.8				9.86	1640
10/7/2008			209									90.9
10/21/2008[a]		0.657		< 0.5	2.03	3.11	0.00	0.00	0.00		3.41	
10/22/2008[a]	176		218							119		100
8/26/2009			323									77.3

Discharge measurements shown in red were taken by the United States Geological Survey

[a] Seepage run measurements

Table 59. Daily mean discharge data for the NPS Gage, August through November 2006

NATIONAL PARK SERVICE
Grand Teton National Park – Calendar Year 2006
433825110350101 Gros Ventre River at Upstream NPS Boundary

LOCATION. – Latitude 43°38'25", Longitude 110°35'01" (NAD83) just east of Kelly in Teton County, Wyoming (NE ¼ NE ¼ NE ¼ Section 1, T42N, R115W) The Station is located just downstream of the NPS and US Forest Service boundary (hydrologic unit code 17040102).

DRAINAGE AREA. – 622 square miles (as measured at the downstream USGS gage at Kelly, Station #13015400).

PERIOD OF RECORD. – Seasonal record from August 2006 through November 2008.

GAGE. – Water-stage recorder. The elevation of Station is 6690 feet above mean sea level determined from a GPS survey in September 2008.

REMARKS. –The record is considered fair.

DATES OF SEASONAL OPERATION. – July 1 through November 30. Gage was installed on August 9, 2006.

Discharge, cubic feet per second
CALENDAR YEAR JANUARY TO DECEMBER 2006
DAILY MEAN VALUES

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	---	---	137	147	128	---
2	---	---	---	---	---	---	---	---	138	147	119	---
3	---	---	---	---	---	---	---	---	136	156	131	---
4	---	---	---	---	---	---	---	---	135	165	144	---
5	---	---	---	---	---	---	---	---	134	170	149	---
6	---	---	---	---	---	---	---	---	134	175	150	---
7	---	---	---	---	---	---	---	---	134	200	152	---
8	---	---	---	---	---	---	---	---	138	238	159	---
9	---	---	---	---	---	---	---	---	140	239	172	---
10	---	---	---	---	---	---	---	176	143	230	173	---
11	---	---	---	---	---	---	---	169	141	219	160	---
12	---	---	---	---	---	---	---	163	139	209	149	---
13	---	---	---	---	---	---	---	159	135	199	141	---
14	---	---	---	---	---	---	---	157	133	190	143	---
15	---	---	---	---	---	---	---	156	144	182	134	---
16	---	---	---	---	---	---	---	159	159	185	128	---
17	---	---	---	---	---	---	---	159	163	195	139	---
18	---	---	---	---	---	---	---	156	160	187	145	---
19	---	---	---	---	---	---	---	153	154	179	138	---
20	---	---	---	---	---	---	---	150	151	181	133	---
21	---	---	---	---	---	---	---	147	153	182	142	---
22	---	---	---	---	---	---	---	145	165	172	145	---
23	---	---	---	---	---	---	---	142	170	165	144	---
24	---	---	---	---	---	---	---	141	166	160	129	---
25	---	---	---	---	---	---	---	139	162	161	114	---
26	---	---	---	---	---	---	---	144	158	160	111	---
27	---	---	---	---	---	---	---	154	155	153	114	---
28	---	---	---	---	---	---	---	156	151	148	116	---
29	---	---	---	---	---	---	---	150	149	145	109	---
30	---	---	---	---	---	---	---	146	148	145	98	---
31	---	---	---	---	---	---	---	141	---	141	---	---
TOTAL	---	---	---	---	---	---	---	---	4425	5525	4109	---
MEAN	---	---	---	---	---	---	---	---	148	178	137	---
MAX	---	---	---	---	---	---	---	---	170	239	173	---
MIN	---	---	---	---	---	---	---	---	133	141	98	---
AC-FT	---	---	---	---	---	---	---	---	8780	10960	8150	---

Table 60. Daily mean discharge data for the NPS Gage, July through November 2007

NATIONAL PARK SERVICE
Grand Teton National Park – Calendar Year 2007
433825110350101 Gros Ventre River at Upstream NPS Boundary

LOCATION. – Latitude 43°38'25", Longitude 110°35'01" (NAD83) just east of Kelly in Teton County, Wyoming (NE ¼ NE ¼ NE ¼ Section 1, T42N, R115W) The Station is located just downstream of the NPS and US Forest Service boundary (hydrologic unit code 17040102).

DRAINAGE AREA. – 622 square miles (as measured at the downstream USGS gage at Kelly, Station #13015400).

PERIOD OF RECORD. – Seasonal record from August 2006 through November 2008.

GAGE. – Water-stage recorder. The elevation of Station is 6690 feet above mean sea level determined from a GPS survey in September 2008.

REMARKS. –The record is considered fair below 250 cfs; and poor above 250 cfs.

DATES OF SEASONAL OPERATION. – July 1 through November 30.

