

“In Search of CFS’ers”

Or

“How in Heck does the USGS Measure Streamflow”

Presented to

Red River Basin Advisory Committee

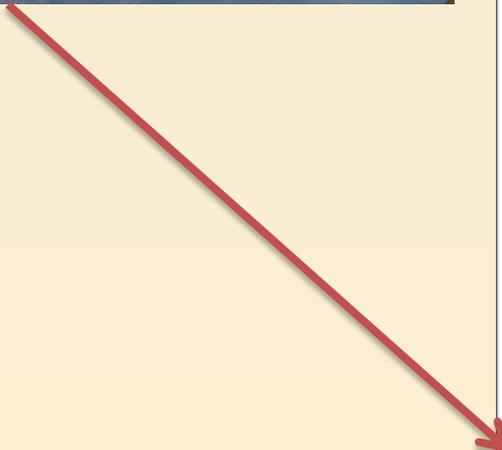
by

Mick Baldys

U.S. Geological Survey
North Texas Program Office

March 26, 2013

Field to the Office



--- Predefined displays ---		Group table by	Select sites by number or name		
TX Streamflow / Lake Table		Major River Basin	<input type="text"/>	go	show sites on a map
Customize table to di current-condition para					
Station Number	Station name	Date/Time	Gage height, feet	Dis-charge, ft ³ /s	
● Arkansas River Basin					
07228000	Canadian Rv nr Canadian, TX	03/21 13:45 CDT	2.24	54	
● Red River Basin					
07299540	Pr Dog Twm Fk Red Rv nr Childress, TX	03/21 13:45 CDT	7.42	1.4	
07299670	Groesbeck Ck at SH 6 nr Quanah, TX	03/21 14:00 CDT	7.07	8.1	
07300000	Salt Fk Red Rv nr Wellington, TX	03/21 13:45 CDT	3.20	21	
07301300	N Fk Red Rv nr Shamrock, TX	03/21 13:45 CDT	0.86	39	
07301410	Sweetwater Ck nr Kelton, TX	03/21 13:45 CDT	6.48	6.8	
07308200	Pease Rv nr Vernon, TX	03/21 14:00 CDT	5.18	1.4	
07308500	Red Rv nr Burkburnett, TX	03/21 13:30 CDT	2.78	26	
07311600	2~N Wichita Rv nr Paducah, TX	03/21 13:45 CDT	2.96	0.00	
07311630	2~Middle Wichita Rv nr Guthrie, TX	03/21 13:45 CDT	7.12	3.2	
07311700	N Wichita Rv nr Truscott, TX	03/21 13:45 CDT	6.17	11	

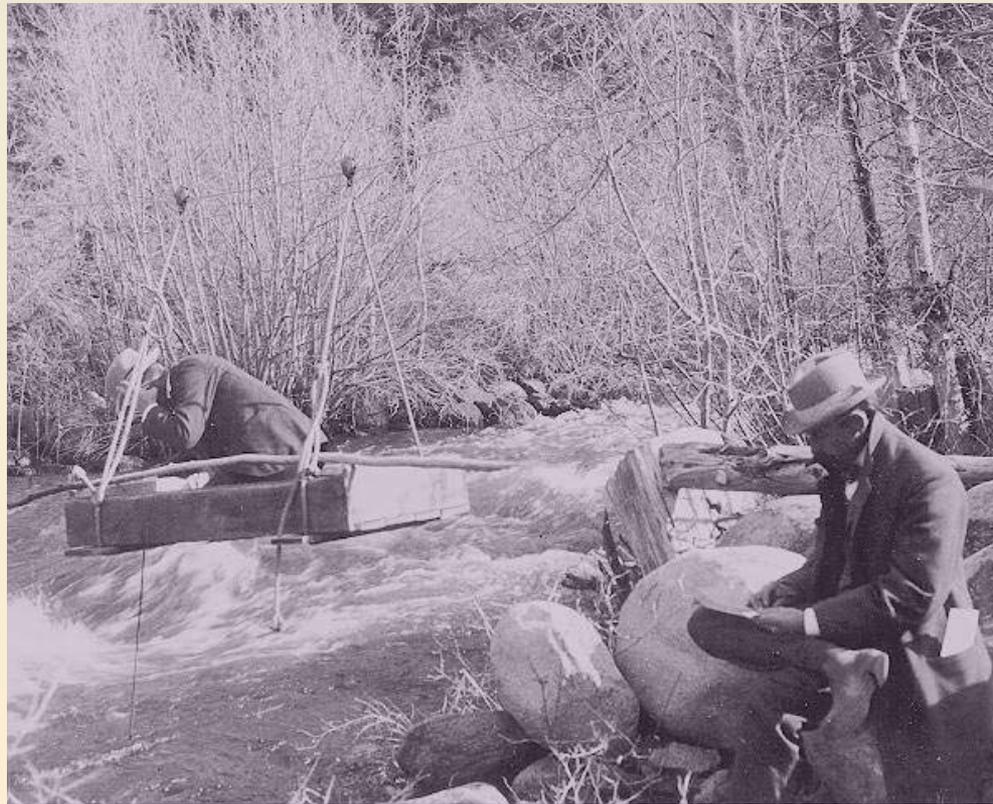
Presentation Objectives

- Relate USGS units to water provider units
- Describe how the USGS measures streamflow in the field
- Show the calculation methods used
- Describe how the data is presented and how the data can be obtained/used

What is a cfs???

