

SURFACE WATER STATION DESCRIPTION **MANCOS RIVER AT ANITAS FLAT, CO – 371508108212801** **MESA VERDE NATIONAL PARK**

Prepared by: Kathryn Converse Date: March 14, 2006
Reviewed by: Gwen Gerber Date: May 15, 2006
Reviewed by: Mark Wondzell Date: July 19, 2006
Approved by: William Hansen Date: October 17, 2006

LOCATION

The National Park Service's Water Resource Division – Water Rights Branch (NPS-WRB) station on the Mancos River within Mesa Verde National Park (MEVE) is located at N 37° 15' 14", W 108° 21' 26" North American Datum 1927 (NAD27¹, based on a 1:12000 scale aerial photograph), HUC 14080107, in Montezuma County, Colorado. The station is located approximately 7.4 miles south/southwest of Mancos, CO, approximately 3.0 miles south (downstream) of the confluence with Mud Creek, on the right bank about 1.05 miles inside the MEVE boundary (**Figure 1**).

ACCESS:

Take County Road 38 south off of State Highway 160 to access the station (County Road 38 is 3 miles west of the town of Mancos and approximately 3.5 miles east of the turn off to MEVE). County Road 38 is paved for approximately the first 3 miles (**Figure 1**). Acquire permission to proceed the last two miles across private property (see NOTIFICATION). A high clearance vehicle is recommended; the last quarter mile must be maneuvered with a small 4 – wheel drive vehicle or walked due to wet road conditions and steep ravines. See **Figure 2** for a Station Location Map.

The location for high flow measurements is a private bridge located two miles upstream of the station (**Figures 1, 2 and 3**). This private drive turns east just after the pavement ends. Permission to use the private bridge for high flow measurements has been granted by the landowner, Vance and Naria Koppenhaffer. They request that vehicles be parked off the road, which is also the residence driveway.

NOTIFICATION:

Prior to each station visit Charlie Mitchell's son (Blake Mitchell) or son-in-law (Paul Crook) must be contacted by MEVE personnel (see Local Park Partner Section).

Land Owner: Charlie Mitchell

Contacts:	Son	Blake Mitchell	(970) 533-7253
	Son-in-law	Paul Crook	(970) 533-7829

ESTABLISHMENT

The station was installed by NPS personnel on July 18, 2000, to monitor streamflow and determine if the decreed federal reserved water right is being met (refer to the History Folder Section 6: Correspondence and Miscellaneous Supporting Materials).

ELEVATION

Land surface elevation is 6330 feet above mean sea level (NGVD 29², based on a 7.5 minute series topographic map, Mancos Quadrangle and Global Positions Systems³ WGS 84⁴).

¹ North American Datum 1927 (NAD27) is a datum based on the Clarke ellipsoid of 1866. The reference or base station is located at Meades Ranch in Kansas. There are over 50,000 surveying monuments throughout the US and these have served as starting points for more local surveying and mapping efforts. Use of this datum is gradually being replaced by the North American Datum of 1983.

² National Geodetic Vertical Datum 1929 (NGVD29) is a fixed reference adopted as a standard geodetic datum for elevations determined by leveling. It was formerly called "Sea Level Datum of 1929." Although the datum was derived from the mean sea level at 26 tide station, it does not necessarily represent local mean sea level at any particular place.

³ Global Positioning System (GPS) is a system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

⁴ The World Geodetic System 1984 (WGS 84) defines a fixed global reference frame for the Earth, for use in geodesy and navigation.

DRAINAGE AREA

The station has a drainage area of 160 mi² (based on GIS analysis of Digital Elevation Model (DEM) data).

HYDROLOGIC CONDITIONS

The Mancos River is characterized by a semi-arid climate, moderately high altitudes, and pinyon-juniper forests (us-parks.com). Mesa Verde means “green table” describing the National Park as a high flat sloping plain covered with vegetation. The Mancos River drains Mesa Verde and cuts the deep valley along the mesa’s eastern and southern edge. Valley slopes are moderate ranging from about 0.2 to 2.0%. More than twenty canyons cut through the Mesa and drain into the Mancos River. The Mancos River and tributaries cut through the Cliff House Sandstone and Menefee Geologic formations. The Point Lookout Sandstone, Menefee Formation, and Cliff House Sandstone create the Mesa Verde Group, which overlies two older formations. The younger Mancos Formation is 2,000 feet of dark gray shale, while the Dakota Sandstone is a beach sand underlying most of Colorado. The Cliff House Sandstone is composed of deposited beach sands and shallow water sands. Deposited woody shales, coals, and coarse irregular sands comprise the sediments of the lower Menefee Formation. Water percolates through the sandstone until it reaches an impervious layer in the Menefee Formation where it can be seen in seeps and springs along the canyon edges (Skridulis, 2004).

Mesa Verde National Park has mild weather during summer months and some winter months. Snow storms occur as late as May and as early as October. Summer days (June through September) are generally warm to hot, with cool evenings. Afternoon thunder storms are common during July and August. The park receives approximately 18 inches of precipitation each year, almost half of which comes in the form of snow. Average snow fall varies between 80 to 100 inches per year.

CHANNEL AND CONTROL

Bed material at the station varies from moderately deep silt in the slow moving water to embedded gravels and small cobbles in swifter flows. The pool/riffle sequences change spatially through time due to high flows associated with spring runoff and the monsoon season.

The low and mid-flow control is a natural riffle downstream of the orifice (**Figure 4**) and is composed of gravel and cobbles and that have shifted upstream approximately 20 feet since station installation. Control changes can be seen in the development of five ratings over the past five water years. The channel is control at higher flows. At approximately 3.0 feet of stage water enters a broad floodplain. At stages greater than 4.6 feet, the downstream bend creates a backwater effect (**Figure 4**). **Figure 5** illustrates the channel cross-section at the station. During winter months, the low and mid-flow control is affected by ice (**Figure 6**).

