SURFACE WATER STATION ANALYSIS/ DESCRIPTION
SEASONAL WATER YEARS 2006 - 2009
GROS VENTRE RIVER AT UPSTREAM NPS BOUNDARY – 433825110350101
GRAND TETON NATIONAL PARK

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LOCATION

The National Park Service's Water Resource Division – Water Rights Branch (NPS-WRB) surface water gaging station (Station) on Gros Ventre River (GVR) on the south-eastern boundary of Grand Teton National Park (GRTE) is located at 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 (USFS) boundary (hydrologic unit code 17040102) (**Figure 1**). A US Geological Survey (USGS) gage at Zenith, WY (13015000 Gros Ventre River at Zenith[1], WY) is located approximately 14 miles downstream of the NPS Station. Also, in WY2008 the NPS contracted with the USGS to re-install the stream gage at Kelly, WY (13015400 Gros Ventre River at Kelly[2], WY) just 2.7 miles downstream of the NPS Station (**Figure 2**).

To access the Station from the GRTE Science and Resource Management offices in Moose, WY travel west on Teton Park Road for about 0.6 miles (**Figure 3**). Turn south on Highway 89/191 and travel about 5.5 miles to Gros Ventre Junction. Turn east on Gros Ventre River Road and travel approximately 7 miles to the town of Kelly. The road takes a 90 degree turn north in the town of Kelly. A little over a mile past Kelly the Gros Ventre River Road turns right towards Kelly Warm Springs. After approximately 2.2 miles you cross the NPS/USFS boundary. Park the vehicle in the dirt pull-off on the south side of the road and walk on the west side of the wooden fence/NPS boundary down to the GVR. The gage is just downstream.

ESTABLISHMENT

The Station staff gage was installed on July 25, 2006 and the datalogger was installed on August 8, 2006. The Station began recording at 15 minute intervals starting on August 9, 2006. The Station was established by NPS-WRB to develop a water budget to evaluate water rights and use on the GVR and to support efforts to minimize or eliminate de-watering downstream of the Highway 89/191 Bridge. Station data work-up was limited to July through November (during the irrigation season) and the Station was discontinued on November 30, 2008. The data logger was removed on August 31, 2009. The staff plate remains in place at the request of GRTE.

The USGS Kelly gage is a better location for a gaging station because of the stable control (low head dam), the more uniform channel bottom for wading measurements, and the ability to collect high flow discharge measurements (up to 700 cfs by wading and over 700 cfs via the Kelly bridge). The NPS boundary gage was originally installed to determine flows entering GRTE and in 2008 it was determined that the USGS Kelly gage could be used as a surrogate for NPS boundary gage. Discharges at Kelly are typically higher than at the NPS station by 20 to 40 cubic feet per second (cfs) due to runoff and spring inflow downstream of the NPS Station (see *Special Computations* discussion below).

ELEVATION

The elevation of the station is approximately 6,690 feet above the North American Vertical Datum (NAVD), 1988 as determined from a GPS[3] survey in September, 2008.

[1] http://nwis.waterdata.usgs.gov/wy/nwis/uv?13015000
[2] http://nwis.waterdata.usgs.gov/wy/nwis/uv/?site_no=13014500&agency_cd=USGS
[3] Global Positioning System

HYDROLOGIC CONDITIONS / DRAINAGE AREA

The GVR is located in northwestern Wyoming northeast of Jackson and southeast of GRTE (**Figure 1**). The headwaters of the GVR reside in the Gros Ventre Mountains, east and southeast of GRTE in the Bridger-Teton National Forest. From the Gros Ventre Mountains, the river flows westerly towards the Teton Valley, where it forms part of the southern boundary of GRTE, and eventually joins the Snake River about 5 miles northwest of Jackson, WY.

The GVR is a cobble-bed mountain river with a drainage basin area of 622 square miles (as measured at the downstream USGS station at Kelly). Elevations in the Gros Ventre watershed range from over 10,000 ft in the Gros Ventre Mountains in the Bridger-Teton National Forest to about 6,200 feet at the GVR's confluence with the Snake River. The average annual total precipitation recorded for Jackson, WY is about 16-inches/year. Precipitation is directly influenced by topography and generally increases with elevation. Some areas in the upstream portions of the Gros Ventre watershed receive significantly more precipitation, up to 30-inches/year. Monthly average temperatures range from approximately 17 °F January to 61 °F and monthly maximum temperatures range from 26 °F to 67 °F (WRCC, 2006).

The NOAA (National Oceanic and Atmospheric Administration) NCDC (National Climate Data Center) weather station at Moose, WY (cooperative station number 486428) was used to relate precipitation events and temperature to gage data. The Moose weather station is located within the Snake River drainage basin at an elevation of 6470 feet and 6.7 miles northwest of the Station. Data from the Moose station is available on-line at http://www.ncdc.noaa.gov/oa/ncdc.html. See Section 5 of the water year folder for precipitation data.

From the GRTE boundary on the Gros Ventre downstream to the town of Kelly, WY, Tensleep Sandstone, Amsden and Phosphoria Formations and Madison Limestone outcrops are found adjacent to the river. This part of 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 the town of Kelly. Kelly Warm Springs and Teton Valley Ranch Warm Springs manifests along the downthrown (west) side of this normal fault. From Kelly downstream to the GVR's confluence with the Snake River, alluvial gravel underlies and surrounds the river. Terrace gravel, floodplain and swamp deposits, as well as glacial outwash also surround the river. Downstream from Kelly the GVR becomes wide and severely braided indicating the extent of the alluvium and the lack of bedrock outcropping 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 Tweeinot and Shooting Iron Formations (Love et al. 1999, Love and Love 1988).

Riparian vegetation along the lower GVR is comprised mostly of narrowleaf cottonwood (*Populus angustifolia*) and sandbar willow (*Salix exigua)* cover. Habitat types are generally defined as palustrine and riverine (LGVRSG 1990). Upland land cover surrounding the lower GVR is comprised of mountain sagebrush, aspen forest and irrigated cropland. In the mountains surrounding the lower GVR, Douglas fir is the dominant land cover type.

CHANNEL AND CONTROL

The channel bottom is composed of large cobbles and small to large boulders. The right bank is a steep eroding terrace comprised of old river deposits of sand, cobbles, and small boulders. The left bank is a low elevation cobble bar with young riparian vegetation and is partially submerged in high flows. The channel is straight for about 100 feet upstream before the GVR bends south and splits around a cobble bar. The channel is straight for about 220 feet downstream where it bends 90 degrees at a bedrock outcrop (**Figure 4**).

The section control during low and mid-flows is a cobble and small boulder riffle downstream of the staff gage (**Figure 5**). This riffle may get re-worked seasonally in high flows and/or during ice affect but has remained 50-150 feet downstream of the Station's staff gage since installation. The section control gets submerged at a gage height between 5.8 and 6.6 feet. The channel control at high flows is the bedrock outcrop at the 90 degree bend in the river approximately 220 feet downstream (**Figure 6**).