- cfs stands for cubic feet per second (ft^3/s)
- 1 cfs contains 7.48 gallons
- 1 cfs for one day = 1.98347 ac-ft
- 1 cfs for one day = 646,317 gallons
- 1 cfs/day = 0.6463 million gallons per day (mgd)
- 1 mgd = 1.55 cfs/d

Streamgaging in 1901



Analog Recorders



More recent times



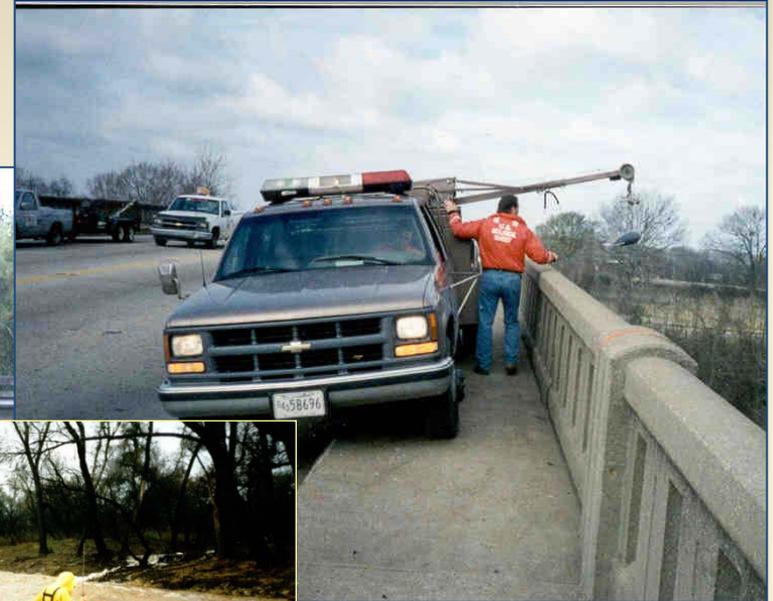
Typical USGS gaging station



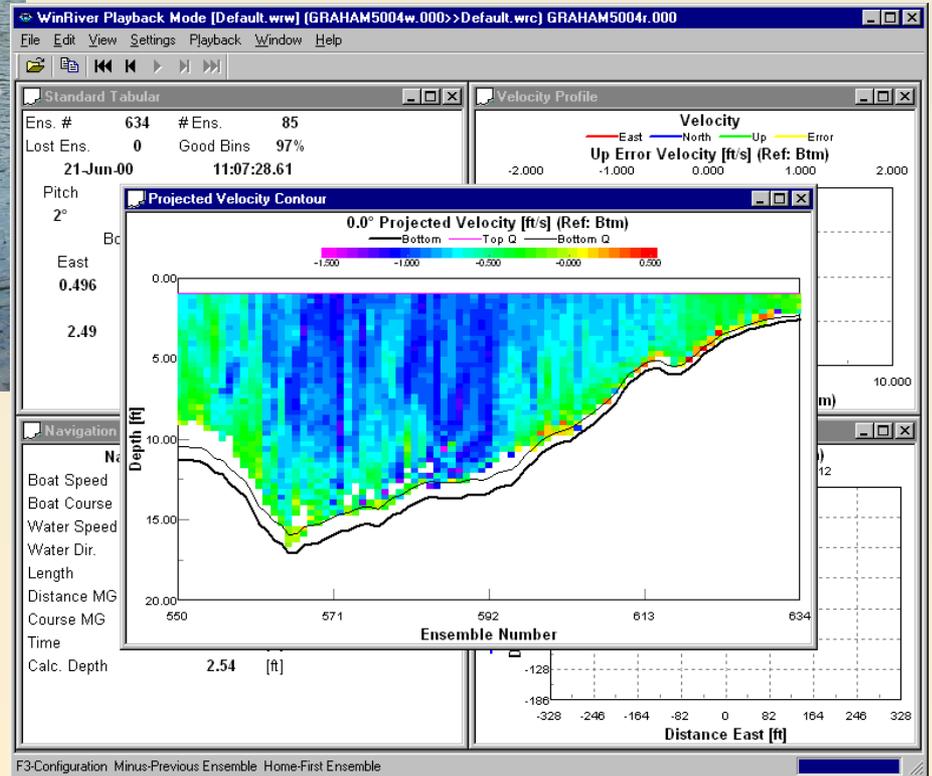
- Senses water level
- Records data 15 min.
- Transmits hourly
- Adjusted automatically
- Available on internet

Discharge monitoring

Conventional River Discharge Measurements



Acoustic Doppler Current Profiler



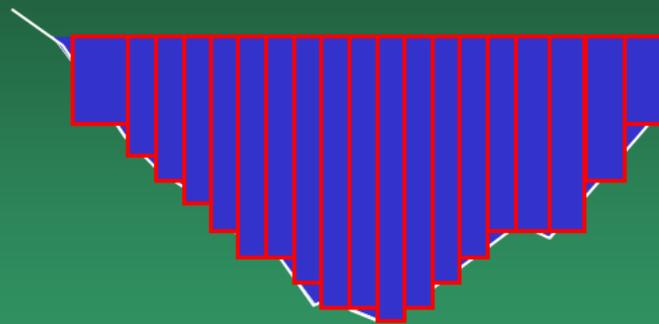
Computation method

THE VELOCITY-AREA METHOD

Discharge = (Area of water in cross section) x (Water velocity)



Channel cross section is divided into numerous sub sections



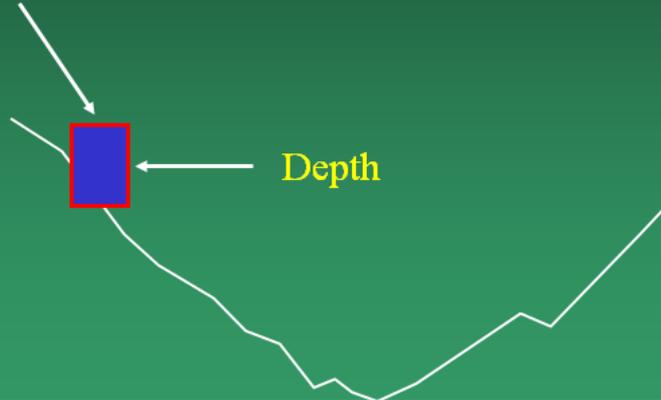
Discharge of each sub-section = Area x Average Water Velocity