The channel is straight for 100 feet above the station where flow exits from a sharp bend. The right bank of the bend is very steep, composed of erodable silt and is undercut. Below the station, the channel is straight for 100 feet and has sloping banks anchored by dense stands of willows and grasses (**Figure 4**).

GAGE

The station has remained at the same location since establishment, however, channel changes (scour/fill) caused NPS personnel to change the base gage⁵ and orifice locations several times. See **Figure 7** for sketch map with locations of the station’s equipment. See the History section for a description of equipment changes.

The stage sensor is a Design Analysis – Waterlog® H350XL/H355 (serial number S#001187, **Figure 8**) bubbler system with a Geostationary Operational Environmental Satellites (GOES) transmitter that provides satellite telemetry data retrieval (**Figure 9**).

This stage sensor system is termed the Data Collection Platform (DCP). The DCP is housed in a Hoffman steel enclosure mounted on 4” x 4” wood posts (**Figure 9**). The orifice line is housed in a one-inch polyvinyl chloride (PVC) casing and buried from the Hoffman enclosure to near the right edge of water. The orifice line is housed in a two-inch galvanized steel pipe in the Mancos River. The standard orifice cap was upgraded to a Standard Orifice

⁵Base gage is the principle equipment that indicates stage.

Static Tube (SOST) on August 10, 2005 to minimize velocity effects on stage readings. The steel pipe is secured by wire to a fence post (T-bar), which is driven into the channel on the downstream side of the steel pipe.

Date, time, stage, air temp, battery voltage and DCP transmitted power are recorded at 15 minute intervals and transmitted via GOES every 3 hours. The NPS-WRB has a cooperative agreement with the Cheyenne, Wyoming district of the USGS to use their Local Readout Ground Station (LRGS) for data retrieval. Data are automatically decoded and entered into the USGS's database for processing (on a water year basis) in Automated Data Processing System (ADAPS)⁶. Data can also be retrieved directly from the DCP with a data card. Data stored on the DCP are deleted annually.

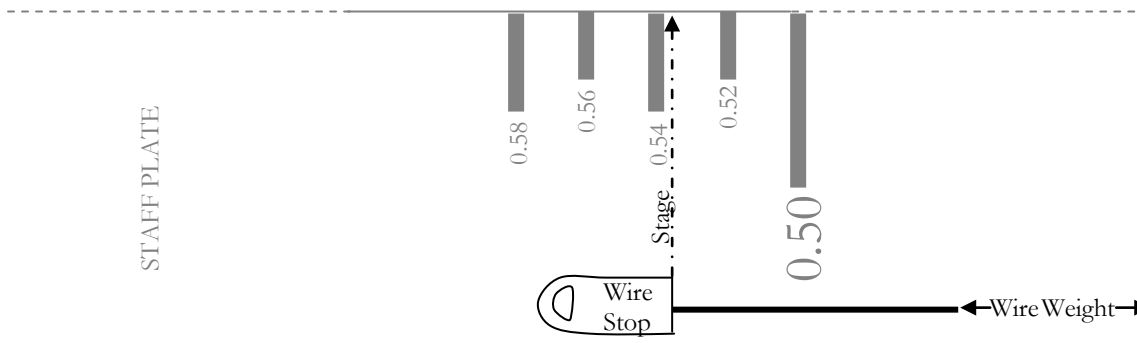
Transmitter information are:

- ID: FA4087CC
- Channel: 002 west
- Rate: 3 hours; 15 minute logged data is transmitted every 3 hours.
- Time offset: 00:25:08; every three hours data is transmitted at 00:25:08 of that hour.
- Window: 1 minute; the data is transmitted during a time span of one minute.
- Antenna direction: Azimuth from true north = 205 degrees, Azimuth from magnetic north = 220 degrees, latitude = 40 degrees.

Date, time, stage, battery voltage and DCP transmitted power can be viewed by the public on a real-time website (http://waterdata.usgs.gov/wy/nwis/uv/?site_no=371508108212801&agency_cd=USNPS), which updates every three hours. The NPS-WRB contracts with the USGS to make two discharge measurements, review the water year folder, and make the record available to the public in real-time format.

The base gage is a cantilever (outer horizontal staff or OHS) which measures stages from 0.00 to 6.72 feet gage datum⁷. Stage is measured by holding the wire weight on water surface and reading the staff plate number indicated by the flat edge of the wire stop (refer to the **Diagram** below). The cantilever (**Figure 10**) was installed at the downstream orifice location on August 10, 2005. The high stage vertical staff (outer vertical staff, OVS-2), which records stages from 3.34 to 6.74 feet is used to confirm the cantilever stage during high flow events. A crest-stage-gage (CSG) was installed on August 12, 2005, to record high stage events (up to 8 feet, see **Figure 11**). See **Figure 7** for a sketch map of gage equipment locations.

Wire Stop Diagram



⁶ Automatic Data Processing System (ADAPS) version 4.5.

⁷ Gage datum is the datum whose surface is at the zero elevation of the station.

