Maintaining Gage Datum: Levels at Gaging Stations

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A visit to Pacific Creek at Moran, WY

The gage is referenced to a wire-weight gage attached to the upstream left bank side of the bridge. There are several brass caps or reference marks located around the gage.

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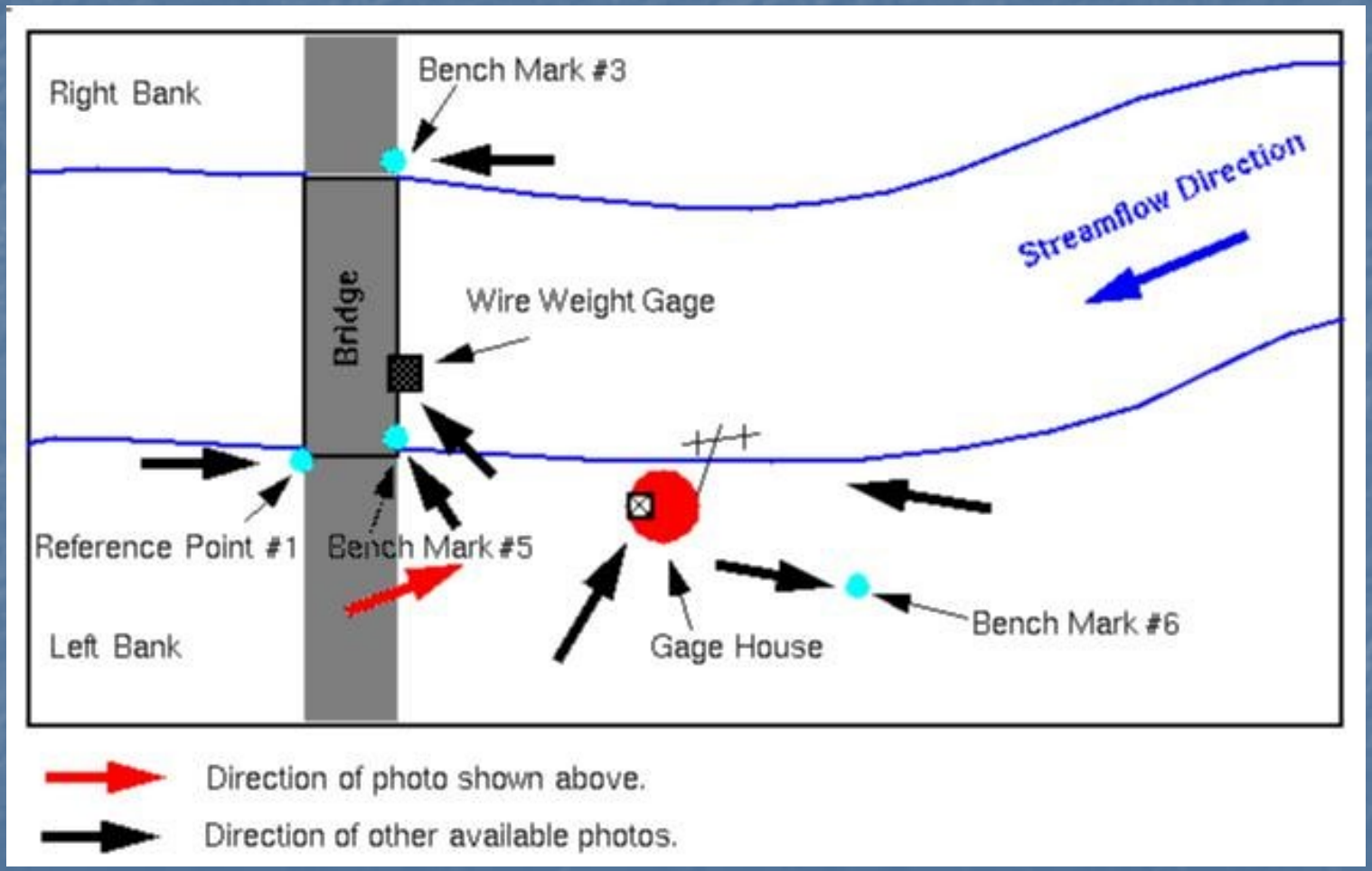
Plan View of Gage Site



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Reference Marks

- Should have at least three stable RMs
- They should be independent of each other
- At least one should be located above the maximum potential flood stage

Preparation for a level circuit

- **Two-peg test the instrument to verify the collimation error is within |0.003| ft/100. Enter the results in the two-peg test log**
  - **Be sure to run tests on both the optical and digital systems of the instrument**
- **With a steel tape determine that the enamel sections on the Philadelphia or Chicago rod read within 0.002 ft**

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Preparation for a level circuit (cont.)