Area of each sub-section determined by directly measuring width and depth

Width

Area = Width x Depth

Depth

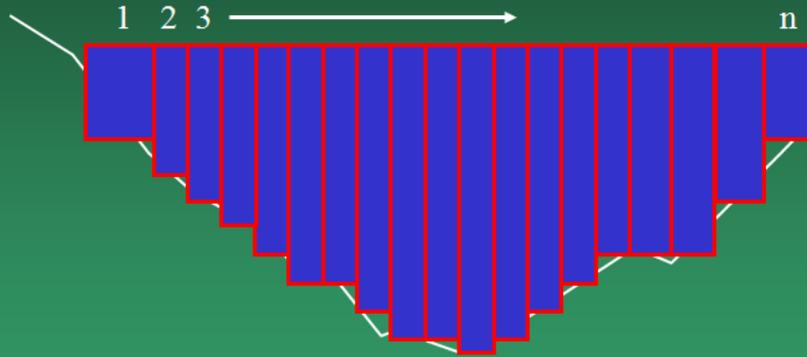


Water velocity in each sub-section is estimated using a current meter to measure water velocity at selected locations



Stream discharge is sum of discharges in all sub-sections

$$\text{Total Discharge} = ((\text{Area}_1 \times \text{Velocity}_1) + (\text{Area}_2 \times \text{Velocity}_2) + \dots (\text{Area}_n \times \text{Velocity}_n))$$

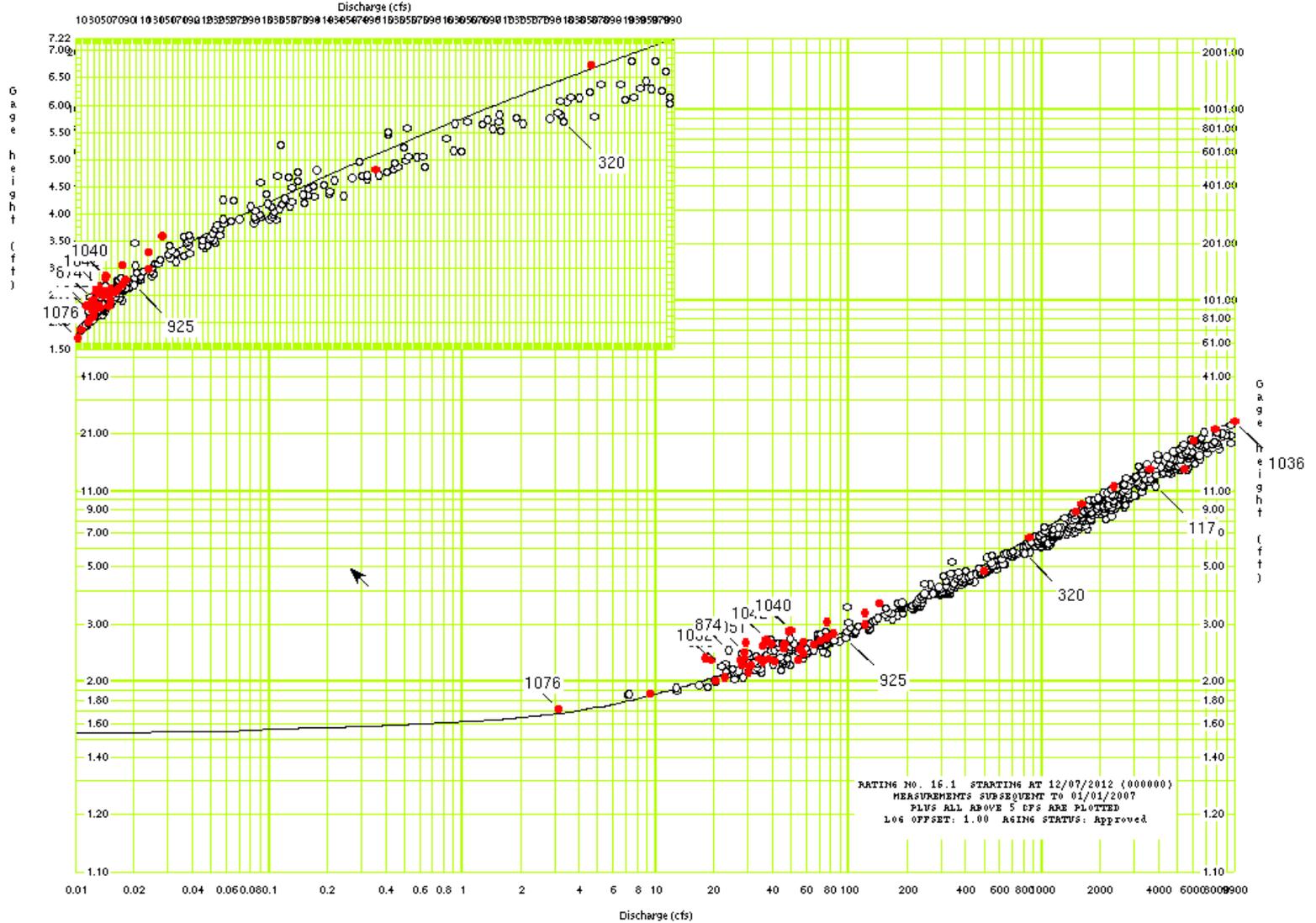


What is gage height?