HISTORY

July 18, 2000	The following was performed by NPS-WRB and MEVE personnel: 1) Installed a stage sensor Campbell Scientific CR-510 with a 15-minute logging interval. 2) Surveyed reference marks (RMs)⁸ 1, 2 and 3. RM3 was considered base⁹ elevation (until April 16, 2003). 3) Mounted OVS sections on adjustable planks and secured to steel rods (Figure 12). The original base gage (until October 1, 2004) was an enameled OVS in two sections (a lower and upper section) reading from 0.00 to 6.74 feet. Surveyed the lower OVS (OVS-1, 0.00-3.32 feet) on July 18, 2000.
December 19, 2000	Surveyed OVS-2.
July 20 to August 5, 2001	Fire burned a significant portion of upstream drainage area. Sediment loads increased significantly following fire, but rating remained relatively stable. Increased sediment loads/deposits noted during final weeks of 2002 WY.
November 7, 2001	Upgraded the original Campbell Scientific CR-510 to a Design Analysis – Waterlog® H350XL/H355.
November 8, 2001	Installed and surveyed the ground rod. OVS-2 was moved and stabilized.
May 9, 2002	Added a GOES transmitter to the DCP and began transmitting.
November 5, 2002	Installed cantilever because sedimentation problems affected OVS-1. Installed channel constrictors on the right side of the channel to concentrate flow over orifice in an attempt to increase flow velocities to keep orifice area sediment free.
November 20, 2002	Further constricted channel with placement of stone on both banks. Width at orifice was decreased from 5 feet to approximately 4 feet.
December 11, 2002	Relocated orifice upstream 25 feet to the cantilever gage location. Moved the orifice to improve relationship between DCP and outside gages. The cross sectional areas differed between the original orifice location and the cantilever's location.
April 16, 2003	Established ground rod base elevation for level surveys.
September 15 and 16, 2004	Moved orifice back to original location using the original piping (Figure 12). Upstream orifice location acted as a control during low flows. Relocated OVS-1 to the left bank where higher flows should alleviate sedimentation problems (Figure 12 and 13).
October 1, 2004	Established cantilever base gage.
May 23, 2005	High flows washed out OVS-1. The cantilever streamward 6x6 wood footing shifted (-0.24 foot) following the high flow event that scoured its stabilizing bank.
August 10, 2005	Upgraded orifice cap to the SOST to minimize velocity effects to stage record.
August 12, 2005	Relocated cantilever to the same location as the orifice and calibrated cantilever to gage datum. Installed and surveyed CSG and RMs 4, 5 and 6.

⁸ Reference Marks (RMs) are permanent markers, installed in the ground or on a structure in the vicinity of a station, whose elevation above the gage datum is known.

⁹ Base is the reference mark to which all other reference mark elevations are based.

REFERENCE AND BENCHMARKS

A base and six reference marks (RMs) have been established at the station for elevation control. See **Table 1** for elevations. All **bold** survey elevations in **Table 1** are for points currently surveyed, while regular text survey elevations are for points which no longer exist (**Figure 7**). See **Figures 14 and 15** for descriptions and pictures of station reference marks. Refer to Section 4 of WY 2005 Folder for survey details.

Table 1: Survey Elevations

Date	Units = feet for all elevations noted in table.												
	Ground Rod	RM-1	RM-2	RM-3	RM-4	RM-5	RM-6	OVS-1*	OVS-2	OHS	Orifice Cap*	CSG	PZF
July 18, 2000		6.20	6.07	6.47				3.24					NS
December 19, 2000		6.19	6.08	6.47				3.24	6.65				NS
July 11, 2001		6.18	6.07	6.47				3.35	6.60				0.16
November 8, 2001	6.57	6.19	6.08	6.47				2.01	5.049 (Reset 5.197)		0.26		0.21
May 9, 2002	6.57	6.18	6.06	6.47				2.099 (Reset 2.001)	5.20		0.23		0.13
September 19, 2002	6.58	6.18	6.07	6.47				2.00	5.20		0.26		NS
November 5, 2002	6.57	NS	6.07	6.47				2.00	5.20	7.75	0.25		NS
November 20, 2002	6.57	6.19	6.08	6.47				2.00	NS	7.75	0.26		NS
April 16, 2003	6.57	NS	6.08	6.48				2.06	5.20	7.75	0.49		NS
October 8, 2003	6.57	6.18	6.07	6.47				NS	NS	7.75	0.47		NS
May 18, 2004	6.57	6.20	6.07	6.48				2.18	NS	7.75	0.48		-0.31
September 15, 2004	6.57	6.18	6.07	6.47				2.18	5.20	7.75	0.49		-0.19
September 16, 2004	6.57	6.18	6.07	6.47				1.99	5.20	7.74	0.23		-0.17
August 9, 2005	6.57	6.20	6.06	6.48					5.20	7.71	0.17		NS
August 12, 2005	6.57	6.20	6.06	6.48	7.93	4.82	4.56		5.20		0.18	8.26	-0.15

*Elevations surveyed at different OVS1 and orifice locations. See Section 4 of WY 2005 folder for more detail.

Elevations are relative to gage datum determined from the July 11, 2001, survey. NS is abbreviation for Not Surveyed.

DISCHARGE MEASUREMENTS

Wading discharge measurements can be made 25 feet upstream or downstream of the orifice in stages up to approximately 1.2 feet. In roughly 1.2 to 2.5 feet stages water velocities near the orifice create safety concerns and wading discharge measurements should be made 200 feet upstream of the station in a location above the river bend where all of the river discharge is in one channel (note: a side channel influent exists 100 feet above the station). The private bridge approximately two miles upstream should be used for stages above 2.5 feet using a bridge crane or tethered Acoustic Doppler Current Profiler (ADCP).

HIGH FLOWS

Maximum peak flow of 1510 cfs occurred on May 23, 2005.

POINT OF ZERO FLOW

The point of zero flow (PZF) is the deepest part of the channel at the control just downstream of the orifice. The elevation of the PZF relative to gage height has varied, dependent on channel changes and measurement method, between + 0.21 feet and – 0.31 feet (**Table 1**).

WINTER FLOW

During ice effect, the daily discharge record is estimated using climate and discharge data from comparison stations. Air temperature data collected by the DCP at this station are also used to identify periods of probable ice effect. Comparison station data sources are described below:

- Maximum, minimum and mean air temperature and precipitation data can be acquired from Weather Underground station located in Cortez, CO. The data is located at <http://www.wunderground.com/history/airport/KCEZ/2005/1/18/MonthlyHistory.html#calendar>
- Daily discharge values can be acquired from the United States Geological Survey (USGS) station 09371000 (Mancos River near Towaoc). This gage is located about 25 river miles southwest of the NPS Mancos River station, approximately 100 yards upstream from Highway 666 bridge. The contact at the USGS Durango office is David Grey (970) 247-4140 ext. 10.
- Daily discharge values can be acquired from the State of Colorado, Department of Water Resources (DWR) station MANMANCO (Mancos River near Mancos, CO). This station is located about 12 river miles upstream of the NPS Mancos River station. The contact at CO-DWR is Scott D. Brinton (970) 247-1845 ext. 7007.

