



USGS Utah Water Science Center Streamgaging Program and Data Access

Ryan Rowland, Data Chief, Utah Water Science Center

**Special thanks to Cory Angeroth, Steve Gerner, and Mike Freeman,
Utah Water Science Center**

Discussion Topics



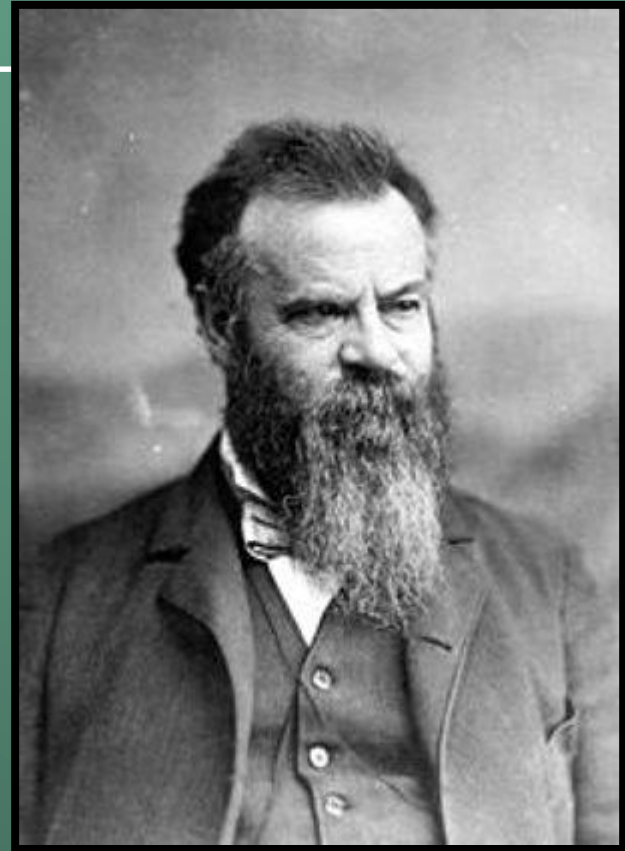
Hiking to sampling site on San Rafael River, Utah

- Brief Overview of USGS Water Resources Mission Area
- Overview of USGS Utah Water Science Center
- Streamgaging Methods and Data Access

Mission Areas of USGS

- Core Science Systems
- Ecosystems
- Energy and Minerals
- Natural Hazards
- Water Resources

<https://www.usgs.gov/science/mission-areas>



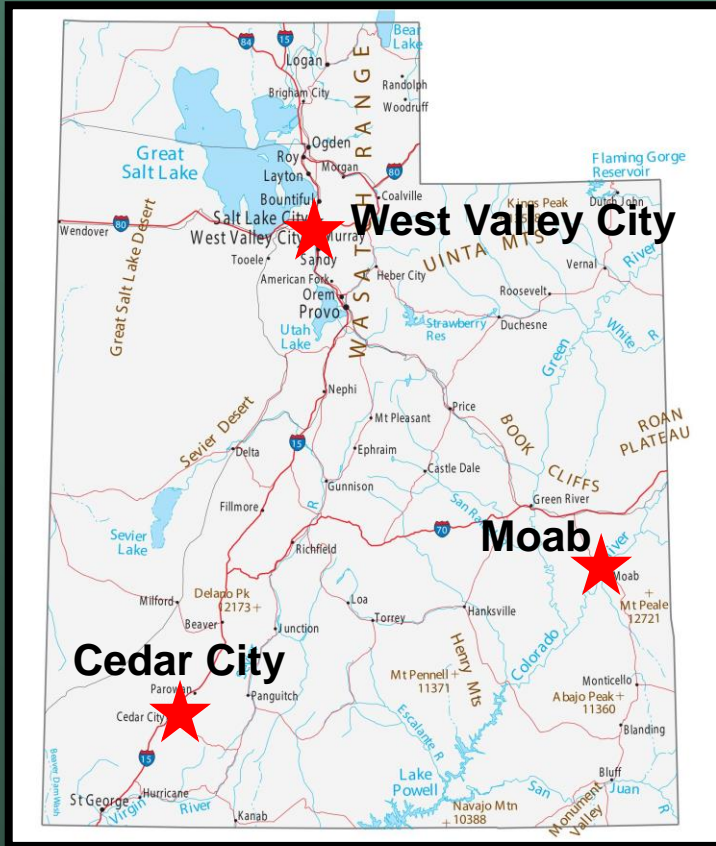
*John Wesley Powell, USGS
Director, 1881-1894*

What We Do in the Water Resources Mission Area

We work with partners to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and water use and availability.