Discharge, cubic feet per second
CALENDAR YEAR JANUARY TO DECEMBER 2007
DAILY MEAN VALUES

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	345	133	103	110	143	---
2	---	---	---	---	---	---	324	132	102	109	134	---
3	---	---	---	---	---	---	305	137	101	110	126	---
4	---	---	---	---	---	---	285	138	101	114	123	---
5	---	---	---	---	---	---	276	138	111	118	123	---
6	---	---	---	---	---	---	273	144	126	135	121	---
7	---	---	---	---	---	---	267	146	132	157	118	---
8	---	---	---	---	---	---	254	138	129	159	116	---
9	---	---	---	---	---	---	240	128	123	152	115	---
10	---	---	---	---	---	---	223	120	119	147	117	---
11	---	---	---	---	---	---	212	115	115	142	123	---
12	---	---	---	---	---	---	199	109	112	138	123	---
13	---	---	---	---	---	---	191	106	108	134	122	---
14	---	---	---	---	---	---	184	103	105	130	123	---
15	---	---	---	---	---	---	177	101	103	126	108	---
16	---	---	---	---	---	---	172	100	102	123	108	---
17	---	---	---	---	---	---	169	104	99	125	125	---
18	---	---	---	---	---	---	171	115	99	127	140	---
19	---	---	---	---	---	---	170	143	99	135	144	---
20	---	---	---	---	---	---	160	163	100	174	139	---
21	---	---	---	---	---	---	149	157	99	204	120	---
22	---	---	---	---	---	---	140	147	98	181	98	---
23	---	---	---	---	---	---	133	144	103	164	86	---
24	---	---	---	---	---	---	128	143	113	158	82	---
25	---	---	---	---	---	---	128	135	117	153	82	---
26	---	---	---	---	---	---	134	126	117	152	88	---
27	---	---	---	---	---	---	153	118	116	151	96	---
28	---	---	---	---	---	---	162	113	113	147	98	---
29	---	---	---	---	---	---	157	108	112	142	98	---
30	---	---	---	---	---	---	148	105	111	143	99	---
31	---	---	---	---	---	---	140	103	---	149	---	---
TOTAL	---	---	---	---	---	---	6169	3912	3288	4409	3438	---
MEAN	---	---	---	---	---	---	199	126	110	142	115	---
MAX	---	---	---	---	---	---	345	163	132	204	144	---
MIN	---	---	---	---	---	---	128	100	98	109	82	---
AC-FT	---	---	---	---	---	---	12240	7760	6520	8750	6820	---

Table 61. Daily mean discharge data for the NPS Gage, August through November 2008

NATIONAL PARK SERVICE
Grand Teton National Park – Calendar Year 2008
433825110350101 Gros Ventre River at Upstream NPS Boundary

LOCATION. – Latitude 43°38'25", Longitude 110°35'01" (NAD83) just east of Kelly in Teton County, Wyoming (NE ¼ NE ¼ NE ¼ Section 1, T42N, R115W) The Station is located just downstream of the NPS and US Forest Service boundary (hydrologic unit code 17040102).

DRAINAGE AREA. – 622 square miles (as measured at the downstream USGS gage at Kelly, Station #13015400).

PERIOD OF RECORD. – Seasonal record from August 2006 through November 2008.

GAGE. – Water-stage recorder. The elevation of Station is 6690 feet above mean sea level determined from a GPS survey in September 2008.

REMARKS. – The record is considered fair below 250 cfs, and poor above 250 cfs.

DATES OF SEASONAL OPERATION. – July 1 through November 30. Flows above the rating (6.10 ft or 443 cfs) were not computed (July 1 through August 5).

Discharge, cubic feet per second
CALENDAR YEAR JANUARY TO DECEMBER 2008
DAILY MEAN VALUES

DAY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	---	---	---	---	---	---	---	---	227	160	155	---
2	---	---	---	---	---	---	---	---	272	159	164	---
3	---	---	---	---	---	---	---	---	251	159	175	---
4	---	---	---	---	---	---	---	---	228	164	189	---
5	---	---	---	---	---	---	---	---	214	172	187	---
6	---	---	---	---	---	---	---	406	203	177	170	---
7	---	---	---	---	---	---	---	395	195	173	156	---
8	---	---	---	---	---	---	---	396	187	169	162	---
9	---	---	---	---	---	---	---	400	179	167	170	---
10	---	---	---	---	---	---	---	389	178	168	169	---
11	---	---	---	---	---	---	---	379	183	169	169	---
12	---	---	---	---	---	---	---	350	184	167	165	---
13	---	---	---	---	---	---	---	318	179	166	168	---
14	---	---	---	---	---	---	---	297	173	170	173	---
15	---	---	---	---	---	---	---	282	169	175	152	---
16	---	---	---	---	---	---	---	270	166	178	145	---
17	---	---	---	---	---	---	---	257	167	176	148	---
18	---	---	---	---	---	---	---	248	166	173	148	---
19	---	---	---	---	---	---	---	238	164	172	146	---
20	---	---	---	---	---	---	---	227	165	171	147	---
21	---	---	---	---	---	---	---	220	183	172	144	---
22	---	---	---	---	---	---	---	213	200	173	131	---
23	---	---	---	---	---	---	---	205	199	164	128	---
24	---	---	---	---	---	---	---	201	191	160	123	---
25	---	---	---	---	---	---	---	198	181	161	112	---
26	---	---	---	---	---	---	---	193	176	160	110	---
27	---	---	---	---	---	---	---	183	170	155	113	---
28	---	---	---	---	---	---	---	180	167	153	117	---
29	---	---	---	---	---	---	---	178	163	153	123	---
30	---	---	---	---	---	---	---	175	162	152	130	---
31	---	---	---	---	---	---	---	178	---	151	---	---
TOTAL	---	---	---	---	---	---	---	---	5642	5139	4489	---
MEAN	---	---	---	---	---	---	---	---	188	166	150	---
MAX	---	---	---	---	---	---	---	---	272	178	189	---
MIN	---	---	---	---	---	---	---	---	162	151	110	---
AC-FT	---	---	---	---	---	---	---	---	11190	10190	8900	---