- Gage height is the water-surface elevation, in feet above the gage datum (vertical datum)
- Datum is referenced to North American Vertical datum of 1988 (preferred) or National Geodetic Datum of 1929



Wichita Rv at Wichita Falls, TX USGS 07312500



Rating curve table for Wichita River at Wichita Falls

STATION:07312500 Wichita Rv at Wichita Falls, TX TYPE:STREAM AGENCY:USGS STATE:48 COUNTY:485
 LATITUDE: 335434 LONGITUDE: 0983200 NAD27 DRAINAGE AREA:3140 CONTRIBUTING DRAINAGE AREA:1054 DATUM:924.26 NGVD29

Date Processed: 2013-03-21 14:24 By sbaldys

Rating for Discharge FROM DCP (cfs)

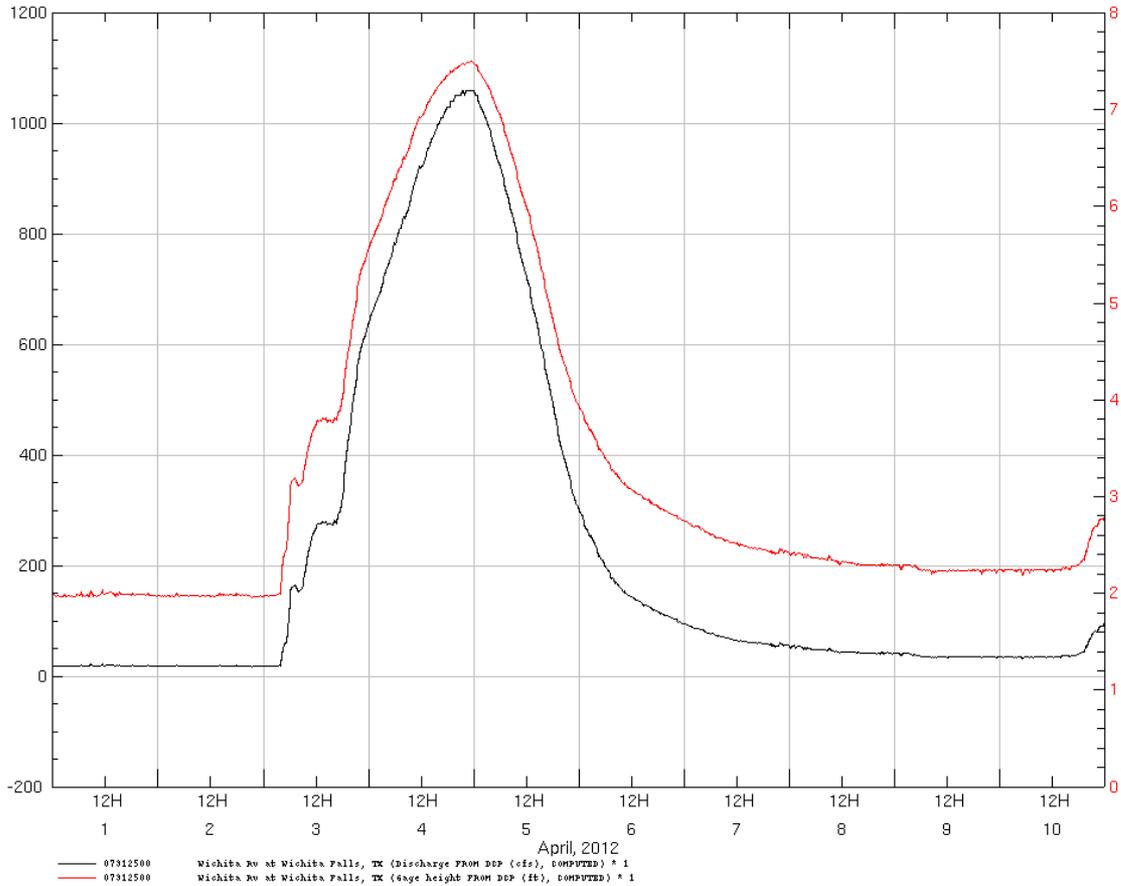
RATING ID: 16.1 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by skelley on 09-28-2011 @ 12:45:04 CDT, Updated by skelley on 09-28-2011 @ 13:01:47 CDT

RATING REMARKS: Same as RT 16.0 above 6.5 ft., tweaked lower end to better fit most recent measurements

OFFSET: 1.00

EXPANDED RATING TABLE

Gage height, feet	Discharge (cfs)										DIFF IN Q PER .1 UNITS
	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	
1.50	0.00*	0.00	0.01	0.01	0.01*	0.06*	0.11	0.19	0.33*	0.45	0.61
1.60	0.61	0.83	1.1	1.5*	1.7	2.0	2.4	2.7	3.2	3.6*	3.3
1.70	3.9	4.2	4.6	4.9	5.3	5.6	6.0	6.5*	6.8	7.1	3.6
1.80	7.5	7.9	8.3	8.7	9.1	9.5	10.0	10.4	10.9	11.4	4.4
1.90	11.9	12.4*	12.9	13.4	13.8	14.3	14.8	15.3	15.9	16.4	5.1
2.00	17.0	17.5	18.1	18.7	19.3	19.9	20.5	21.2	21.8	22.5	6.2
2.10	23.2	23.9	24.6	25.3	26.0	26.8*	27.5	28.2	28.9	29.6	7.1
2.20	30.3	31.1	31.8	32.6	33.4	34.1	34.9	35.8	36.6	37.4	8.0
2.30	38.3	39.1	40.0	40.9	41.8	42.7	43.6	44.6	45.5	46.5	9.1
2.40	47.4	48.4	49.4	50.5	51.5	52.5	53.6	54.7	55.8*	56.7	10.3
2.50	57.7	58.6	59.6	60.6	61.6	62.6	63.6	64.7	65.7	66.8	10.1
2.60	67.8	68.9	70.0	71.1	72.2	73.3	74.4	75.5	76.7	77.8	11.2
2.70	79.0	80.2	81.3	82.5	83.7	85.0	86.2	87.4	88.7	89.9	12.2
2.80	91.2	92.5	93.8	95.1	96.4	97.7	99.0	100	102	103	12.8
2.90	104	106	107	109	110	112	113*	114	116	117	14.0
3.00	118	119	121	122	123	125	126	127	129	130	13.0
3.10	131	133	134	136	137	138	140	141	143	144	15.0
3.20	146	147	149	150	152	153	155	156	158	159	15.0
3.30	161	162	164	165	167	168	170	172	173	175	15.0
3.40	176	178	180	181	183	185	186	188	190	191	17.0



- Gage datum at site is 924.26 above NGVD 1929

Streamflow data is available on the web!