REGULATION AND DIVERSION

Diversions influence summer discharge because base flows are often primarily irrigation return flows.

ACCURACY

Record accuracy is good between 10 and 200 cubic feet per second (cfs). The current rating is weakly defined at discharges less than 10 cfs and greater than 200 cfs and record accuracy may be downgraded to fair. The record is poor during winter periods when ice occurs.

COOPERATION

The station is maintained by MEVE staff and the NPS WRD-WRB. MEVE staff visit the station to inspect equipment and conduct discharge measurements. Winter visits are less frequent. WRB processes the record in ADAPS (USGS) and collects periodic Q measurements and provides QA/QC. The USGS is contracted with the NPS to collect two discharge measurements during the water year providing additional QA/QC.

LOCAL PARK PARTNER

Park Staff Contacts:

Sylvia Oliva (970) 529-5065

Marilyn Colyer (970) 529-5064

Mesa Verde National Park

Natural Resources

P.O. Box 8

Mesa Verde, CO 81330

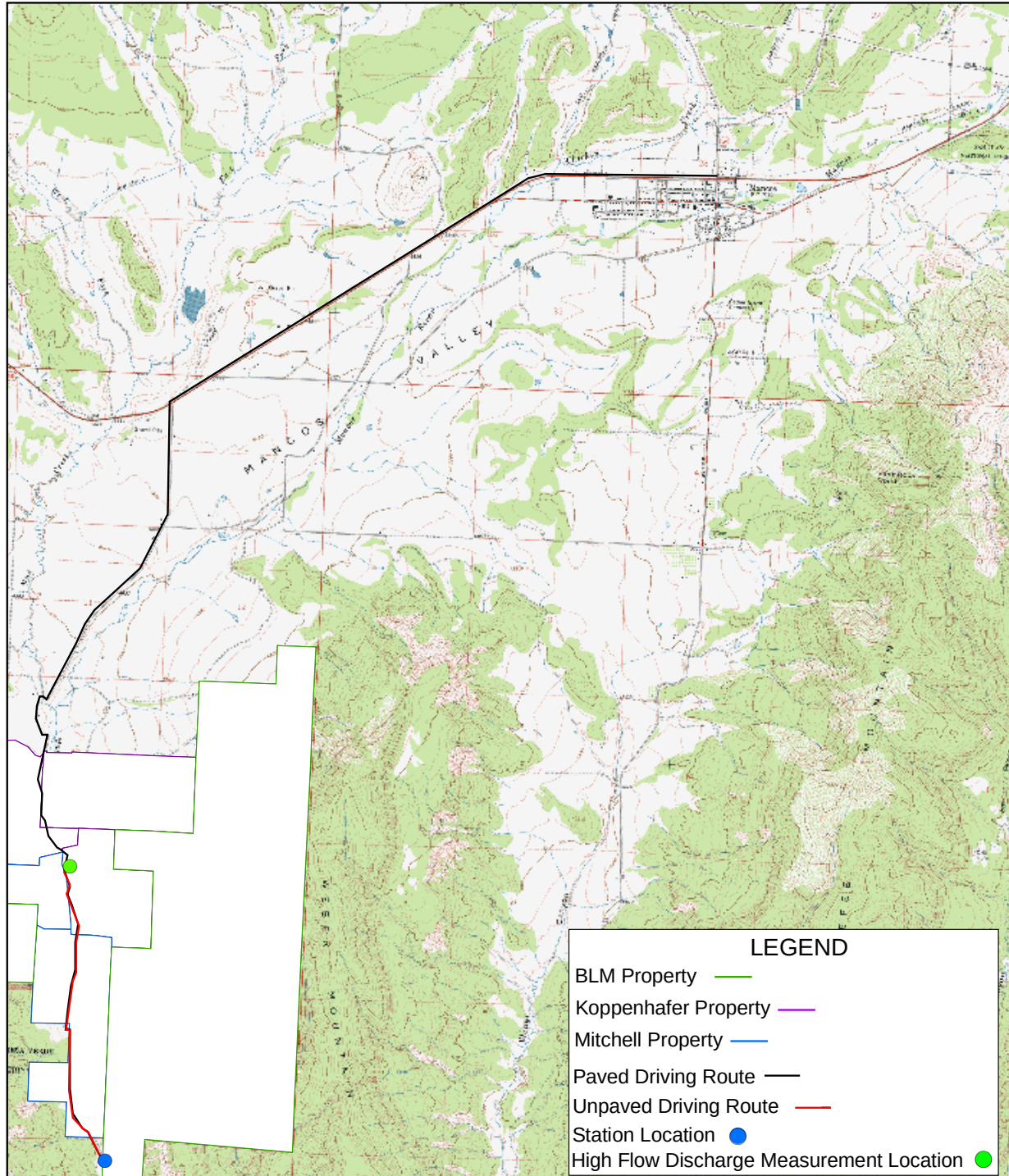
REFERENCES

"Mesa Verde National Park Geology" US-Parks.com. 2000-2004. US-Parks.com Inc. 21 June 2004
<http://www.us-parks.com/US_National_Parks/mesa_verde/mesa_verde_geology.shtml>.