Since Station operation and discharge measurements were limited to a 2-year 3-month period it was not possible to get repetitive confirmation of changes to the section control as a result of high flows and/or ice affect. According to measurements taken before and after high flows in 2007 and in 2008 it appears that the section control remained stable

(due to the continuous -0.08 shift during that period, see *Discharge, Rating, and Shifts* section below). According to the ice affected periods of 2006/2007 and 2007/2008 only the 2006/2007 winter appears to have effected the section control (shown by a change from a 0.00 shift before ice affect to a -0.08 shift following ice affect, see *Discharge, Rating, and Shifts* section below). This is plausible since the winter of 2006/2007 had a significant ice damn event in January (see **Figure 7** for comparison hydrographs of the winter of 2006/2007 and the winter of 2007/2008).

GAGE

The stage sensor / datalogger is an In-Situ Inc. Level Troll 500 (Serial #108835). The datalogger is housed in a Hoffman steel enclosure mounted to a tree (**Figure 8**). Gage height data are logged at 15 minute intervals. The datalogger cable is housed in 1 inch buried flexible conduit (**Figure 9**). At the right edge of water 1.5 inch galvanized pipe houses the datalogger and cable which is secured to the channel bottom with steel U-clamps and pins. The base gage is an enameled outside vertical staff (OVS) reading from 3.34 to 7.34 feet, mounted on a treated 2 x 6 inch wood board in 6 inch steel u-channel and secured to the channel bottom with solid steel round rod driven approximately 2 feet into the channel bottom (**Figure 10**).

The NPS-WRB has a cooperative agreement with the Lakewood, Colorado District of the USGS to use their database for processing stream flow records (Automated Data Processing System, ADAPS, version 4.7). Streamflow records for the Gros Venter River Station are processed on a water year basis under the ADAPS station name and number: Gros Ventre River at Upstream NPS Boundary, #433825110350101.

GAGE HEIGHT RECORD (Refer to *Sections 2* and *6* of water year folder)

Manual stage readings (from the OVS) are recorded during datalogger downloads, discharge measurements, and site visits (See *Site Visit Summary* spreadsheet in *Section 2* of the water year folder). Stage readings are noted to the nearest 0.01 foot.

The datalogger's 15 minute gage height record (96 unit values per day) is complete from August 9, 2006 through November 30, 2008 with the exception of the following (refer to the unit values inventory tables in *Section 6* of the water year folder):

- On ten occasions, 86, 93, 94 or 95 values are recorded each day instead of the usual 96. These missing values correspond with site visits when data were being downloaded.
- On August 11, 2006, 99 values are recorded instead of the usual 96. The additional values correspond with a site visit with multiple manual starts of the datalogger.
- On October 30, 2006, 97 values were recorded instead of the usual 96. The additional value corresponds with a site visit when the 15 minute interval was changed from the standard reference (on the hour, 15 minutes after the hour, 30 minutes after the hour, and 45 minutes after the hour) to a non-standard reference.
- On March 22, 2007, 50 unit values are recorded instead of the ususal 96. The logger was set to 12:00 a.m. instead of 12:00 p.m. resulting in 12 hours of missing values.

The following edits were made to the gage height record from August 9, 2006 through November 30, 2008:

- Since the Station was installed to gather flow data for the irrigation season (July 1 through November 30), unit values for December 1 through June 30 were X'd out in Hydra.
- On August 25, 2006, two unit values were X'd out in Hydra as erroneous. The erroneous values correspond with a site visit when problems were encountered resetting the datalogger (refer to the site visit unit value table in *Section 6* of the water year folder).

DATA CORRECTIONS (Refer to data correction tables in *Section 6* of water year folder)

Manual stage readings are compared to the datalogger readings to determine if corrections to the continuous record are necessary. For water years 2006-2009, data corrections ranging from -0.04 to +0.03 feet (with one exception dicussed below) were made to the record. These data corrections are minimal and are likely due to instrament drift. See **Table 1** for data corrections.

A -0.14 difference between the datalogger and staff gage occurred sometime between November 15, 2007 and September 16, 2008 (a period of almost 10 months[4]). According to levels surveys the elevation of the staff gage remained unchanged during this time period (see *Reference and Benchmarks / Level Surveys* section below). A plot of raw unit values did show a data jump on February 22, 2008 during ice affect (**Figure 7**); it is likely that ice shifted the orifice/datalogger housing. This could not be confirmed with the final levels survey on April 23, 2009 due to high flows (see *Reference and Benchmarks / Level Surveys* section below). In addition, a site visit to download the datalogger occurred on February 22, 2008; the staff plate could not be read due to ice. It is unknown if activities during the site visit are connected to the jump in data. No other jumps appear in the record prior to September 16, 2008,therefore, the -0.14 correction was applied to the record starting on February 22, 2008. A continuous correction was made until the datalogger was reset on September 16, 2008.

Table 1: Data Corrections

CORRECTION CURVES

Correction set #1 Gage Height Corrections

DD 1, Gage height (ft)

	STARTS	AGE	ENDS	INPUT	CORR.	INPUT	CORR.	INPUT	CORR.
PRV: None									
				2006 Water Year					
1	2006/08/25 08:33:00 MDT	R		5.34	0.00				
	Transitional data corr 0.00 to -0.03								
2	2006/08/29 08:30:00 MDT	R		5.43	-0.03				
	Transitional data corr -0.03 to 0.00								
3	2006/09/06 08:45:00 MDT	R		5.32	0.00				
4	2006/09/08 14:00:00 MDT	R		5.34	0.00				
	Transitional data corr 0.00 to 0.01								
5	2006/09/13 08:50:00 MDT	R		5.32	0.01				
	Transitional data corr 0.01 to 0.02								
6	2006/09/20 08:47:00 MDT	R		5.37	0.02				
	Continuous data corr of 0.02								
7	2006/09/22 12:58:00 MDT	R	2006/09/22 12:59:00 MDT	5.43	0.02				
	Data logger reset 1st reset UV @ 13:30								
				2007 Water Year					
1	2006/10/10 09:43:00 MDT	R		5.66	0.00				
	Transitional data corr 0.00 to 0.01								
2	2006/10/18 09:31:00 MDT	R		5.53	0.01				
	Continuous data corr of 0.01								
3	2006/10/26 09:56:00 MDT	R		5.42	0.01				
	Transitional data corr 0.01 to 0.00								
4	2006/10/27 11:50:00 MDT	R		5.41	0.00				
5	2006/10/30 10:30:00 MST	R		5.37	0.00				
	Transitional data corr 0.00 to 0.02								
6	2006/10/31 11:15:00 MST	R	2006/10/31 11:28:00 MST	5.33	0.02				
	Data logger reset 1st reset UV @ 11:29								
7	2007/03/22 12:04:00 MDT	R		5.61	0.00				
	Transitional data corr 0.00 to -0.03								
8	2007/04/11 09:45:00 MDT	R	2007/04/11 09:46:00 MDT	5.54	-0.03				
	Data logger reset								
9	2007/06/15 09:56:00 MDT	R		6.64	0.00				
	Transitional data corr 0.00 to -0.04								
10	2007/07/20 09:16:00 MDT	R	2007/07/20 09:17:00 MDT	5.52	-0.04				
	Data logger reset 1st reset UV @ 09:31								
11	2007/07/20 09:18:00 MDT	R		5.48	0.00				
	Transitional data corr 0.00 to -0.03								
12	2007/07/25 15:22:00 MDT	R		5.39	-0.03				
	Transitional data corr -0.03 to -0.01								
13	2007/08/03 11:13:00 MDT	R		5.40	-0.01				
	Continuous data corr of -0.01								
14	2007/08/30 11:30:00 MDT	R		5.23	-0.01				
	Transitional data corr -0.01 to 0.00								
				2008 Water Year					
1	2007/10/05 10:43:00 MDT	R		5.29	0.00				
	Transitional data corr 0.00 to 0.01								
2	2007/10/18 09:01:00 MDT	R		5.32	0.01				
	Transitional data corr 0.01 to 0.03								
3	2007/11/15 09:33:00 MST	R	2007/11/15 09:34:00 MST	5.21	0.03				
	Data logger reset 1st reset UV @ 09:45								
4	2008/02/22 13:45:00 MST	R	2008/09/16 13:30:00 MDT	5.25	-0.14				
	Cont data corr -0.14 logger reset 1st UV @ 13:45								
5	2008/09/16 13:31:00 MDT	R		5.50	0.00				
	Transitional data corr 0.00 to 0.02								
6	2008/09/17 10:09:00 MDT	R		5.49	0.02				
	Continuous data corr 0.02								
				2009 Water Year					
1	2008/10/23 17:45:00 MDT	R	2008/10/23 17:46:00 MDT	5.46	0.02				
	Data logger reset 1st reset UV @ 18:03								
NXT: None									