- **Locate the initial or reference bench mark and the other reference marks or brass caps, clear debris away**
- **Determine where you are going to set up for each shot**
- **Level the instrument and begin by noting the time and initial elevation**

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Take a backsight on the origin (given elevation) to establish the initial elevation or height of the instrument (HI) for the level.

Then take Foresights (FS) to objects [RMs, RPs, gages, WS etc.] to determine the first elevations. Establish an independent turning point (TP) by taking a FS on a stable object that is not included in the level circuit.

Move and level the instrument. Take a BS to the established TP to determine a second HI. Take FS's to the same objects to obtain the second elevations. The final FS should be taken on the original RM.

Two criteria for a valid level circuit:

Compute closure error of circuit [given elevation of origin minus final elevation of origin]. Closure must be less than or equal to $|0.003*\sqrt{n}|$ where *n* is number of instrument setups. Distribute closure error to all HIs of level circuit.

Compute difference between First and Second elevations for each object of level circuit. Difference in elevations must be less than or equal to |0.005| ft.

Willow Creek Floodway Channel near Idaho Falls, ID

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Key Points to Anticipate

- Try to balance the distances from the instrument to all objects of level circuit
- Obtain 2 shots on the water surface from different HIs and read the recorder, also noting the time of day
- Shoot the bottom of the wire-weight while near the water surface
- Turn on a stable object and shoot items in the reverse order to the point of beginning

To Conclude the Level Circuit

- Verify that the circuit meets OSW criteria.
- Field check level notes
- Adjust gages if they differ from levels by |0.015| or more.
- Write up the reason for and the findings of the level circuit on the note sheet
- Have the level notes checked a second time.
- Update the station description, level summary sheet, station history and SIMS
- Update the office files

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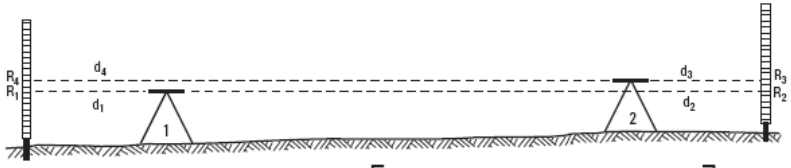
Back sheet

PEG TEST OF ENGINEER'S LEVEL

Make/Model: System type(s) circle: optical digital



$$\text{Collimation} = c = 100 * \left[\frac{(R_1 + R_3) - (R_2 + R_4)}{(d_2 + d_4) - (d_1 + d_3)} \right]$$

Average of d_2 and d_4 should be less than 110 ft

OPTICAL SYSTEM

$$c = 100 * \left[\frac{(4.930 + 5.415) - (5.772 + 4.572)}{(137.5 + 73.5) - (10 + 74)} \right]$$

c = 0.0008 ft/100ft as found

	R	d
1	4.930	10
2	5.772	137.5
3	5.415	74
4	4.572	73.5

DIGITAL SYSTEM

$$c = 100 * \left[\frac{(\quad + \quad) - (\quad + \quad)}{(\quad + \quad) - (\quad + \quad)} \right]$$

c = _____ ft/100ft as found

	R	d
1		
2		
3		
4		

ADJUSTMENT (level remains set up at 2 and sighted at R_4)

Adjust cross hair to: $R_4 \pm \left[\frac{(cd_4)}{100} \right] = \_\_\_\_ \pm \left[\frac{(\quad)}{100} \right]$

Repeat collimation test after adjustment

CLOSURE ERROR COMPUTATIONS

Circuit No.	No. of Inst. Setups (N)	Allowable closure 0.003 * (N)^.5	Closure Error (CE)	CE/N (take to 0.0001)
1	2	0.0042	-0.003	-0.0015

NOTES or SKETCHES:

Front sheet

U.S. DEPARTMENT OF THE INTERIOR

U.S. Geological Survey

Gaging Station Level Notes

Station Number:	09285900
Station Name	Strawberry River at Pinnacles near Fruitland, Utah
Date	April 20, 2009
Party	MLF (inst.) RJE (rod)

SUMMARY OF OBJECTIVE POINTS

Object	Adj. 1st Elev.	Adj. 2nd Elev.	Diff. (1st Elev. – 2nd Elev.)	Final Elev. (Ave. of Adj. Elev.)
RM2	Given			4.160
RM1	2.788	2.785	0.003	2.786
RM4	6.200	6.197	0.003	6.198
CSG	3.820	3.821	-0.001	3.820
OG	2.552	2.548	0.004	2.550