Skridulis Michael. "Mesa Verde National Park". 20 April 2004. Online. 21 June 2004
<<http://oldsci.eiu.edu/geology/parks/meve/meve.html>>

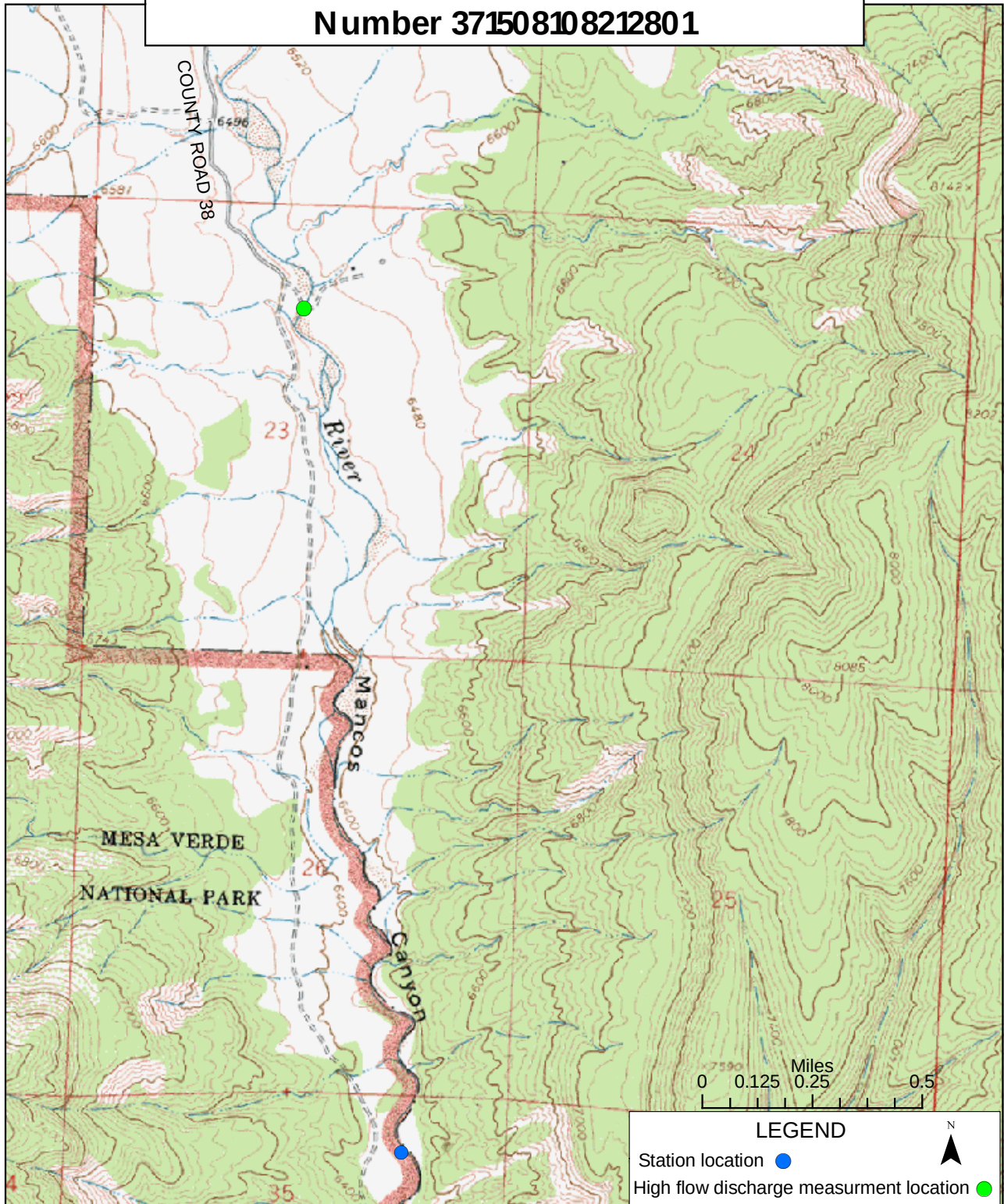


Driving Directions to Mancos River at Anitas Flats Station 371508108212801





**Mancos River at Anitas Flats Station Location
Number 371508108212801**



Produced by Water Resources Division - Water Rights Branch

April 11, 2006

FILE: //INP2300FCS12247/wrb\$/KMC/MEVE (copy)/MEVE/2005WY/Maps/Locationmap.mxd

Figure 3: Looking downstream at Mancos River at Anitas Flat Station high flow bridge measurement location.
Photograph taken April 4, 2006 by Kathryn Converse.



Figure 4: Looking downstream at Mancos River at Anitas Flat Station channel controls.
Photograph taken April 9, 2006 by Gwen Gerber