Insert from ADAPS

[4] Site visits and discharge measurements at the NPS gage decreased during 2008 since the USGS gage at Kelly (USGS13015400) was installed in March of 2008.

On five occassions (October 27, 2006, March 22, 2007, April 12, 2007, June 15, 2007, and April 24, 2009) data corrections of -0.01 to +0.05 were not made due to fluctuating staff gage heights and/or data logger levels (see *Site Visit Summary Spreadsheet* in Section 2 of the water year folder). On three occasions (August 25, 2006, October 2, 2006, and July 20, 2007) a +/- 0.01 data correction was not made due to the minimal difference with no associated trends; +/-0.01 is considered within observation errror. Corrections of +/- 0.01 were only made if they were associated with a trend related to corresponding site visits.

HISTORY

The NPS Station collected stage data on 15-minute intervals from August 2006 through August 2009. A chronological log of the Station history is shown below.

July 25 and August 8, 2006	NPS Station installed
March, 2008	USGS re-installed gage at Kelly; funding provided by NPS
November 30, 2008	End of NPS gage data work-up
August 31, 2009	Removal of data logger and associated piping and housing. Staff plate was left in place at the request of GRTE.

The USGS measured seasonal stream discharge at the Kelly gage, approximately 2.7 miles downstream of the NPS gage, in 1918 and from 1945 to 1958. The USGS gage at Zenith, approximately 14 miles downstream of the NPS gage, has been recording seasonal (April – November) stream discharge since 1987.

REFERENCE AND BENCHMARKS / LEVEL SURVEYS (Refer to *Section 4* of water year folder)

Three reference marks (RM-1, RM-2, and RM-3), and three measuring points were established at the Station for elevation control. See **Table 2** for elevations. Reference marks RM-1, RM-2, and RM-3 were installed in July 2006 and are rebar with end caps driven into the right bank and set in concrete (**Figure 11 and Figure 12**). Reference mark elevations remained unchanged during the Station's operation. RM-3 shows a +0.01 change during the November 1, 2006 survey. It was noted that the end cap was not installed completely level, therefore it was noted in the 2007 and 2009 survey's that the middle point of the endcap was surveyed.

Three measuring points (MP-1, MP-2, and MP-3) were established on the staff gage as shown in **Figure 10** to determine elevation changes: 1) a bolt installed near 6 feet (MP-1), 2) the downstream top of the metal staff plate (MP-2), and 3) the downstream top of the 2 x 6 treated wood board the staff plate is secured to (MP-3). MP-3 was the least repeatable due to the greater surface area. The staff gage was visibly canted downstream and towards the left bank following the first winter after installation. Levels surveys indicate the elevation of MP's on the staff gage changed up to -0.04 feet during the Station's operation (see *Datum Corrections* section below).

Table 2: Reference, and measuring point elevations.

Date	RM-1	RM-2 [1]	RM-3	MP-2 (Metal)	MP-3 (Wood)	MP -1 (Bolt)	Datum Correction [2]	Remarks
08/09/06	17.77	17.43	17.46	7.34	7.33	6.11	0.00	Staff Gage (DS Top of Metal) used as base[1] to establish all elevations to gage datum
11/01/06	17.77	17.43	17.47	7.34	7.33	6.10	+0.01	RM-2 used as base
04/11/07	17.77	17.43	17.46	7.31	7.29	6.08	+0.03	RM-2 used as base
04/23/09	17.77	17.43	17.46	7.31	7.29	6.08	+0.03	RM-2 used as base

[1] The base is the reference mark on which all reference mark elevations are based (it is considered the most stable).
[2] See *Datum Corrections* section below

The orifice behind the end cap was surveyed after installation on August 9, 2006 but could not be re-surveyed during the close-out survey on April 23, 2009 due to high flows. The point of zero flow and a cross section of the section control were not surveyed during the Station's operation due to coarse substrate, flows that didn't drop below 100 cfs, annual re-working of the riffle during high flows, the length and width of the riffle (over 60 feet wide and 50 feet long), and the stage dependant location of the riffle.

DATUM CORRECTIONS (Refer to *Section 4* of water year folder for survey data and *Section 6* for datum correction tables)

According to level surveys, MP-1 showed a -0.01 (-0.006 [5]) change in elevation between installation on August 9, 2006 and November 9, 2006; MP-2, and MP-3 did not show the same elevation change (-0.003 and -0.002, respectively, **Table 2**). All MP's showed a change in elevation after the first winter (2006/2007) when the staff plate was visibly canted. MP-1 and MP-2 showed a -0.03 elevation change (-0.026 and -0.034, respectively) and MP-3 showed a -0.04 elevation change (-0.038). Since the gage was canted downstream and towards the left bank there is a greater elevation change at the top of the staff plate (7.34 feet) than at the bolt near 6 feet. The staff gage remained stable after the 2006/2007 winter through the last survey in April of 2009.

Transitional datum corrections were made from 0.00 feet at gage start-up to +0.01 feet on the November 2006 survey; and +0.01 feet from the November survey to +0.03 feet to the April 2007 survey (**Table 3**). A continuous correction of +0.03 was made from the April 2007 survey to the end of the record.