Table 62. Daily mean discharge data for the Kelly Gage, April through September 2008 (USGS 2010)

Water-Data Report 2008

13014500 GROS VENTRE RIVER AT KELLY, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°37'20", long 110°37'30" referenced to North American Datum of 1927, in NW ¼ sec.11, T.42 N., R.115 W., Teton County, WY, Hydrologic Unit 17040102, Blue Miner Lake quad., 3 mi below Turpin Creek, and 0.3 mi south of Kelly, WY.
DRAINAGE AREA.--622 mi².
PERIOD OF RECORD.--June to September 1918, October 1944 to September 1958 (continuous record), 2002, 2006, 2007 miscellaneous discharge measurements, April to September 2008 (seasonal records only).
GAGE.--Water-stage recorder. Elevation of gage is 6,660 ft above NGVD of 1929, from topographic map. National Park Service data collection platform with satellite telemetry at station.
REMARKS.--Records good except for estimated daily discharges, which are poor. Diversions above and below station for irrigation.
EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 6,960 ft³/s, June 16, 1918, gage height, 9.95 ft (site and datum then in use); minimum daily discharge 102 ft³/s, December 16, 1944.
EXTREMES FOR CURRENT YEAR.--Maximum discharge 3680 ft³/s, May 22, gage height 6.44 ft; minimum daily discharge, 103 ft³/s, April 1, 2.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2007 TO SEPTEMBER 2008
DAILY MEAN VALUES

[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	103	423	1,420	2,150	490	253
2	---	---	---	---	---	---	103	343	1,580	2,050	467	289
3	---	---	---	---	---	---	104	305	1,860	1,980	449	275
4	---	---	---	---	---	---	104	309	1,790	1,940	430	256
5	---	---	---	---	---	---	109	354	1,670	1,850	408	243
6	---	---	---	---	---	---	106	487	1,670	1,770	395	234
7	---	---	---	---	---	---	109	641	1,530	1,610	386	227
8	---	---	---	---	---	---	110	639	1,240	1,500	387	223
9	---	---	---	---	---	---	e119	623	1,030	1,420	388	221
10	---	---	---	---	---	---	e125	564	1,050	1,340	382	220
11	---	---	---	---	---	---	e131	514	1,230	1,270	376	224
12	---	---	---	---	---	---	e135	541	1,080	1,160	358	225
13	---	---	---	---	---	---	e141	521	971	1,040	336	220
14	---	---	---	---	---	---	e148	521	911	970	321	214
15	---	---	---	---	---	---	153	532	1,100	931	305	209
16	---	---	---	---	---	---	158	686	1,480	898	295	205
17	---	---	---	---	---	---	154	1,040	1,900	901	285	202
18	---	---	---	---	---	---	156	1,460	2,340	881	277	199
19	---	---	---	---	---	---	173	2,030	2,690	833	264	197
20	---	---	---	---	---	---	219	2,530	2,670	782	257	200
21	---	---	---	---	---	---	212	3,090	2,490	754	250	216
22	---	---	---	---	---	---	193	3,200	2,490	767	243	233
23	---	---	---	---	---	---	190	2,210	2,640	785	238	232
24	---	---	---	---	---	---	210	1,620	2,740	778	233	225
25	---	---	---	---	---	---	208	1,310	2,760	730	230	218
26	---	---	---	---	---	---	189	1,170	2,600	675	225	212
27	---	---	---	---	---	---	177	1,190	2,560	643	220	206
28	---	---	---	---	---	---	192	1,120	2,430	614	216	203
29	---	---	---	---	---	---	275	1,160	2,240	580	214	200
30	---	---	---	---	---	---	439	1,210	2,200	546	211	197
31	---	---	---	---	---	---	---	1,240	---	514	214	---
Mean	---	---	---	---	---	---	165	1,083	1,879	1,118	315	223
Max	---	---	---	---	---	---	439	3,200	2,760	2,150	490	289
Min	---	---	---	---	---	---	103	305	911	514	211	197

Table 63. Daily mean discharge data for the Kelly Gage, October and November, 2008 and April through September 2009 (USGS 2010)

Water-Data Report 2009

13014500 GROS VENTRE RIVER AT KELLY, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°37'20", long 110°37'30" referenced to North American Datum of 1927, in NW ¼ sec.11, T.42 N., R.115 W., Teton County, WY, Hydrologic Unit 17040102, Blue Miner Lake quad., 3 mi below Turpin Creek, and 0.3 mi south of Kelly, WY.