USGS Current Conditions for selected River Basins in Texas - Windows Internet Explorer

http://waterdata.usgs.gov/tx/nwis/current?type=flow_res&site_no_list=&office_wch.rdb&group_key=basin_cd

USGS Home
Contact USGS
Search USGS

National Water Information System: Web Interface

USGS Water Resources (District Access) Data Category: Current Conditions Geographic Area: Texas GO

Combined Texas Streamflow and Lakes Table -- 42 site(s) found
[PROVISIONAL DATA SUBJECT TO REVISION](#)

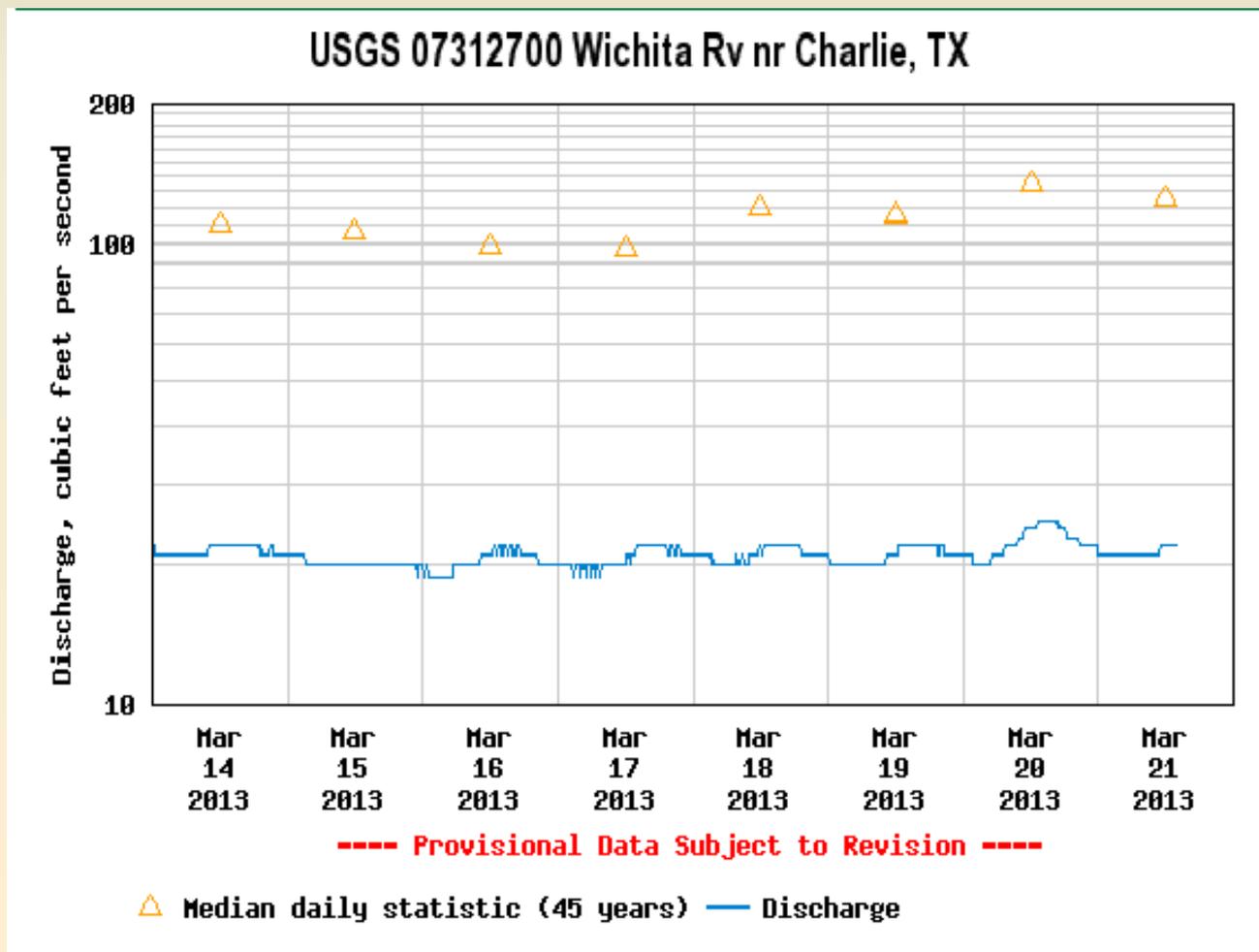
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 TX Streamflow / Lake Table Group table by: Major River Basin Select sites by number or name: [] go show sites on a map

[Customize table to display other current-condition parameters](#)