GAGE READINGS

Time	WS	DCP		Ref. OG
13:05		1.52		1.52
13:15	1.517	1.52		1.52
13:25	1.515	1.52		1.52
13:30		1.52		1.52

INSTRUMENT

Make/Model: Leitz Sokkisha Optical
Serial Number: 354635
Collimation (optical): 0.0008
Collimation test date: April 20,2009
Collimation (digital):
Collimation test date:

ROD

Scale material: Invar CTE 0.8*10^-6 (1/F° or 1/C°)
CTE conversions: (1/°F * 1.8 = 1/°C) and ((1/°C)/1.8 = 1/°F)
Temperature (T): Rod: 75 (°F or °C); Air: 75 (°F or °C)
Standard temp (T_o): (70°F) or 20°C or other: ____
Given/Origin elevation: 4.160
Max elevation of objective point: 6.200
Min elevation of objective point: 1.520
Max elevation difference (L): 3.157
$C_t = CTE * L(T-T_o)$ C_t = <0.0001
Other devices used as rod (list): none
Rod taped (circle): (yes) no
Rod level used (circle): (yes) no

GAGE RESET

	Ref. OG	DCP		
Found	1.52	1.52		
Left	1.52	1.52		

WEATHER: Clear, sunny, warm

NOTES: No changes needed or made.

Computed by: MLF Checked by: RJE Date: April 22, 2009

Level notes and computations

OBJECT	BS	CORRECTED BS BS+(CTE*BS*(T−T0))	HEIGHT OF INSTRU-MENT (HI)	FS	CORRECTED FS FS+(CTE*FS*(T−T0))	ELEVATION	Remarks
RM2	5.017		9.177			4.160	Given; Cap 15' NE gage
RM1				6.388		2.789	Cap in concrete pier
RM4				2.976		6.201	Bolt in tree 10' SE gage
CSG				5.356		3.821	Index top lower cap
OG				6.624		2.553	Ref. gage (staff plate)
WS	@13:15			7.660		1.517	OG=1.52, DCP=1.52
TP1				8.195		0.982	
		Moved Instrument					
TP1	8.335		9.317				
WS	@13:25			7.802		1.515	OG=1.52, DCP=1.52
OG				6.766		2.551	
CSG				5.493		3.824	
RM4				3.117		6.200	
RM1				6.529		2.788	
RM2				5.154		4.163	
	CLOSURE ERROR = 4.160 - 4.163 = -0.003						
	CElimit = |0.003*(√2setups)| = |0.004|						

CLOSURE-ERROR ADJUSTMENT TO HI	ADJUSTED 1st ELEVATION	ADJUSTED 2nd ELEVATION	DIFFERENCE (AE1 −AE2)	FINAL ELEVATION	OLD ELEVATION	Remarks
-0.0015					4.160	Given, Origin
	2.788		0.003	2.786	2.788	
	6.200		0.003	6.198	6.200	
	3.820		-0.001	3.820	3.822	
	2.552		0.004	2.550	2.550	Nail at 2.55
	1.516					Held on rock, +/-.01
-0.0030						
		1.512				Held on rock, +/-.01
		2.548				Nail at 2.55
		3.821				
		6.197				
		2.785				

UNITED STATES
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

LEVEL SUMMARY

Station No. **13011500**
*reference gage

STATION NAME: Pacific Creek at Moran, WY

DATE	PARTY	BM3 9.282	BM4 7.616	BM5 17.887	RP1 4.790	RM1 7.612	Wire-Weight	Bridge plate	BM6 8.773	Orifice Cap		REMARKS
7/12/1978	R. Erickson L. Hall	*9.282	7.600		4.790							
10/20/1978	N. Jacobson D. Miller	*9.282	7.616		4.801		16.396					
8/12/1982	R. Taylor L. Hellewell	*9.282	7.612	17.912			16.398					
6/29/1983	R. Taylor R. Erickson	*9.282	7.625				16.397					BM#4 frost heaved
11/8/1989	S. Landon K. Kirlin	*9.282		17.916		7.612	16.401		8.773			
3/22/1990	N. Jacobson S. Landon	*9.282		17.920		7.618	16.404		8.773			
9/28/1993	R. Erickson D. Cole	*9.282		17.302	4.790	7.604	16.390					
4/24/1996	B. VandeKamp N. Jacobson	*9.282		17.905	4.768	7.637	16.391	9.829	8.764			RP#1 bent down
4/4/1999	D. Cole N. Jacobson	*9.282		17.914	4.774	7.612	16.399		8.760			
4/23/2002	N. Jacobson T. Brennan	*9.282		17.914	4.785	7.612	16.400	15.388	8.758			
4/19/2005	N. Jacobson J. Bateman	*9.282	CSG Base 5.426	17.914	4.784	7.622	16.400		8.748	3.065		Est. elev. for newly installed csg base bolt and orifice cap
4/22/2008	N. Jacobson B. VandeKamp	*9.282	5.418	17.916		7.614	16.402	17.844		3.064		
9/14/2011	N. Jacobson J. Bateman	*9.282	5.417	17.916	4.788	7.622	16.402	17.822	8.738	3.063		