DRAINAGE AREA.--622 mi².

PERIOD OF RECORD.--June to September 1918, October 1944 to September 1958 (continuous record), 2002, 2006, 2007 miscellaneous discharge measurements, April to September 2008 (seasonal records only).

GAGE.--Water-stage recorder. Elevation of gage is 6,660 ft above NGVD of 1929, from topographic map. U.S. Geological Survey data collection platform with satellite telemetry at station.

REMARKS.--Records good. Diversions above and below station for irrigation.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 6,960 ft³/s, June 16, 1918, gage height, 9.95 ft (site and datum then in use); minimum daily discharge 102 ft³/s, December 16, 1944.

EXTREMES FOR CURRENT YEAR.--Maximum discharge 3,920 ft³/s, June 2, gage height 6.61 ft; minimum daily discharge, 139 ft³/s, April 7.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2008 TO SEPTEMBER 2009
DAILY MEAN VALUES

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	196	196	---	---	---	---	150	305	3,220	1,880	537	276
2	195	207	---	---	---	---	149	305	3,490	1,900	515	269
3	195	218	---	---	---	---	148	340	3,640	1,770	497	264
4	201	232	---	---	---	---	147	391	3,200	1,710	483	260
5	209	231	---	---	---	---	144	416	3,030	1,580	475	258
6	213	214	---	---	---	---	140	457	3,030	1,490	463	259
7	210	199	---	---	---	---	139	475	2,840	1,470	464	260
8	204	204	---	---	---	---	146	491	2,530	1,410	464	261
9	202	213	---	---	---	---	155	466	2,110	1,290	458	256
10	204	213	---	---	---	---	160	447	1,780	1,160	436	252
11	209	213	---	---	---	---	162	476	1,670	1,070	410	248
12	205	210	---	---	---	---	171	584	1,920	1,040	391	246
13	204	209	---	---	---	---	187	579	1,940	1,060	377	243
14	207	214	---	---	---	---	208	531	2,060	1,080	368	245
15	210	193	---	---	---	---	241	544	2,130	1,000	364	248
16	214	184	---	---	---	---	275	640	2,100	924	366	258
17	212	187	---	---	---	---	271	790	2,060	876	364	261
18	209	187	---	---	---	---	284	1,030	2,210	841	352	254
19	214	186	---	---	---	---	323	1,500	2,240	819	339	248
20	216	187	---	---	---	---	364	2,080	2,120	824	328	243
21	218	---	---	---	---	---	433	2,370	2,410	804	323	240
22	219	---	---	---	---	---	497	2,240	2,660	760	316	237
23	210	---	---	---	---	---	551	2,270	2,270	721	310	235
24	206	---	---	---	---	---	610	2,340	2,030	696	321	234
25	207	---	---	---	---	---	533	2,300	2,020	674	339	232
26	205	---	---	---	---	---	440	2,360	2,130	692	334	231
27	200	---	---	---	---	---	385	2,280	2,430	708	318	228
28	197	---	---	---	---	---	355	2,330	2,250	678	303	224
29	197	---	---	---	---	---	344	2,480	2,020	638	293	223
30	195	---	---	---	---	---	326	2,590	1,900	597	288	223
31	192	---	---	---	---	---	---	2,970	---	563	283	---
Mean	206	---	---	---	---	---	281	1,270	2,381	1,056	383	247
Max	219	---	---	---	---	---	610	2,970	3,640	1,900	537	276
Min	192	---	---	---	---	---	139	305	1,670	563	283	223

Table 64. Daily mean discharge data for the Kelly Gage, October and November 2009 and April through September 2010 (USGS 2010)

Water-Data Report 2010

13014500 GROS VENTRE RIVER AT KELLY, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°37'20", long 110°37'30" referenced to North American Datum of 1927, in NW ¼ sec.11, T.42 N., R.115 W., Teton County, WY, Hydrologic Unit 17040102, Blue Miner Lake quad., 3 mi below Turpin Creek, and 0.3 mi south of Kelly, WY.

DRAINAGE AREA.--622 mi².

PERIOD OF RECORD.--June to September 1918, October 1944 to September 1958 (continuous record), 2002, 2006, 2007 miscellaneous discharge measurements, April 2008 to September 2010 (seasonal records only).

GAGE.--Water-stage recorder. Elevation of gage is 6,660 ft above NGVD of 1929, from topographic map. U.S. Geological Survey data collection platform with satellite telemetry at station.

REMARKS.--Records good. Diversions above and below station for irrigation.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 6,960 ft³/s, June 16, 1918, gage height, 9.95 ft (site and datum then in use); minimum daily discharge 102 ft³/s, December 16, 1944.