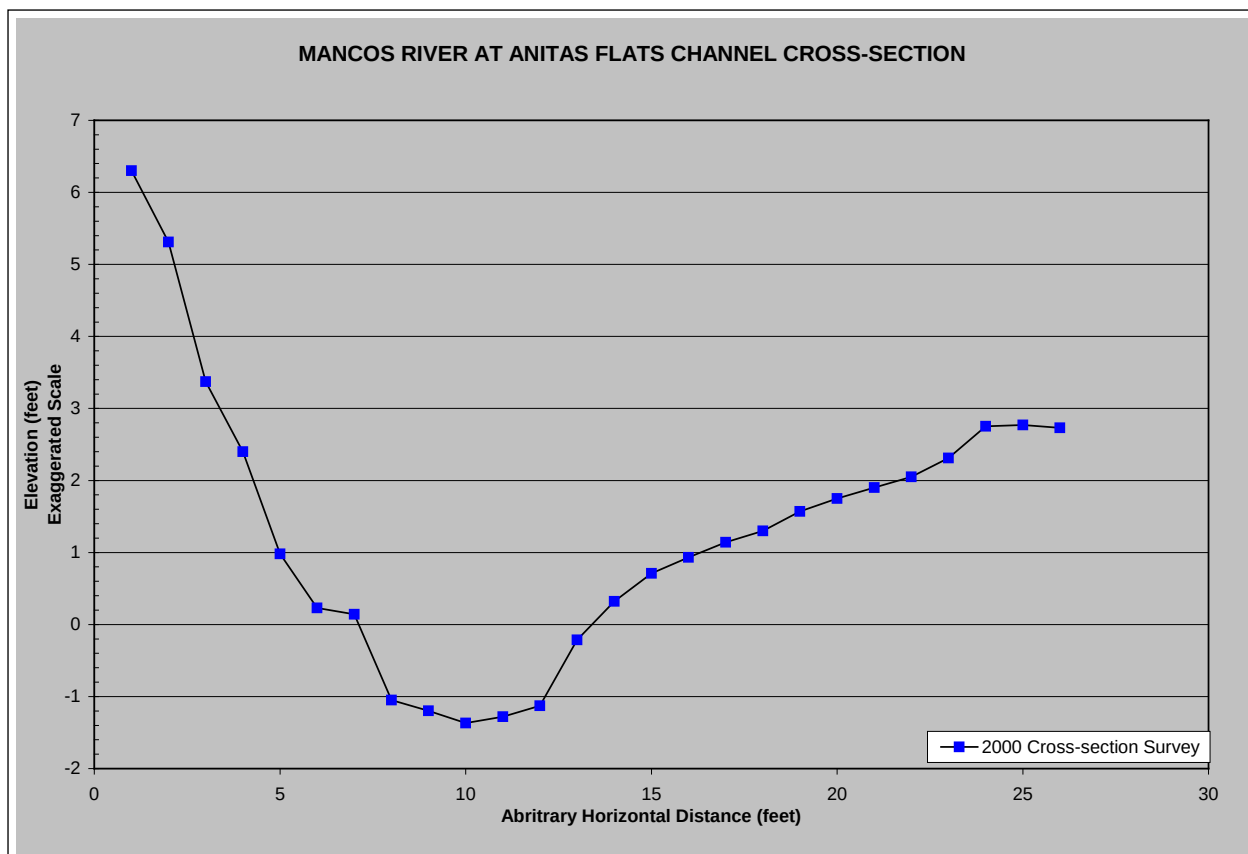


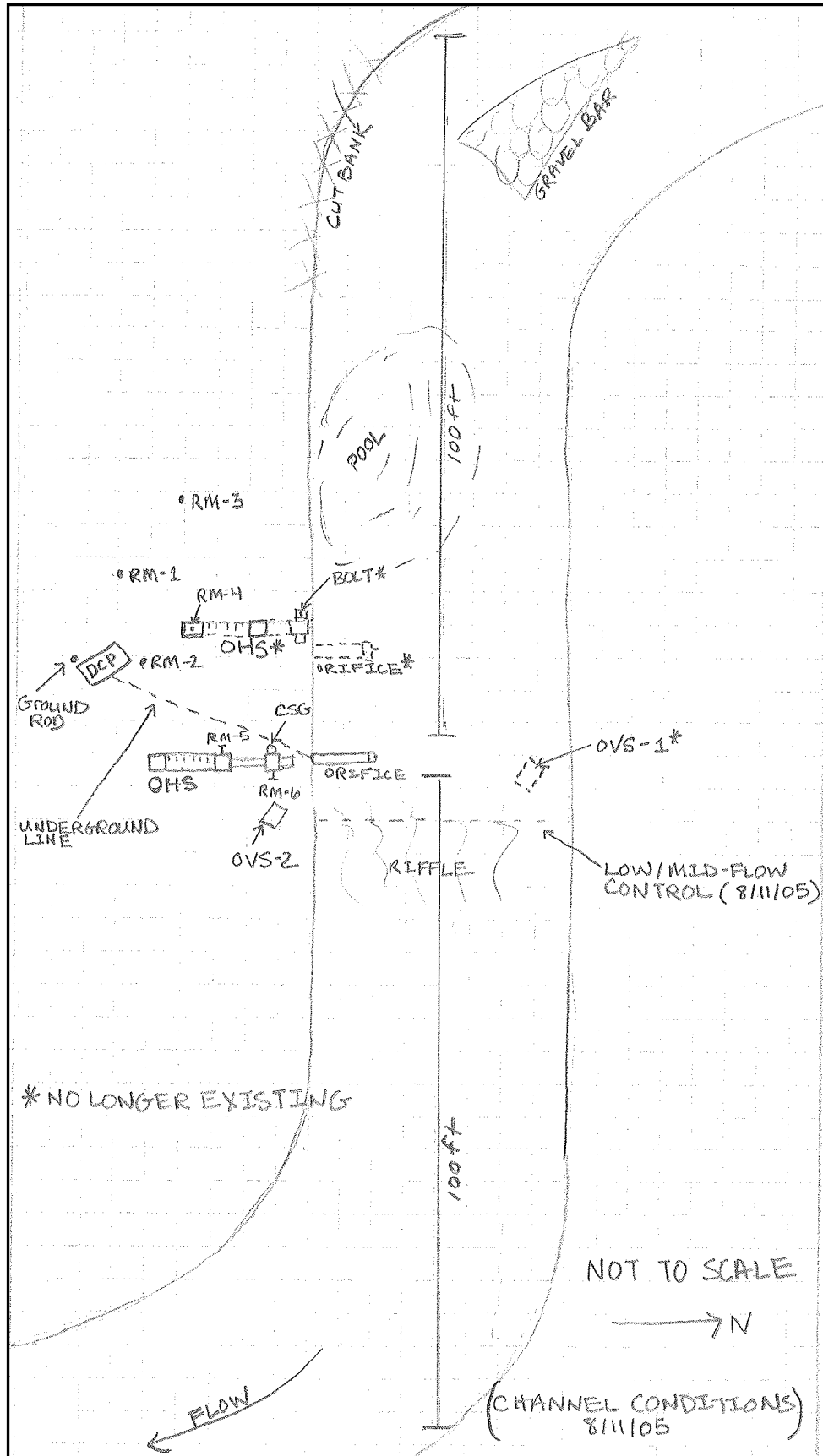
Figure 5: Mancos River at Anitas Flat Station looking upstream at channel cross-section. The 2000 cross – section is the discharge measurement location 15 feet upstream of the control.