Table 3: Datum Corrections

U.S. DEPARTMENT OF THE INTERIOR - U.S. GEOLOGICAL SURVEY - WATER RESOURCES

STATION:433825110350101 GROS VENTRE RIVER AT UPSTREAM NPS BOUNDRY TYPE:STREAM AGENCY:USNPS STATE:56 COUNTY:039
LATITUDE: 433825.36 LONGITUDE: 1103501.60 NAD83 DRAINAGE AREA: CONTRIBUTING DRAINAGE AREA: DATUM:
Date Processed: 2009-07-28 16:20 By jchafey

Correction set #2 Datum Corrections from Levels

CORRECTION CURVES
DD 1, Gage height (ft)

	STARTS	AGE	ENDS	INPUT	CORR.	INPUT	CORR.	INPUT	CORR.
PRV: None									
				2006 Water Year					
1	2006/08/09 11:00:00 MDT	R		5.50	0.00				
	Transitional datum corr 0.00 to 0.01								
				2007 Water Year					
1	2006/11/01 09:55:00 MST	R		5.28	0.01				
	Transitional datum corr 0.01 to 0.03								
2	2007/04/11 09:35:00 MDT	R		5.51	0.03				
	Continuous datum corr of 0.03								
				2008 Water Year					
1	2008/09/30 23:59:00 MDT	R		5.46	0.03				
	Continuous datum corr of 0.03								
				2009 Water Year					
1	2009/04/23 15:37:00 MDT	R	2009/09/30 23:59:00 MDT	6.55	0.03				
	Continuous datum corr of 0.03 to end of WY2009								
NXT: None									

Insert from ADAPS

DISCHARGE, RATING, AND SHIFTS (Refer to *Section 2 and 3* of the water year folder for discharge measurement forms, discharge measurement summary, rating table, shift curves, and rating plots).

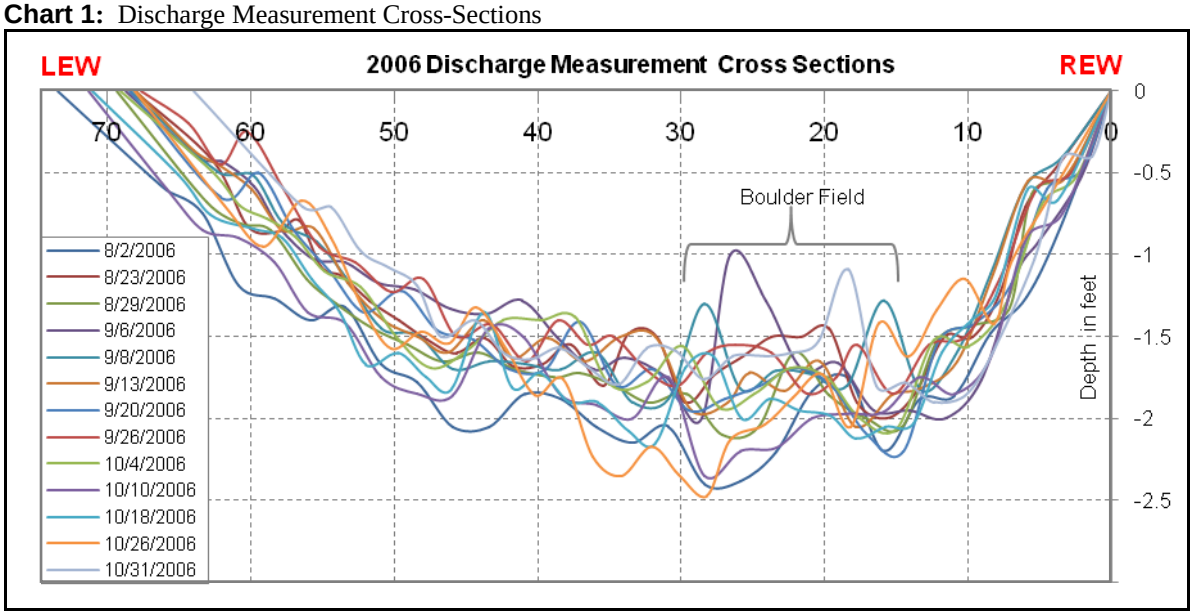
Wading discharge measurements at low and mid-flows (less than 250 cfs) are taken near the Station's staff gage. Wading at discharges above 250 cfs is not safe at the Station due to channel substrate, depths, and velocities. There are no public bridges in the vicinity of the Station therefore high flow discharge can only be determined via indirect methods. Since the purpose of the gage is to track the low and mid-flow record at the Station during the irrigation season, no indirect discharge measurements were performed.

Rating 1.0 was created using 13 discharge measurements collected from August 2006 through October 2006 ranging from 133 to 232 cfs. All measurements were taken approximately 10 feet upstream of the staff plate. All measurements were rated fair due to the number of verticals exceeding 5% of the total discharge and the coarse channel substrate (**Figure 13**). Depth profiles from the 13 measurements are plotted in **Chart 1** below to show the channel irregularity.

A straight line rating between 5.00 feet (77 cfs) and 6.10 feet (443 cfs) was created in GRSAT[6] with a zero offset. All 13 measurements ranged between +8.0% and -8.0% from the rating. Five measurements plotted below the rating and 8 measurements plotted above the rating with an average percent difference of -1.1%.

[5] Closure error for all four surveys was less than 0.001 feet.
[6] GRSAT – Graphical Rating and Shift Application Tool, US Geological Survey Version 2.2

Chart 1: Discharge Measurement Cross-Sections



Measurement 14 was performed under ice conditions and downgraded to poor and was not used in the rating. Measurements 15 through 21 were taken from March 2007 through October 2008 ranging from 103 to 207 cfs. Measurements 20 and 21 were taken back to back (as a part of the October 22, 2008 seepage run) and were within 3.8%. Due to coarse channel substrate, measurements 15 through 21 were downgraded to fair. These 7 measurements differed from the rating between -10% and -14.2%. Since the 2006/2007 winter had significant ice damning which resulted in movement of the staff gage (see *Datum Corrections* section above and **Figure 7**) it may have also caused a shift in the control. As a result, a -0.08 shift was applied to measurements 15 through 21; resultant percent differences ranged from -3.0 to +2.3 (**Table 4**). Since it is not known exactly when the shift took place, a transitional shift was applied (from 0.00 on October 31, 2006 to -0.08 on March 22, 2007). A continuous shift of -0.08 was carried through to the end of the record.

Table 4: Shift Curves

Rating STGQ # 0001

SHIFT CURVES
08/01/2006 - 12/31/2008
DD 2, Discharge (cfs)

	STARTS	ENDS	INPUT	SHIFT	INPUT	SHIFT	INPUT	SHIFT
PRV:	10/31/2006 11:20:00 MST		5.00	0.00	6.10	0.00		
	transition from 0.00 to -0.08							
1	10/31/2006 11:20:00 MST		5.00	0.00	6.10	0.00		
	transition from 0.00 to -0.08							
2	03/22/2007 10:50:00 MDT	12/01/2008 00:00:00 MST	5.25	-0.08	5.57	-0.08	6.10	0.00
	Continuous shift of -0.08 to end of record							

Insert from ADAPS

Discharges above 6.10 feet, or approximately 2 times the highest measured discharge, were not calculated. Gaps in the seasonal record exist in July and August when gage heights exceeded the rating curve. Discharges above 250 cfs were downgraded to poor due to the lack of rating definition. Also, since only 3 discharge measurements were taken during the 2008 irrigation season (July through November, 2008), all DV's during this period were downgraded to fair.