EXTREMES FOR CURRENT YEAR.--Maximum discharge 2,790 ft³/s, June 8, gage height 5.70 ft; minimum daily discharge, 113 ft³/s, December 9.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2009 TO SEPTEMBER 2010
DAILY MEAN VALUES

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	227	218	154	---	---	---	146	255	697	1,370	293	218
2	234	216	145	---	---	---	144	234	811	1,330	286	219
3	234	209	130	---	---	---	144	222	984	1,190	275	213
4	238	205	123	---	---	---	137	220	1,480	995	278	205
5	244	200	121	---	---	---	136	215	2,260	837	279	199
6	246	204	116	---	---	---	140	204	2,370	759	274	194
7	245	208	115	---	---	---	138	196	2,460	705	273	191
8	246	203	115	---	---	---	135	188	2,690	657	268	190
9	251	190	113	---	---	---	139	187	2,500	638	267	194
10	248	178	---	---	---	---	140	191	2,350	637	265	206
11	244	188	---	---	---	---	142	203	2,610	645	256	208
12	241	201	---	---	---	---	152	201	2,200	633	246	203
13	245	192	---	---	---	---	172	198	1,690	612	240	198
14	254	171	---	---	---	---	173	200	1,350	584	239	192
15	260	158	---	---	---	---	171	213	1,310	535	233	185
16	261	150	---	---	---	138	182	265	1,700	496	227	183
17	255	154	---	---	---	140	215	355	2,280	471	222	179
18	250	164	---	---	---	146	249	520	1,950	464	218	175
19	251	171	---	---	---	150	278	752	1,560	450	211	172
20	255	170	---	---	---	145	317	778	1,550	426	206	169
21	254	173	---	---	---	140	381	696	1,580	410	201	167
22	247	168	---	---	---	142	482	656	1,630	437	198	166
23	239	162	---	---	---	145	445	570	1,550	429	203	166
24	235	161	---	---	---	141	379	543	1,460	398	210	166
25	232	163	---	---	---	139	372	507	1,480	371	208	166
26	219	163	---	---	---	140	343	467	1,600	347	202	168
27	219	164	---	---	---	140	317	500	1,610	327	196	168
28	217	169	---	---	---	138	340	605	1,490	317	202	168
29	199	162	---	---	---	142	337	799	1,370	312	220	166
30	198	156	---	---	---	151	293	796	1,340	304	226	165
31	211	---	---	---	---	148	---	695	---	292	220	---
Mean	239	180	---	---	---	---	238	407	1,730	593	237	185
Max	261	218	---	---	---	---	482	799	2,690	1,370	293	219
Min	198	150	---	---	---	---	135	187	697	292	196	165

Table 65. Daily mean discharge data for the Zenith Gage, April through September 2006 (USGS 2009)

Water-Data Report 2006

13015000 GROS VENTRE RIVER AT ZENITH, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°33′26″, long 110°45′46″ referenced to North American Datum of 1983, in SW ¼ NW ¼ SW ¼ sec.34, T.42 N., R.116 W., Teton County, WY, Hydrologic Unit 17040102, on left bank, 20 ft upstream from county road bridge, 0.5 mi southwest of Jackson Hole Country Club, and 5.5 mi north of Jackson.
DRAINAGE AREA.--683 mi².
PERIOD OF RECORD.--July to September 1917, July to September 1918 (monthly discharge only, published in WSP 1317),October 1987 to current year (no winter records).
GAGE.--Water-stage recorder. Elevation of gage is 6,260 ft above NGVD of 1929, from topographic map.
REMARKS.--Records fair. Station equipment includes satellite telemetry. Diversions of about 300 ft³/s for irrigation above station.No regulation.
EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 6,170 ft³/s June 6, 1997; maximum gage height, 22.77 ft,June 10, 1996; no flow on many days.
EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of May 18, 1927, when landslide about 12 mi upstream washed out, released about 60,000 acre-ft of impounded water (discharge not determined).
EXTREMES FOR CURRENT YEAR.--Maximum daily discharge, 2,370 ft³/s May 21; no flow Aug. 22 to Sept. 23.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2005 TO SEPTEMBER 2006
DAILY MEAN VALUES

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	46	528	605	356	35	0.00
2	---	---	---	---	---	---	46	559	608	348	35	0.00
3	---	---	---	---	---	---	47	546	710	333	35	0.00
4	---	---	---	---	---	---	47	517	914	320	34	0.00
5	---	---	---	---	---	---	56	450	1,150	311	33	0.00
6	---	---	---	---	---	---	73	455	1,310	299	30	0.00
7	---	---	---	---	---	---	89	512	1,370	269	27	0.00
8	---	---	---	---	---	---	103	553	1,500	253	25	0.00
9	---	---	---	---	---	---	130	507	1,620	214	29	0.00
10	---	---	---	---	---	---	153	416	1,550	144	29	0.00
11	---	---	---	---	---	---	150	374	1,380	111	25	0.00
12	---	---	---	---	---	---	148	389	1,080	109	24	0.00
13	---	---	---	---	---	---	165	501	1,000	107	24	0.00
14	---	---	---	---	---	---	198	770	1,030	100	23	0.00
15	---	---	---	---	---	---	220	974	983	97	23	0.00
16	---	---	---	---	---	---	199	1,250	765	94	22	0.00
17	---	---	---	---	---	---	213	1,640	605	91	21	0.00
18	---	---	---	---	---	---	232	1,930	573	84	20	0.00
19	---	---	---	---	---	---	243	2,170	572	82	18	0.00
20	---	---	---	---	---	---	244	2,350	583	79	17	0.00
21	---	---	---	---	---	---	241	2,370	575	77	13	0.00
22	---	---	---	---	---	---	255	2,200	527	55	0.00	0.00
23	---	---	---	---	---	---	277	1,960	486	54	0.00	0.00
24	---	---	---	---	---	---	280	1,790	457	53	0.00	2.1
25	---	---	---	---	---	---	275	1,550	418	53	0.00	2.9
26	---	---	---	---	---	---	249	1,620	380	52	0.00	3.3
27	---	---	---	---	---	---	257	1,620	391	50	0.00	5.7
28	---	---	---	---	---	---	308	1,500	384	47	0.00	10
29	---	---	---	---	---	---	365	1,180	385	45	0.00	15
30	---	---	---	---	---	---	447	897	371	43	0.00	20
31	---	---	---	---	---	43	---	710	---	40	0.00	---
Total	---	---	---	---	---	---	5,756	34,788	24,282	4,370	542.00	59.00
Mean	---	---	---	---	---	---	192	1,122	809	141	17.5	1.97
Max	---	---	---	---	---	---	447	2,370	1,620	356	35	20
Min	---	---	---	---	---	---	46	374	371	40	0.00	0.00
Ac-ft	---	---	---	---	---	---	11,420	69,000	48,160	8,670	1,080	117