Figure 6: Winter ice conditions at Mancos River at Anitas Flat Station. Photograph taken December 1, 2004 by Marilyn Colyer.

STATION SKETCH MAP
FIGURE 7

Mesa Verde National Park
Mancos River at Anitas Flats
Station 371508108212801



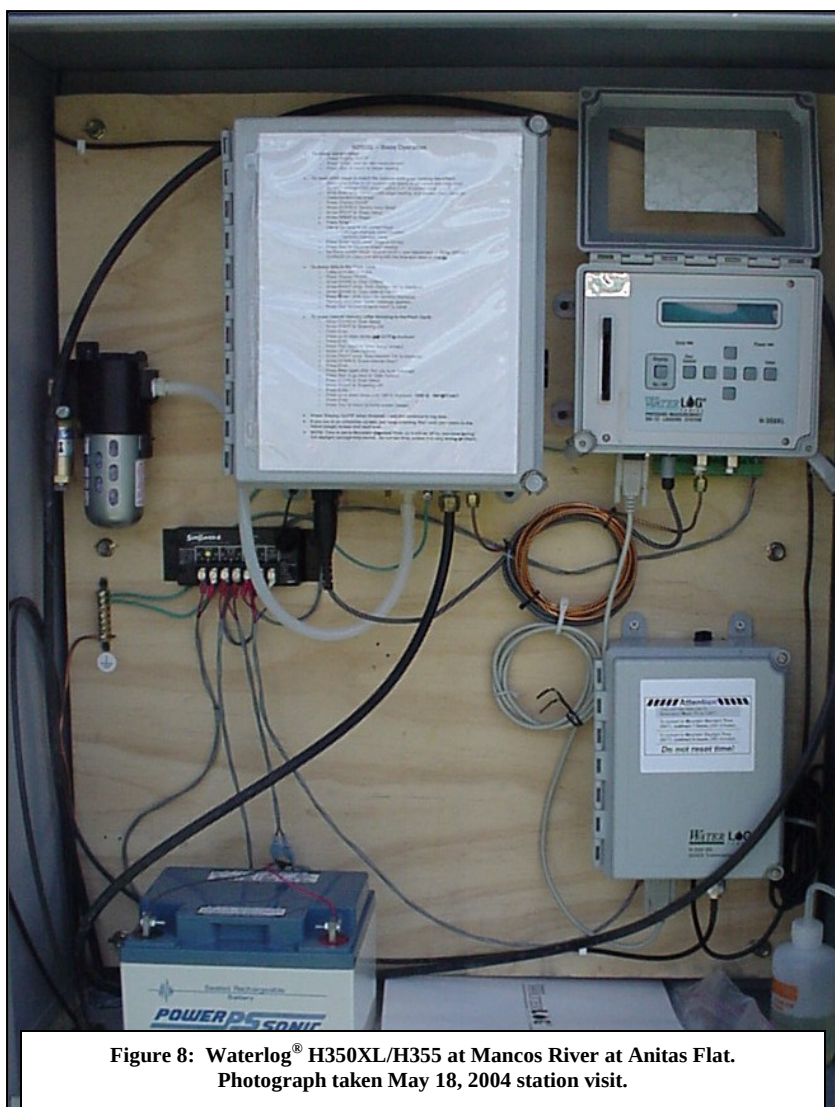




Figure 10: Cantilever (OHS) at Mancos River at Anitas Flat Station.
Photograph taken August 15, 2005 by Gwen Gerber.



Figure 11: Crest-stage-gage (CSG) and high stage vertical staff (OVS 2) at Mancos River at Anitas Flat Station.
Photograph taken August 15, 2005 by Gwen Gerber.