SPECIAL COMPUTATIONS (Refer to *Section 1* of the water year folder for comparison hydrograph)

A comparison hydrograph of the NPS and the USGS Kelly gage during the 2008 irrigation season was plotted; the USGS gage will be used as a surrogate gage after 2008. Differences in daily values are fairly constant below 250 cfs and range from +26 to +46 cfs at the Kelly gage; with an average difference of +38 cfs. Similarly, 12 same day instantaneous discharge measurements were made at these gages during the NPS Station's operation. Differences in

discharges ranged from +22 cfs to + 43 cfs at the Kelly gage; with an average difference of +33 cfs. Above 250 cfs, the hydrographs cross and differences in the daily value discharge do not remain constant (range between +28 to -12 cfs at Kelly). This could be due to 1) the poor rating definition above 250 cfs at the NPS gage, and/or 2) a new rating at the Kelly gage associated with its first year of operation since 1958.

FLOODS

No floods occurred during the Station's operation.

WINTER FLOW

Gage heights are affected by ice on the GVR from December through April (**Figure 7**). See **Figure 14** and **Figure 15** for photos of the NPS gage under partial ice conditions and evidence of ice damning. Only one ice measurement was taken at the Station on January 19, 2007 (96.4 cfs) and is considered poor due to impenetrable shore ice over one foot thick. This measurement plotted 25% from the rating. The ice affected record was X'd out in Hydra since the Station only operates during the irrigation season.

MAXIMUM AND MINIMUM

Maximum and minimum instantaneous discharge and gage height for water years 2006-2009 are not noted since the Station was only seasonally operated. According to 17 years of record (1918, 1945-1958, 2008-2009) at the downstream USGS Kelly gage, high flows occur in May, June, and July and low flows occur in February and March. The highest flow on record at 6,960 cfs at the Kelly gage was recorded on June 16, 1918; mean peak flow is approximately 3,500 cfs. The lowest daily value for the period of record was 101 cfs on March 12, 1956.

REGULATION AND DIVERSION

No known dams or diversions are located upstream of the Station. Eight diversion ditches exist downstream of the Station and upstream of the USGS Zenith gage.

ACCURACY

During low and mid-flows (less than 250 cfs) accuracy of the Station data is fair due to the following: 1) downgrading of all discharge measurements to fair based on channel substrate and/or number of verticals exceeding 5%; 2) limited station operation and data work-up (2 years, 3 months); 3) documented movement of the Station's staff gage and probable movement of the orifice during ice affect; and, 4) minimal site visits during the 2008 irrigation season due to the installation of the USGS Kelly gage and limited staff support. Also, due to the lack of rating definition, flows between 250 and 443 cfs are considered poor. No rating exists for gage heights above 443 cfs.

LOCAL PARK PARTNER

The following personnel performed discharge measurements, downloaded the data logger, and obtained regular staff gage readings:

Jennifer Miller (2006)
Previous NPS-WRD/WRB Term Employee

Lindsay Patterson (2007 and 2008)
Previous Teton Science School Employee and GRTE volunteer

Gwen Gerber (2006 – 2009)
NPS – WRD/WRB Hydrologist
1201 Oakridge Drive, Suite 250
Fort Collins, CO 80526
970-267-2144
gwen_gerber@nps.gov

RECOMMENDATIONS

The ice affected record, the high flow record, and/or the record from December 1, 2008 to August 31, 2009 (date datalogger was removed) could be worked up in the future if requested. To address the lack of rating definition above 250 cfs, an indirect measurement would need to be performed.

Although the staff gage remains in place at the request of GRTE the rating is not valid since the reference marks were removed and elevation changes of the staff gage cannot be tracked.

REFERENCES

Love, J. D. and J. M. Love. 1988. Geologic Road Log of Part of the GVR Valley including the Lower Gros Ventre Slide. The Geologic Survey of Wyoming. 14 p.

Love, J. D., Reed, Jr. J. C. and K. L. Pierce. 1999. Creation of the Teton Landscape. Grand Teton Natural History Association, Grand Teton National Park: Moose, WY. 132 p.

Lower GVR Study Group (LGVRSG): Campbell III, T. M. and C. L. Lasley 1990. Minimum Instream Flows for the Lower GVR, Teton County, Wyoming. 42 p.

Western Regional Climate Center, WRCC. 2006. Climate data for Jackson, WY (Station 484910). From: National Climatic Data Center Historical Listing for NWS Cooperative Network. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?wyjack