Table 66. Daily mean discharge data for the Zenith Gage, April through September 2007 (USGS 2009)

Water-Data Report 2007

13015000 GROS VENTRE RIVER AT ZENITH, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°33′26″, long 110°45′46″ referenced to North American Datum of 1983, in SW ¼ NW ¼ SW ¼ sec.34, T.42 N., R.116 W., Teton County, WY, Hydrologic Unit 17040102, on left bank, 20 ft upstream from county road bridge, 0.5 mi southwest of Jackson Hole Country Club, and 5.5 mi north of Jackson.
DRAINAGE AREA.--683 mi².
PERIOD OF RECORD.--July to September 1917, July to September 1918 (monthly discharge only, published in WSP 1317), October 1987 to current year (no winter records).
GAGE.--Water-stage recorder. Elevation of gage is 6,260 ft above NGVD of 1929, from topographic map.
REMARKS.--Records fair except August 2 to September 30, which is poor. Station equipment includes satellite telemetry. Diversions of about 300 ft³/s for irrigation above station. No regulation.
EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 6,170 ft³/s June 6, 1997; maximum gage height, 22.77 ft, June 10, 1996; no flow on many days.
EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of May 18, 1927, when landslide about 12 mi upstream washed out, released about 60,000 acre-ft of impounded water (discharge not determined).
EXTREMES FOR CURRENT YEAR.--Maximum discharge, 764 ft³/s, gage height, 18.50 ft, May 14; minimum daily, 0.35 ft³/s, Sept. 21.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2006 TO SEPTEMBER 2007
DAILY MEAN VALUES

[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	58	518	63	27	2.7	2.0
2	---	---	---	---	---	---	69	631	62	25	2.5	1.8
3	---	---	---	---	---	---	60	682	80	22	2.5	1.5
4	---	---	---	---	---	---	41	659	188	21	2.7	1.3
5	---	---	---	---	---	---	42	564	293	19	3.0	1.1
6	---	---	---	---	---	---	52	465	408	17	3.1	1.4
7	---	---	---	---	---	---	72	378	429	16	3.2	1.5
8	---	---	---	---	---	---	97	322	362	16	2.7	1.5
9	---	---	---	---	---	---	113	302	299	14	2.6	1.5
10	---	---	---	---	---	---	110	363	257	13	2.6	1.5
11	---	---	---	---	---	---	92	450	167	11	2.5	e1.2
12	---	---	---	---	---	---	77	549	92	10	2.4	e0.90
13	---	---	---	---	---	---	63	631	119	9.0	2.6	e0.80
14	---	---	---	---	---	---	52	700	101	7.8	2.4	e0.65
15	---	---	---	---	---	---	50	697	106	7.3	2.0	0.50
16	---	---	---	---	---	---	60	600	118	6.6	1.6	0.50
17	---	---	---	---	---	---	73	550	127	6.4	1.5	0.50
18	---	---	---	---	---	---	110	546	125	5.8	1.5	0.50
19	---	---	---	---	---	---	138	540	97	5.4	1.5	0.50
20	---	---	---	---	---	---	127	541	79	4.8	e1.2	0.50
21	---	---	---	---	---	---	108	548	69	4.7	e1.0	0.35
22	---	---	---	---	---	---	100	507	56	4.7	1.5	0.37
23	---	---	---	---	---	---	95	394	49	4.3	1.5	0.50
24	---	---	---	---	---	---	91	312	46	4.0	1.6	0.90
25	---	---	---	---	---	---	94	243	42	3.9	1.8	1.00
26	---	---	---	---	---	---	119	198	39	3.9	1.8	1.1
27	---	---	---	---	---	---	132	164	36	3.5	1.7	1.1
28	---	---	---	---	---	---	150	132	33	3.4	1.5	1.0
29	---	---	---	---	---	---	230	174	31	3.1	1.5	1.0
30	---	---	---	---	---	---	365	162	29	2.8	2.1	1.0
31	---	---	---	---	---	---	---	98	---	2.7	2.1	---
Total	---	---	---	---	---	---	3,040	13,620	4,002	305.1	64.9	29.97
Mean	---	---	---	---	---	---	101	439	133	9.84	2.09	1.00
Max	---	---	---	---	---	---	365	700	429	27	3.2	2.0
Min	---	---	---	---	---	---	41	98	29	2.7	1.0	0.35
Ac-ft	---	---	---	---	---	---	6,030	27,020	7,940	605	129	59