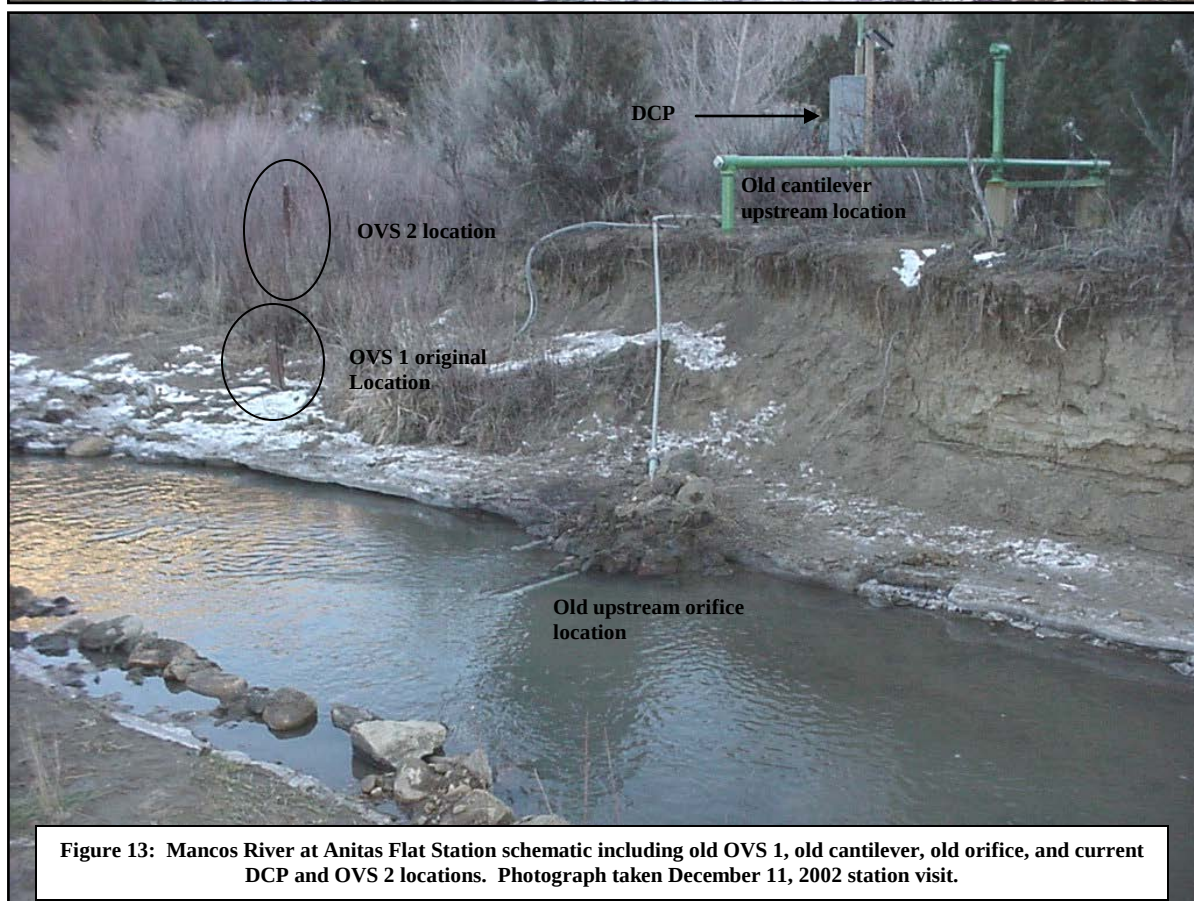
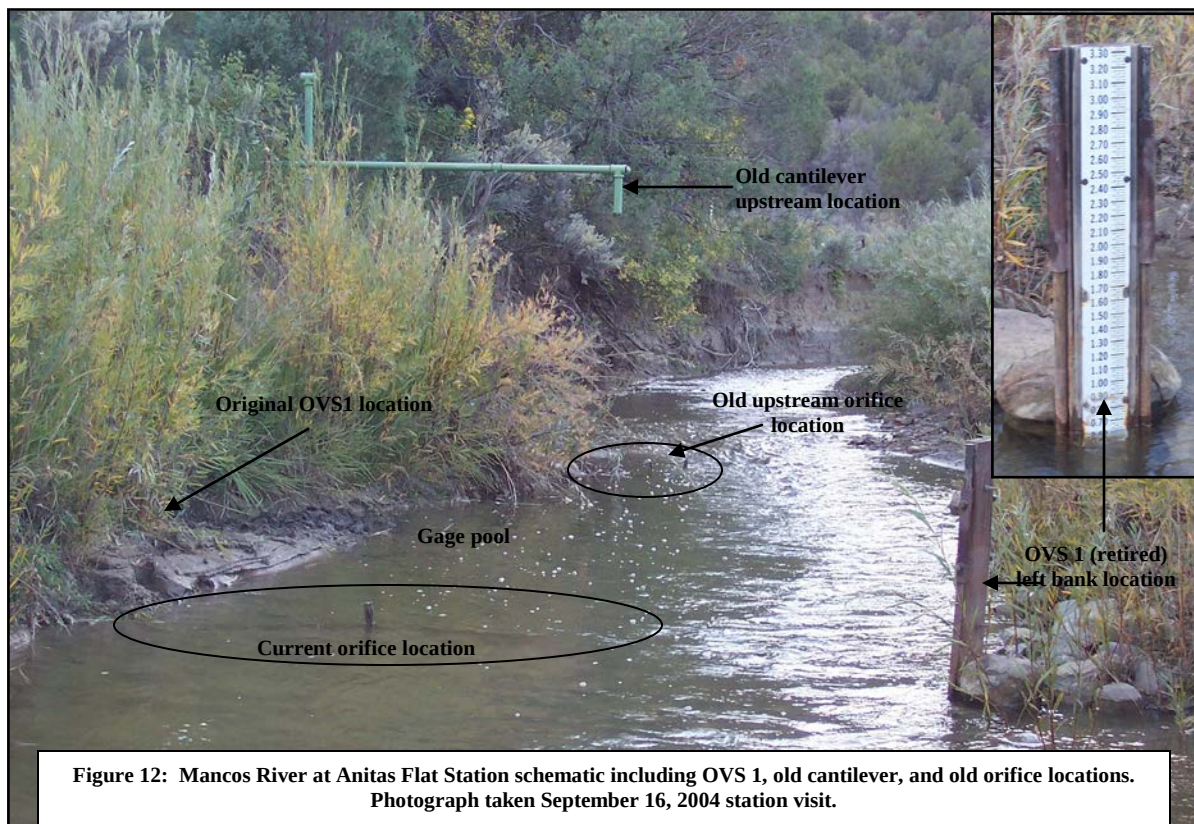


FIGURE 14
Photographs taken April 4, 2006 by Kathryn Converse



FIGURE 15

Photographs taken August 12, 2005 by Gwen Gerber and April 4, 2006 by Kathryn Converse

ACTIVE SURVEY POINT	DATE ESTABLISHED	DESCRIPTION
Ground Rod	November 8, 2001	Base: Top of the ground rod located below the DCP
RM 1	July 18, 2000	Top of rebar located between RM 2 and RM 3
RM 2	July 18, 2000	Top of rebar located furthest downstream near DCP
RM 3	July 18, 2000	Top of rebar located furthest upstream
RM 4	August 12, 2005	Bolt on top of 6"x6" old cantilever's footing
RM 5	August 12, 2005	Bolt on upstream side of 6"x6" new cantilever's center footing
RM 6	August 12, 2005	Bolt on downstream side of 6"x6" new cantilever's streamward footing
OVS 2	December 19, 2000	Nail located at 5.2 feet on high flow vertical staff plate
CSG	August 12, 2005	Crest-Stage-Gage located on new cantilever's streamward footing