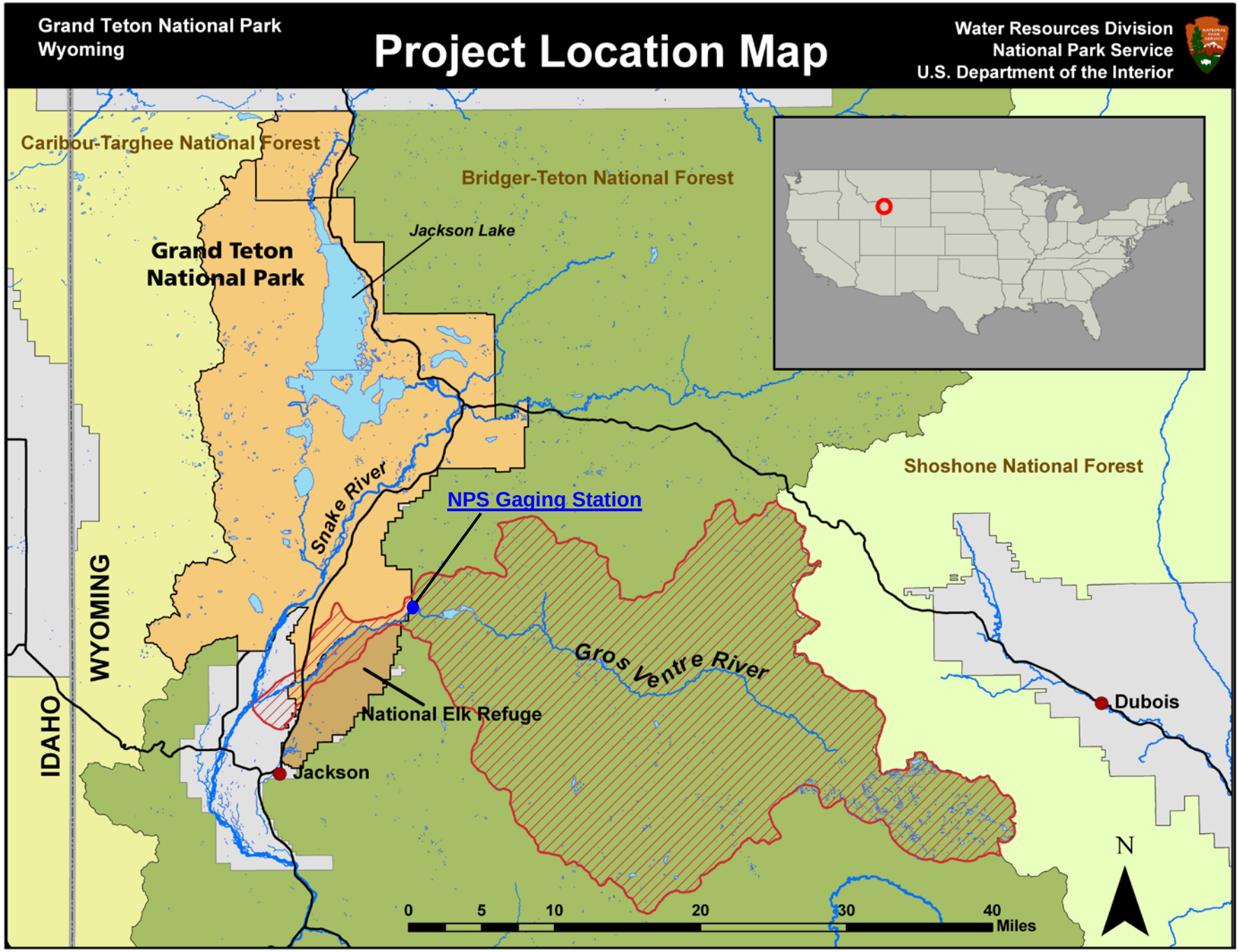


Figure 1: Project Location Map

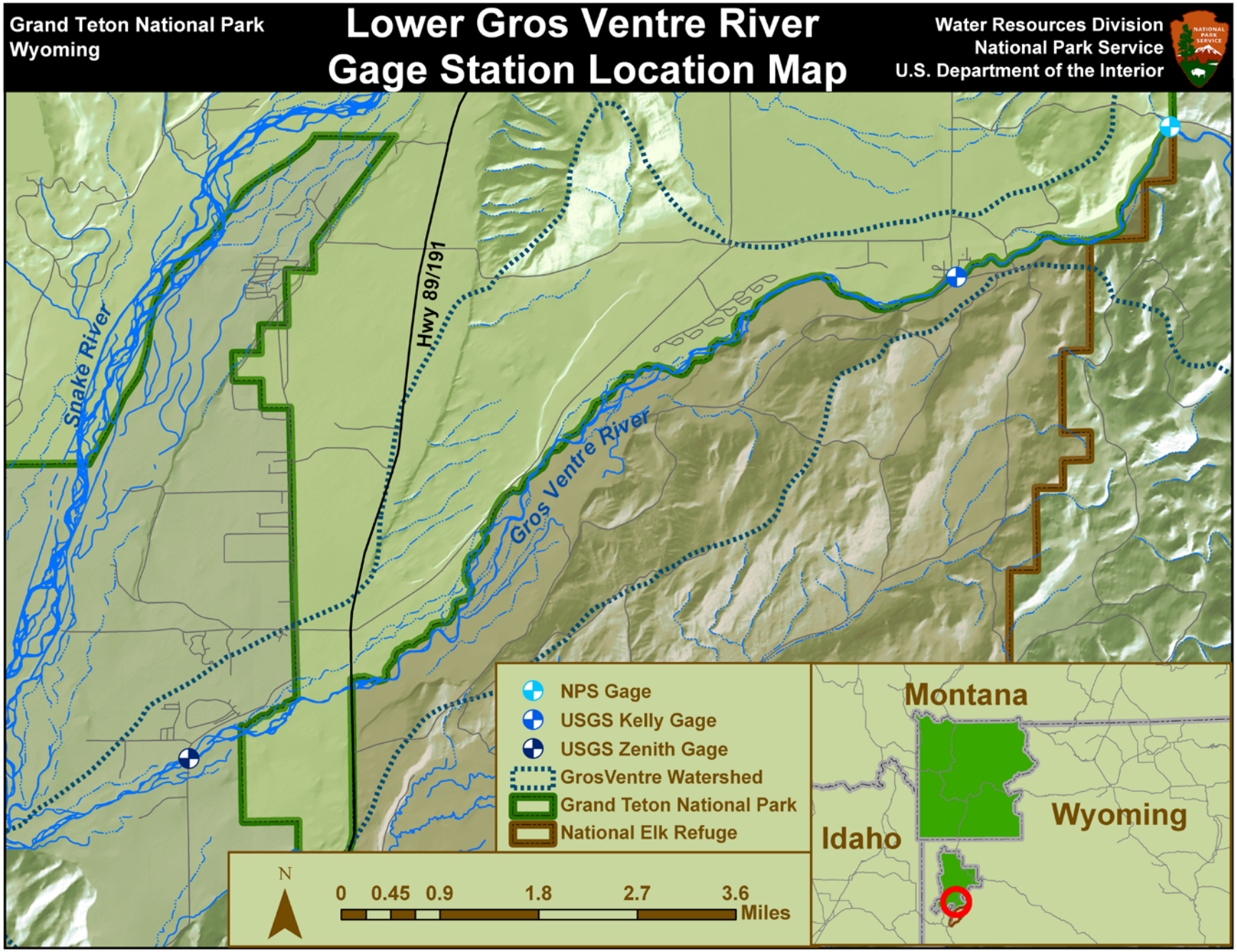


Figure 2: Gage Location Map

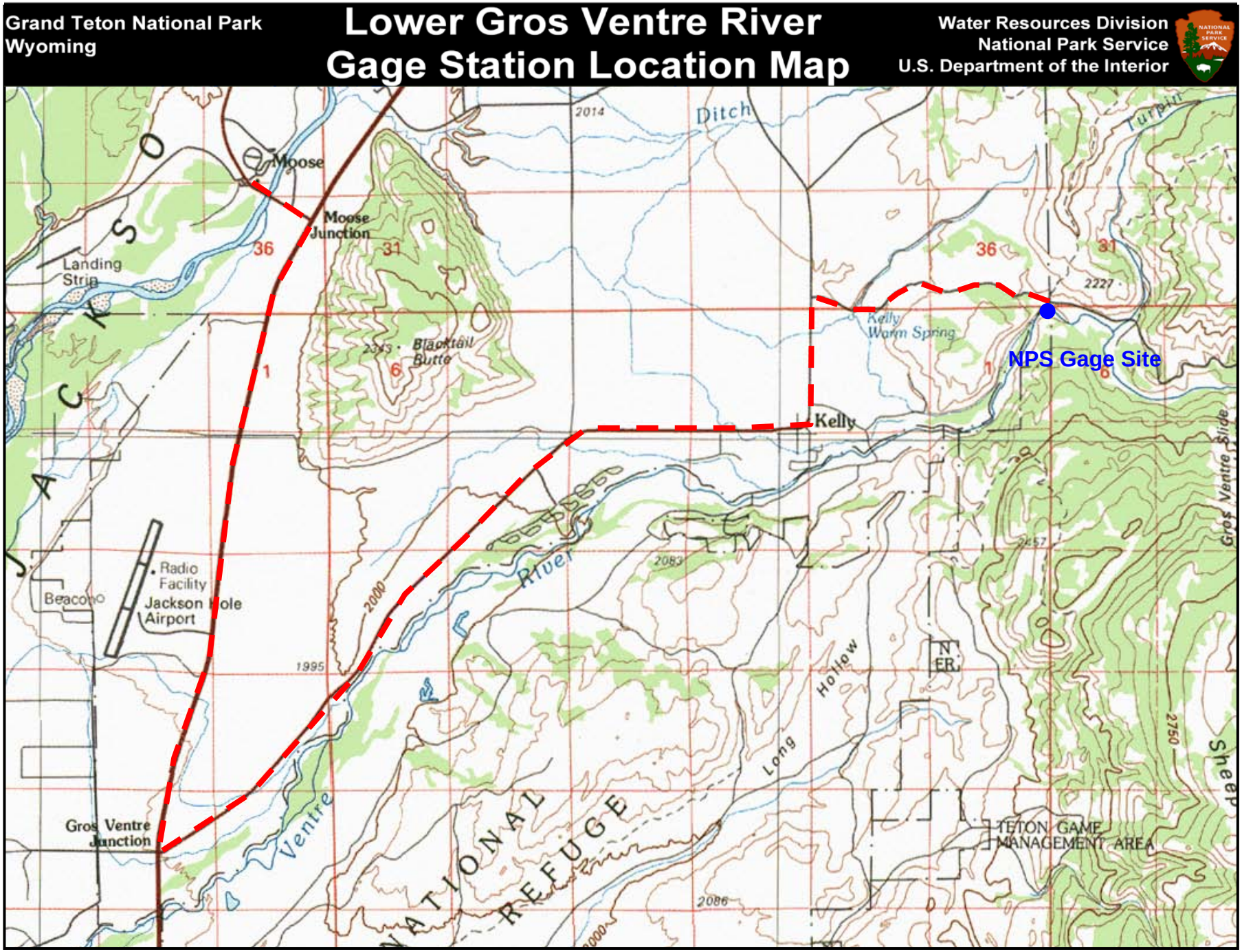


Figure 3: Red dashed line shows the route to the NPS Station from GRTE Natural Resources Building

Figure 4: Aerial photograph of the NPS Station (2006, NAIP Imagery)