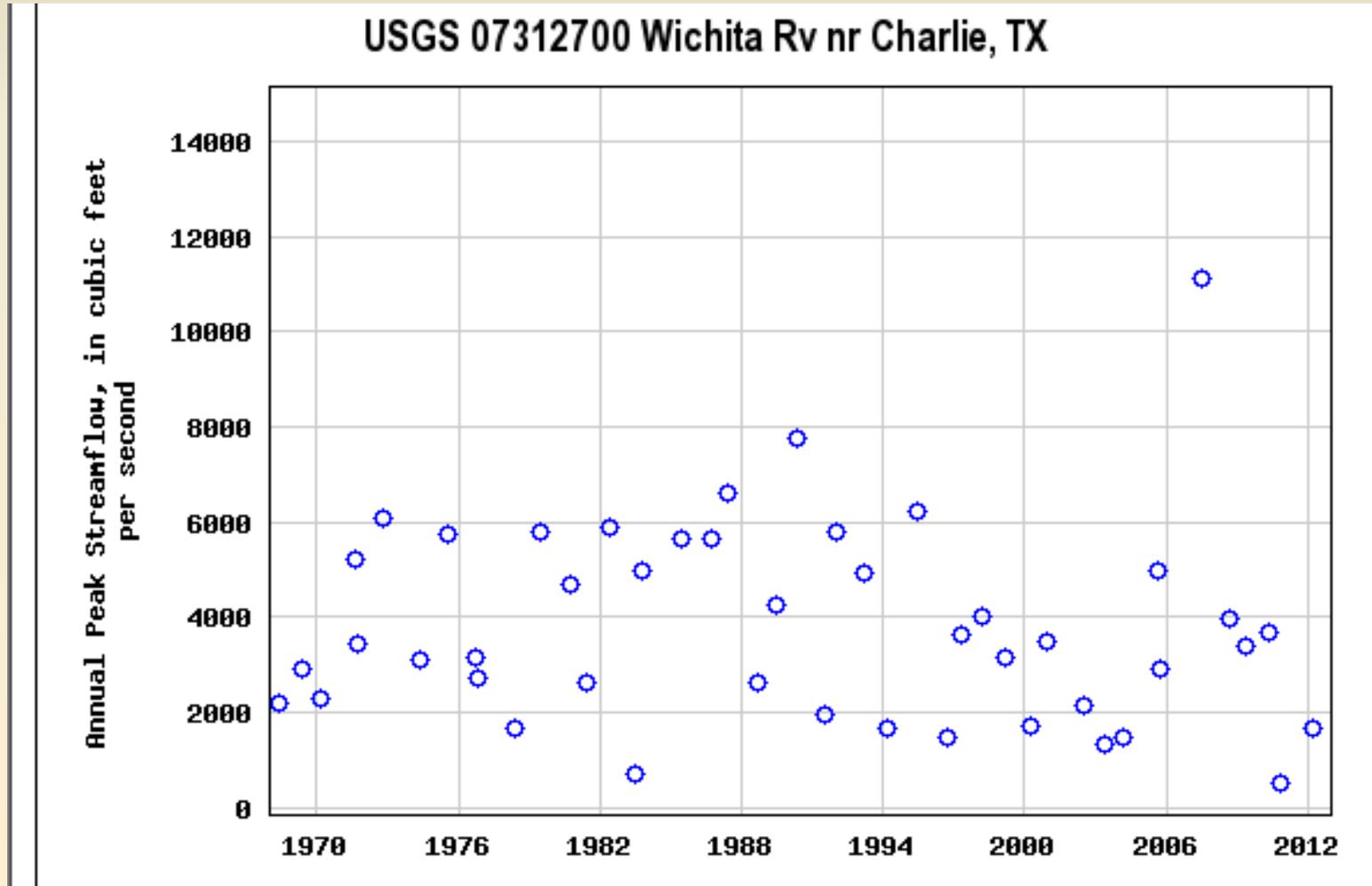
Station Number	Station name	Date/Time	Gage height, feet	Dis-charge, ft ³ /s	Reser-voir elevation above datum, feet	Elev-ation, Reser-voir above storage NGVD	acre-ft
● Arkansas River Basin							
07228000	Canadian Rv nr Canadian, TX	03/08 09:45 CST	2.25	55	--	--	--
● Red River Basin							
07299540	Pr Dog Twn Fk Red Rv nr Childress, TX	03/08 09:45 CST	7.41	0.85	--	--	--
07299670	Groesbeck Ck at SH 6 nr Quanah, TX	03/08 10:00 CST	7.08	8.5	--	--	--
07300000	Salt Fk Red Rv nr Wellington, TX	03/08 09:45 CST	3.23	24	--	--	--
07301300	N Fk Red Rv nr Shamrock, TX	03/08 09:45 CST	0.85	39	--	--	--
07301410	Sweetwater Ck nr Kelton, TX	03/08 09:45 CST	6.50	7.3	--	--	--
07308200	Pease Rv nr Vernon, TX	03/08 10:00 CST	5.24	2.5	--	--	--
07308500	Red Rv nr Burkburnett, TX	03/08 09:30 CST	3.05	82	--	--	--
07311600	2~N Wichita Rv nr Paducah, TX	03/08 09:45 CST	3.01	0.02	--	--	--
07311630	2~Middle Wichita Rv nr Guthrie, TX	03/08 09:45 CST	7.06	3.0	--	--	--
07311700	N Wichita Rv nr Truscott, TX	03/08 09:45 CST	6.14	8.5	--	--	--