Internal Only

Station Description View

13011500 PACIFIC CREEK AT MORAN WY

Responsible Office
U.S. Geological Survey
Idaho Falls Field Office
P.O. Box 51099, 366 D Street
Idaho Falls, ID 83405-1099
(208) 529-4287

Most recent revision: 9/20/2011
Revised by: jake

LOCATION.--Lat 43°51'01", long 110°31'04" referenced to North American Datum of 1983, in SW 1/4 NW 1/4 sec.23, T.45 N., R.114 W., Teton County, WY, Hydrologic Unit 17040101, Moran quad., Grand Teton National Park, on left bank 40 ft upstream from bridge on U.S. Highway 287 at Moran, and at mile 0.5.

ROAD LOG.--Begin at Jackson, Wyoming;

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Mile
 0.0 proceed north on State highway 89-287,
32.0 Moran Junction, turn left and pass through the National Park Service booth,
33.0 Pacific Creek, gage on right.
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View Larger Map

SITE HAZARD ANALYSIS.--The traffic control safety plan must be implemented when inspecting

the gage or making a discharge measurement from the bridge at this site. These plans document the appropriate signs, cones, and possibly flag persons needed to prevent traffic related accidents.

DRAINAGE AREA.--169 mi^2, mean elevation, 8,160 ft.

ESTABLISHMENT AND HISTORY.--Staff gages at various sites and datums prior to September 23, 1944. Recording station 100 ft upstream on left bank September 23, 1944, to November 13, 1959. Moved to right bank 6 ft upstream and operated at that site November 13, 1959, to September, 1976, when it was discontinued. On July 12, 1978, station was relocated from right bank to left bank 35 ft upstream and put back into operation.

GAGE.--A Sutron 8210 datalogger is connected to a USGS-owned Vitel DCP and datalogger equipment. The dataloggers are actuated by a Sutron Accubar pressure sensor. The equipment is housed in a 54-inch CMP shelter. THE REFERENCE GAGE IS A WIRE-WEIGHT GAGE attached to the upstream left bank side of the bridge. Due to continuous and extreme channel change, the permanent orifice lines occasionally become buried.

Check bar elevation is 16.402 ft. Crest-stage gage base bolt elevation is 5.417.

CONTROL.--A continuously shifting cobble and gravel riffle for low stages. At high stages, the bridge wingwalls and right and left bank gabions act as the control.

DISCHARGE MEASUREMENTS.--Low stage measurements are made with a Price AA meter or FlowTracker by wading 100 ft above the gage up to a stage of 5.00 ft. Medium and high water measurements are made by stretching a boat tagline 100 feet above the bridge and pulling a tethered Sontek M9 or StreamPro ADCP back and forth by hand or from the downstream side of the highway bridge (the highway bridge is not preferred because of the severe sheer angles and non-steady flow).

FLOODS.--Maximum discharge of record, 5,350 ft^3/s on May 29, 1983.

POINT OF ZERO FLOW.--

WINTER FLOW.--Some ice effect in winter.

COOPERATION.--Station operated in cooperation with the Idaho Department of Water Resources.

MAP.--A map-plan view of the site with BM's, RM's and reference points is located in the electronic file work images: \\igswiawwfs001\IFFO Descriptions\sketches\13011500

REFERENCE MARKS.--

BM 1 and 2 - Destroyed.

BM 3 is a standard USGS brass cap on upstream right bridge abutment.
Elev. 9.282 ft

BM 4 - Destroyed.