Figure 5: Looking downstream at the NPS staff gage; gage height is 5.54 feet (April 11, 2007, Gerber Photo)

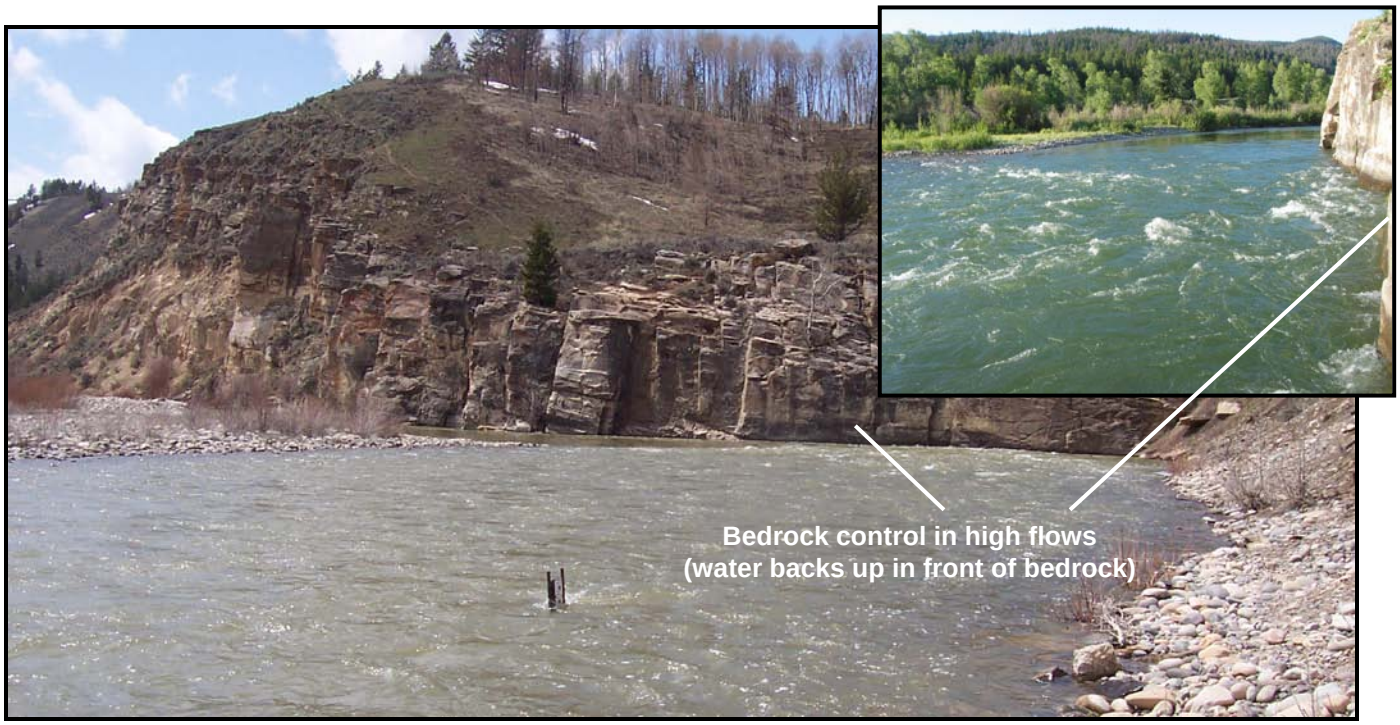


Figure 6: Looking downstream at the NPS staff gage; gage height is aproximately 6.5 feet. **Inset:** looking at bedrock control from right bank (May 8, 2008, inset: June 28, 2006, Gerber Photos)