Local intranet 100%

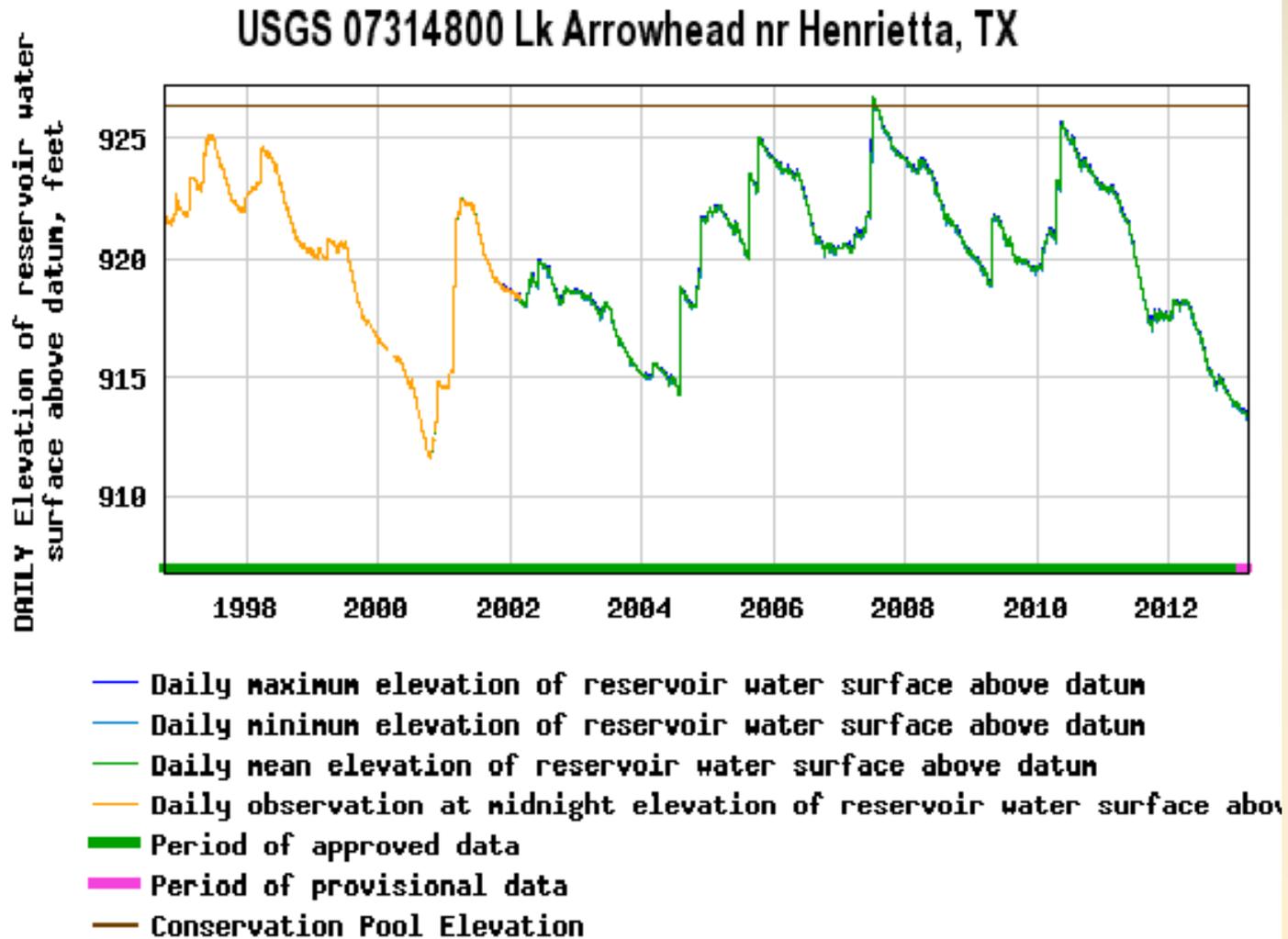
Instantaneous Discharge (and gage height) data are available for 120 days



Long term peak-flow data are also available



Historical data for reservoirs



Uses for streamflow data

- Flood studies
- Availability
- Quality
- Future planning
- Recreation
- Many other uses

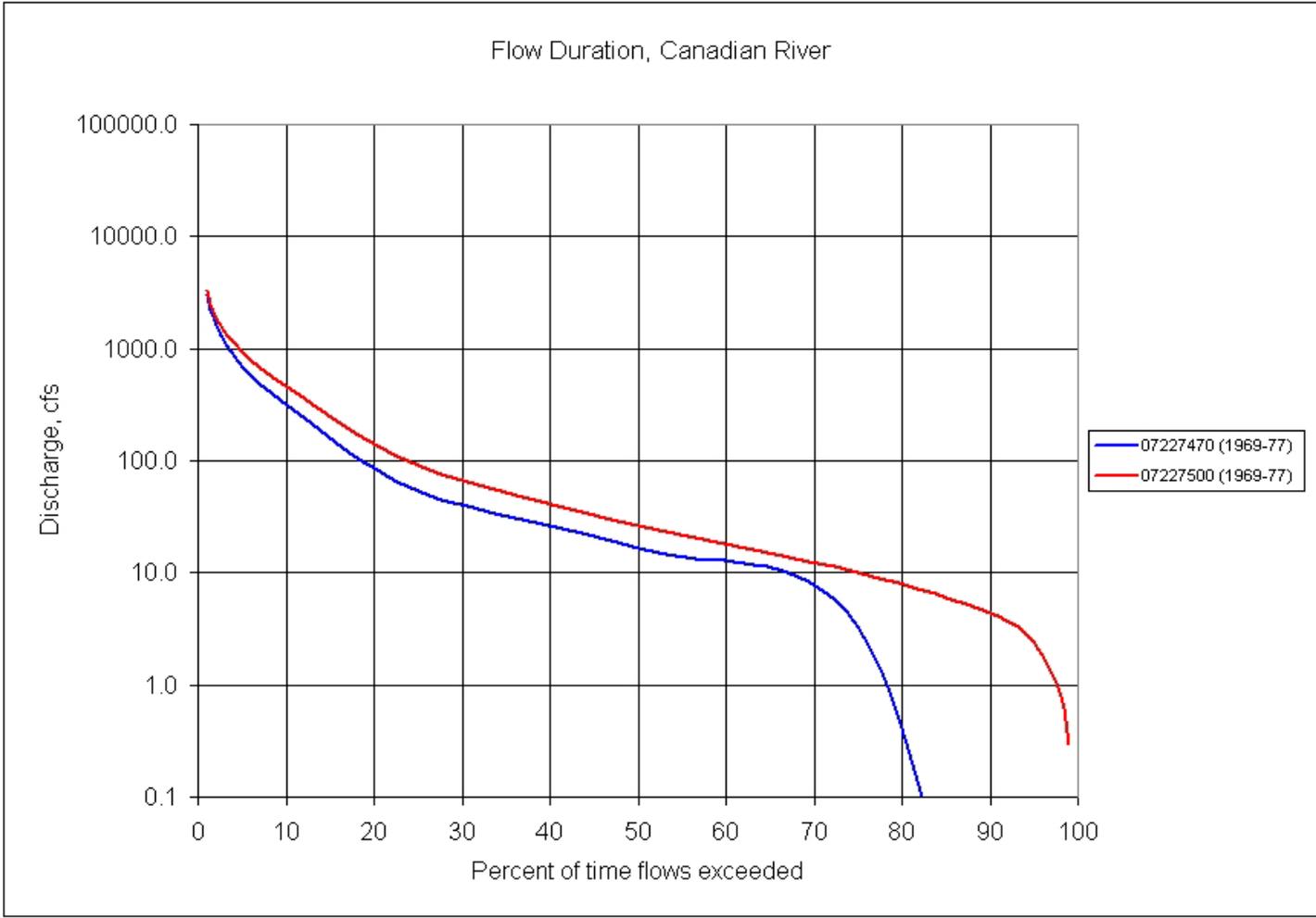
Flow Duration Curves for Canadian R. at Tascosa and nr Amarillo (Hwy 287)