Table 67. Daily mean discharge data for the Zenith Gage, April through September 2008 (USGS 2009)

Water-Data Report 2008

13015000 GROS VENTRE RIVER AT ZENITH, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°33′26″, long 110°45′46″ referenced to North American Datum of 1983, in SW ¼ NW ¼ SW ¼ sec.34, T.42 N., R.116 W., Teton County, WY, Hydrologic Unit 17040102, on left bank, 20 ft upstream from county road bridge, 0.5 mi southwest of Jackson Hole Country Club, and 5.5 mi north of Jackson.
DRAINAGE AREA.--683 mi².
PERIOD OF RECORD.--July to September 1917, July to September 1918 (monthly discharge only, published in WSP 1317), October 1987 to current year (no winter records).
GAGE.--Water-stage recorder. Elevation of gage is 6,260 ft above NGVD of 1929, from topographic map.
REMARKS.--Records fair. Station equipment includes satellite telemetry. Diversions of about 300 ft³/s for irrigation above station. No regulation.
EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 6,170 ft³/s June 6, 1997; maximum gage height, 22.77 ft, June 10, 1996; no flow on many days.
EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of May 18, 1927, when landslide about 12 mi upstream washed out, released about 60,000 acre-ft of impounded water (discharge not determined).
EXTREMES FOR CURRENT YEAR.--Maximum discharge, 3,130 ft³/s, May 21, gage height, 20.09 ft; minimum daily discharge, 4.8 ft³/s, Aug. 31.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2007 TO SEPTEMBER 2008
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	e18	266	1,170	1,970	145	5.6
2	---	---	---	---	---	---	e18	215	1,230	1,880	104	45
3	---	---	---	---	---	---	e18	185	1,530	1,870	101	102
4	---	---	---	---	---	---	e19	185	1,600	1,750	96	103
5	---	---	---	---	---	---	e20	209	1,560	1,540	93	97
6	---	---	---	---	---	---	e19	290	1,540	1,480	90	92
7	---	---	---	---	---	---	e19	383	1,440	1,350	87	88
8	---	---	---	---	---	---	e19	404	1,230	1,230	87	85
9	---	---	---	---	---	---	e19	397	1,070	1,150	86	86
10	---	---	---	---	---	---	e20	368	1,010	1,090	87	84
11	---	---	---	---	---	---	e20	337	1,030	991	85	85
12	---	---	---	---	---	---	e20	345	948	889	81	87
13	---	---	---	---	---	---	e30	342	880	752	77	84
14	---	---	---	---	---	---	e50	334	826	657	73	81
15	---	---	---	---	---	---	e85	339	822	605	69	78
16	---	---	---	---	---	---	e75	404	891	573	65	75
17	---	---	---	---	---	---	e75	597	1,010	512	62	73
18	---	---	---	---	---	---	e80	809	1,230	436	59	71
19	---	---	---	---	---	---	e85	1,090	1,440	405	57	69
20	---	---	---	---	---	---	96	1,620	1,480	374	53	70
21	---	---	---	---	---	---	80	2,380	1,350	335	49	76
22	---	---	---	---	---	---	80	2,640	1,340	322	47	85
23	---	---	---	---	---	---	80	1,690	2,090	324	45	86
24	---	---	---	---	---	---	90	1,300	2,140	311	43	84
25	---	---	---	---	---	---	92	1,140	2,200	290	31	80
26	---	---	---	---	---	---	82	1,100	2,030	261	14	78
27	---	---	---	---	---	---	73	1,100	1,870	247	12	78
28	---	---	---	---	---	---	79	1,070	1,970	240	11	76
29	---	---	---	---	---	---	127	1,080	1,810	228	7.1	74
30	---	---	---	---	---	---	239	1,100	1,920	217	5.5	73
31	---	---	---	---	---	---	---	1,100	---	193	4.8	---
Total	---	---	---	---	---	---	1,827	24,819	42,657	24,472	1,926.4	2,350.6
Mean	---	---	---	---	---	---	60.9	801	1,422	789	62.1	78.4
Max	---	---	---	---	---	---	239	2,640	2,200	1,970	145	103
Min	---	---	---	---	---	---	18	185	822	193	4.8	5.6
Ac-ft	---	---	---	---	---	---	3,620	49,230	84,610	48,540	3,820	4,660

Table 68. Provisional daily mean discharge data for the Zenith Gage, October and November 2008 (Green 2009)

13015000 GROS VENTRE RIVER AT ZENITH, WY

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2008 - SEPTEMBER 2009
PROVISIONAL[a] DAILY MEAN VALUES