BM 5, a Bureau of Public Roads brass cap in the upstream left bank bridge abutment.
Elev. 17.916 ft

RM 1, the southeast gage house step corner. Elev. 7.622 ft

BM 6, a standard USGS brass cap, located 22 ft upstream and 12 ft shoreward from center of gage. Elev. 8.738 ft

RP Bridge plate: the top side of the flange of the steel beam bridge support, located near the 4th vertical rib from the right bank end of the bridge. Elev. 17.822 ft

RP 1, the head of 1/2-inch lag bolt in the side of the downstream leftbank bridge abutment. Elev. 4.788 ft

PHOTOGRAPHS.--Photographs for the site are located in the electronic file \\igswiawwfs001\SiteData\Surface Water\13011500\Images

DATE OF LAST LEVELS.--
Last run: Sep 14, 2011; Next run: Sep 13, 2014; Frequency: 3 years; Status: OPEN

Routine levels were run Sept. 14, 2011, from BM #3 at elevation 9.282 ft. No changes were found for the reference marks. BM #6 is gradually settling.

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Frequency of Levels

OSW Memo 90.10 is the current guidance – (New levels T&M clarifies 90.10):

- As a station is started, levels should be run every year for 3 years.
- Levels at streamflow gaging stations should be run at least every 3 years.
- If, after at least 5 sets of levels over a period of at least 10 years, the gaging station is shown to be stable, a lesser frequency of levels may be adopted.

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Frequency of Levels (cont.)

- If stability is shown to exist, levels should be run at least every:

  - 5 years at regular gaging stations.

  - 3 years at crest-stage stations.
- Levels can always be run more frequently.
- As a station is discontinued, a level circuit should be run.
- A good routine would be to survey at least 1/3 of the levels each year.

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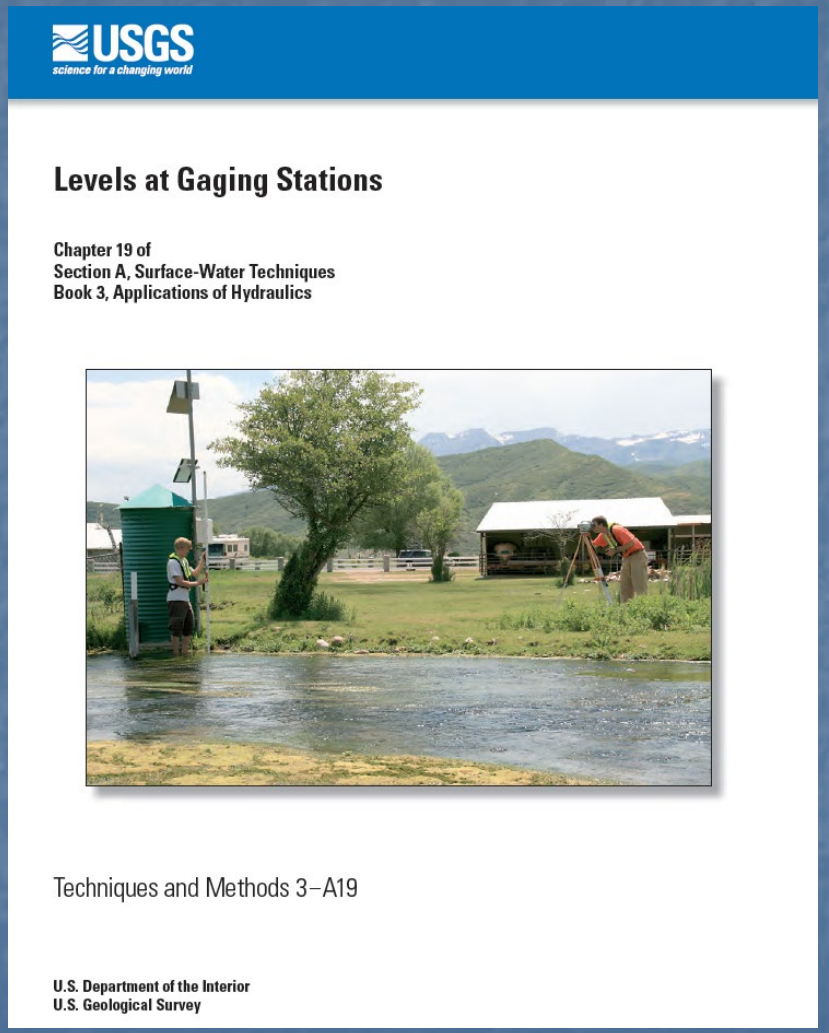
Levels at Gaging Stations

For more information:

- Procedures for Running Levels at Gaging Stations, T. A. Kenney, Techniques and Methods 3-A19
- Levels at Streamflow Gaging Stations, E.J. Kennedy, TWRI, Book 3, Ch. A19
- Levels at Streamflow Gaging Stations A CD-ROM Training Class, K. Michael Nolan, Nathan Jacobson, Robert Erickson, and Stanley Landon
- OSW Memo 90.10 (levels frequency)
- OSW Memo 93.12 (side shots)



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