07227470 Canadian River at Tascosa, TX

	Percent of time flows exceeded	Discharge (cfs)
(1969-77)	99	0.0
	98	0.0
	95	0.0
	90	0.0
	75	3.3
	50	16.4
	25	54.4
	10	313.8
	5	686.6
	2	1609.5
	1	3057.5

07227500 Canadian River near Amarillo, TX

	Percent of time flows exceeded	Discharge (cfs)
(1969-77)	99	0.3
	98	0.8
	95	2.4
	90	4.4
	75	10.2
	50	26.3
	25	90.8
	10	459.3
	5	928.7
	2	1867.3
	1	3292.1



Headlines in the Wichita Falls Time Record News

PROGRESS 2008

61 ■ Sunday, February 24, 2008 Times Record News

Toni Halley/Times Record News

Ray Queen and Avery Scruggins, left, of Puroclean haul out debris as they work to get the molature out of a home in the Horseshoe Bend area in Wichita County. Floodwaters rose about a foot inside the home.



Toni Halley/Times Record News

A Red Cross disaster services van passes over the Wichita River at FM 366 as the river swells underneath. The neighborhoods of the Horseshoe Bend and Wranglers Retreat, both located just off FM 366, were under a mandatory evacuation order from Wichita County Judge Woody Gossom as the water rose in late June.



Flood one for record books

Wichita River notched its highest-ever level of 24.4 feet

Lara N. Richards
Times Record News

It was more water than the Wichita River had ever seen. . . . Rains started falling in late June 2007 and they fell day after day after day, pushing the river further over its banks. . . . The 2007 flood was one for the record books as the river notched its highest-ever level of 24.4 feet. . . . It was an event that sent waves of water into many neighborhoods in Wichita County and the city of Wichita Falls, forcing evacuations and causing millions of dollars in damage. . . . "It was a major undertaking," said Dave Clark, city of Wichita Falls director of community development. "Two rivers been through that degree of disaster before. We did what we had to do and got through it." . . . The Tanglewood and East Side neighborhoods in Wichita Falls were under water. Wranglers Retreat and Horseshoe Bend in Wichita County spilled over so well. . . . Hundreds of homes sustained flood damage, with around 100 or so receiving



Toni Halley/Times Record News

than it could have been. Our emergency personnel, both volunteers and on-call people, really rose to the occasion. The city and county worked well together." . . . Although the flooding happened several months ago, Bourgoin said recovery is still continuing. . . . The county is still waiting on word from state and federal officials about a disaster mitigation grant program, which would give the county funds to purchase and then demolish three homes in Wranglers Retreat that suffered the most damage. . . . The county is also working on public assistance funds from FEMA to work on repairing roads and bridges that were damaged in the flood. . . . "It's still ongoing for the county and will be for a few more months," Bourgoin said. . . . Recovery continues to progress steadily in the city as well, Clark said. . . . "People have moved ahead and are doing repairs," he said. "There's a couple of cases where they have actually elevated the house above the flood plain. There is record setting."

Overview of flood events Wichita Falls

June 30, 2007 Flood:

Stage 24.40 ft , $Q=10,100$ cfs, Mean Velocity = 2.03 ft/sec



Oct. 3, 1941 flood: Stage 24.00 ft,
 $Q=17,800$ cfs,
Mean velocity = 3.60 ft/sec



Wichita River at Loop 11; 1950, 1961, 1996, and 2009



Contest Time!!!!!!!



Wichita River looking downstream

- How much water is there in cfs and mgd???



Pertinent Information

- **Gage Height = 1.72 ft**
- **Width = about the distance to make a first down**
- **Maximum Depth = about the width of home plate**
- **Velocity = the speed your co-worker reaches for his wallet to pay for lunch**

And the answer is.....

- Streamflow = 3.15 cfs
- Area = 21.9 ft²
- Velocity = 0.14 ft/s
- Mean depth = 0.80 ft



Presentation review

- Relate USGS units to water provider units
- Describe how the USGS measures streamflow in the field
- Show the calculation methods used
- Describe how the data is presented and how the data can be obtained/used

Thank You!!!!!!!!!!

sbaldys@usgs.gov