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	72	97	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
2	75	105	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
3	79	112	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
4	83	127	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
5	87	127	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
6	91	116	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
7	90	105	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
8	88	102	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
9	90	111	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
10	90	112	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
11	93	111	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
12	94	109	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
13	92	110	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
14	93	116	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
15	95	104	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
16	97	93	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
17	99	94	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
18	104	94	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
19	109	93	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
20	108	92	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
21	109	92	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
22	111	85	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
23	106	76	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
24	101	78	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
25	101	69	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
26	100	65	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
27	98	65	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
28	94	66	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
29	96	67	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
30	97	71	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
31	96	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mean	95	95	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Min	72	65	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Max	111	127	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

[a] – This data is unpublished and provisional (Green, 2009)

Table 69. Daily mean discharge data for the Zenith Gage, April through September 2009 (USGS 2009)

Water-Data Report 2009

13015000 GROS VENTRE RIVER AT ZENITH, WY

Snake Headwaters Basin Gros Ventre Subbasin

LOCATION.--Lat 43°33′26″, long 110°45′46″ referenced to North American Datum of 1983, in SW ¼ NW ¼ SW ¼ sec.34, T.42 N., R.116 W., Teton County, WY, Hydrologic Unit 17040102, on left bank, 20 ft upstream from county road bridge, 0.5 mi southwest of Jackson Hole Country Club, and 5.5 mi north of Jackson.
DRAINAGE AREA.--683 mi².
PERIOD OF RECORD.--July to September 1917, July to September 1918 (monthly discharge only, published in WSP 1317), October 1987 to current year (no winter records).
GAGE.--Water-stage recorder. Elevation of gage is 6,260 ft above NGVD of 1929, from topographic map.
REMARKS.--Records fair. Station equipment includes satellite telemetry. Diversions of about 300 ft³/s for irrigation above station.
EXTREMES FOR PERIOD OF RECORD.--Maximum daily discharge, 6,170 ft³/s June 6, 1997; maximum gage height, 22.77 ft, June 10, 1996; no flow on many days.
EXTREMES OUTSIDE PERIOD OF RECORD.--Flood of May 18, 1927, when landslide about 12 mi upstream washed out, released about 60,000 acre-ft of impounded water (discharge not determined).
EXTREMES FOR CURRENT YEAR.--Maximum discharge, 3,560 ft³/s June 3, gage height, 20.88 ft; minimum daily discharge, 10 ft³/s Sept. 28.

DISCHARGE, CUBIC FEET PER SECOND
WATER YEAR OCTOBER 2008 TO SEPTEMBER 2009
DAILY MEAN VALUES
[e, estimated]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	---	---	---	---	---	---	50	213	3,170	1,620	245	66
2	---	---	---	---	---	---	49	208	3,080	1,660	243	64
3	---	---	---	---	---	---	46	224	3,230	1,480	235	63
4	---	---	---	---	---	---	46	252	3,020	1,410	228	62
5	---	---	---	---	---	---	44	278	3,000	1,270	221	61
6	---	---	---	---	---	---	41	306	3,050	1,130	213	60
7	---	---	---	---	---	---	38	317	2,700	1,060	205	60
8	---	---	---	---	---	---	45	330	2,490	991	196	61
9	---	---	---	---	---	---	55	324	2,110	845	190	60
10	---	---	---	---	---	---	63	303	1,580	692	183	59
11	---	---	---	---	---	---	71	307	1,370	599	176	58
12	---	---	---	---	---	---	80	336	1,660	554	169	56
13	---	---	---	---	---	---	98	357	1,760	527	156	56
14	---	---	---	---	---	---	124	313	1,830	533	144	51
15	---	---	---	---	---	---	158	314	1,990	508	135	43
16	---	---	---	---	---	---	185	397	1,900	480	128	45
17	---	---	---	---	---	---	193	625	1,880	452	123	48
18	---	---	---	---	---	---	205	974	2,040	421	116	47
19	---	---	---	---	---	---	234	1,660	2,080	408	107	45
20	---	---	---	---	---	---	268	2,460	1,950	399	102	44
21	---	---	---	---	---	---	325	2,690	2,180	379	96	42
22	---	---	---	---	---	---	384	2,610	2,550	358	91	42
23	---	---	---	---	---	---	431	2,700	1,990	e330	87	41
24	---	---	---	---	---	---	472	2,800	1,650	e310	83	31
25	---	---	---	---	---	---	413	2,670	1,630	e290	80	e25
26	---	---	---	---	---	---	331	2,760	1,830	e280	76	e20
27	---	---	---	---	---	---	281	2,730	2,310	e280	74	e15
28	---	---	---	---	---	---	260	2,680	2,140	290	72	e10
29	---	---	---	---	---	---	247	2,830	1,820	274	70	e15
30	---	---	---	---	---	---	226	2,900	1,650	260	69	32
31	---	---	---	---	---	---	---	3,080	---	247	68	---
Total	---	---	---	---	---	---	5,463	40,948	65,640	20,337	4,381	1,382
Mean	---	---	---	---	---	---	182	1,321	2,188	656	141	46.1
Max	---	---	---	---	---	---	472	3,080	3,230	1,660	245	66
Min	---	---	---	---	---	---	38	208	1,370	247	68	10
Ac-ft	---	---	---	---	---	---	10,840	81,220	130,200	40,340	8,690	2,740

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