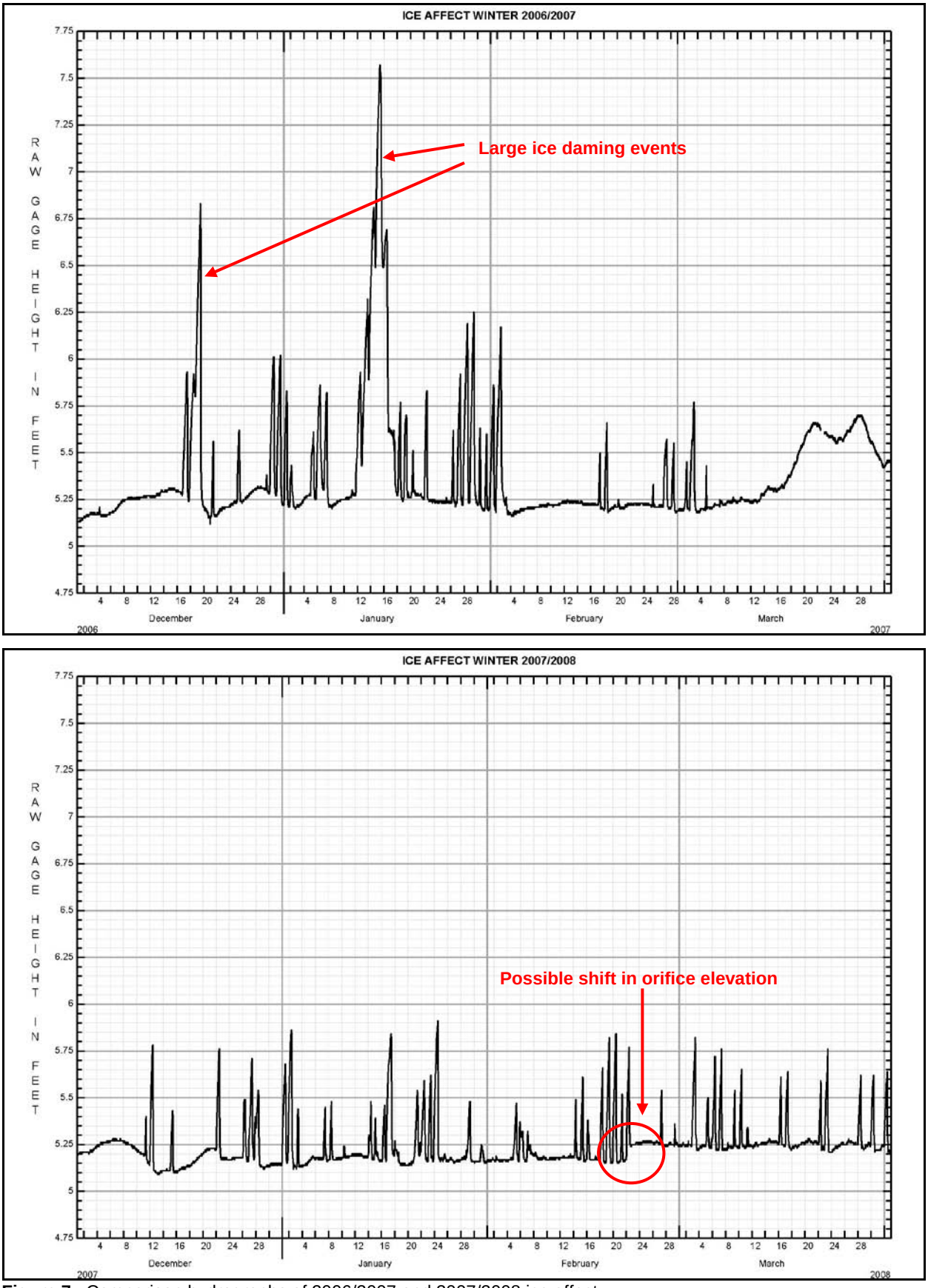


Figure 7: Comparison hydrographs of 2006/2007 and 2007/2008 ice affect.

Figure 8: Photo of datalogger housing (August 9, 2006, Gerber)

Figure 9: Photo of gage installation (August 9, 2006, Miller photo)

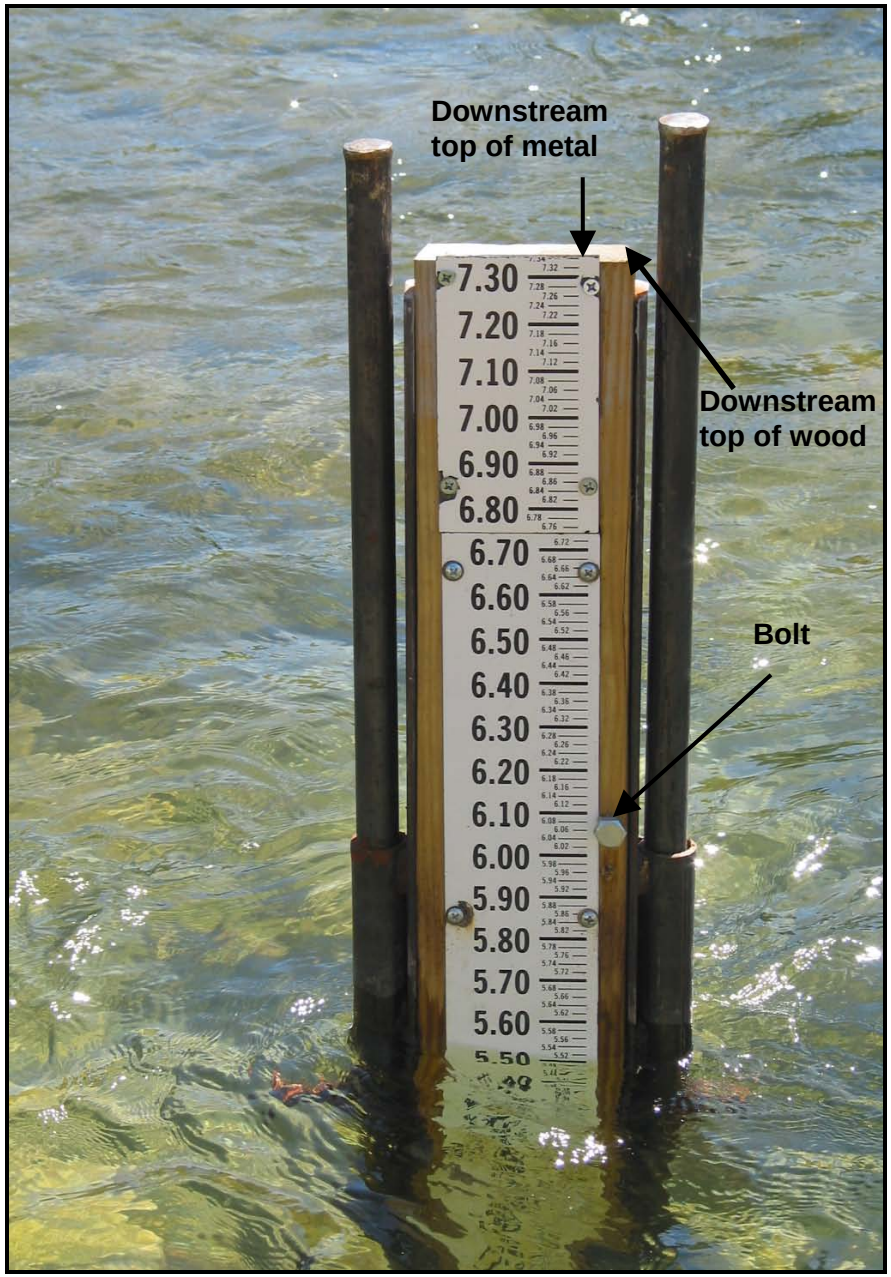


Figure10: Staff gage and measuring points (April 11, 2007, Gerber photo)

Figure 11: RM-1 (August 9, 2006, Gerber photo)

Figure 12: Locations of RM's and data logger on right bank (July 12, 2006, Miller photo)

Figure 13: Photo of coarse channel substrate; gage height is 5.54. (April 11 2007, Gerber photo)

Figure 14: Staff gage with evidence of ice damning (January 19, 2007, Gerber photo)

Figure 15: Photo looking downstream at ice damning (January 19, 2007, Gerber photo)