Our data are used to support management decisions and to respond to emergencies such as floods and droughts.

USGS Utah Water Science Center



- WSC and Salt Lake Field Office co-located in West Valley City
- Field offices also in Moab and Cedar City
- Surveillance Section responsible for stream-gaging and other basic data collection
- Investigations Section conducts hydrologic studies

Base map from <https://gisgeography.com/utah-map/>

U

Examples



Con

G

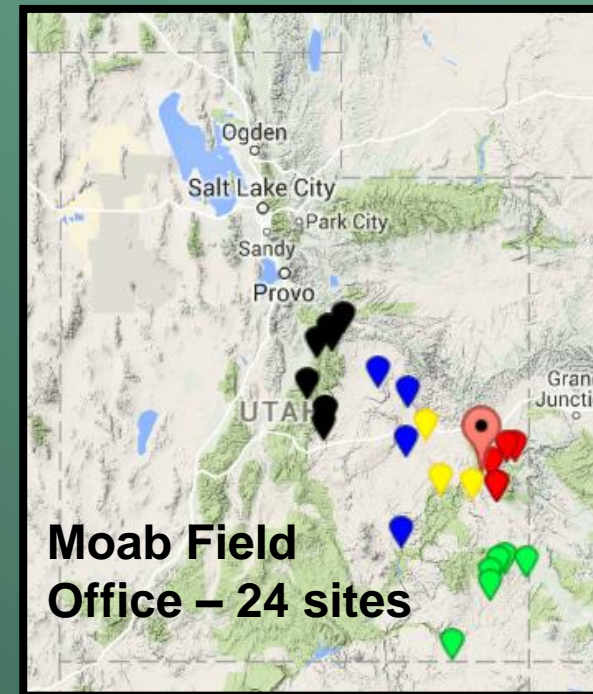
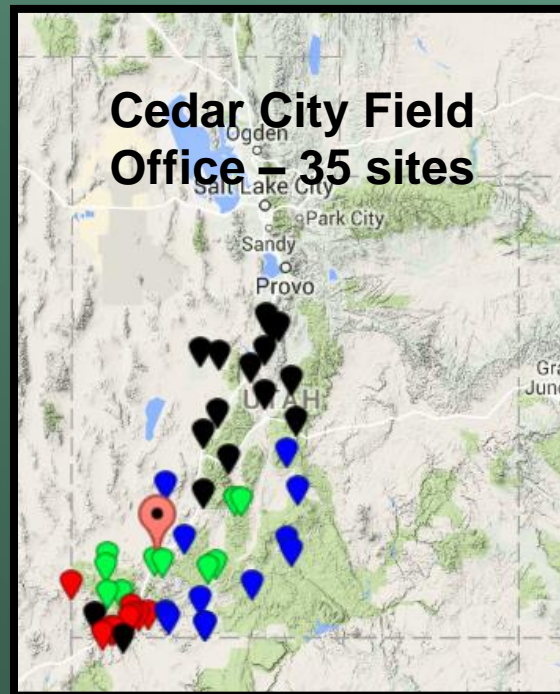
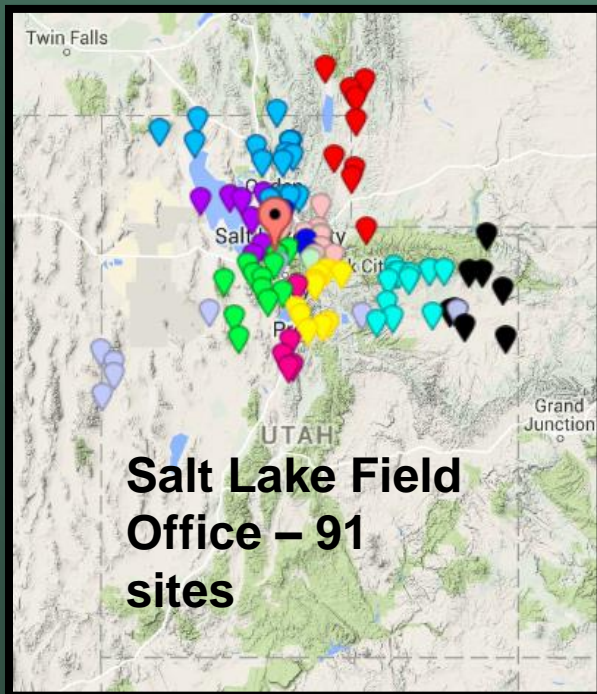
Lake bottom coring

Research well installation for aquifer test

Streamgaging

Overview of Utah's Streamgauge Network

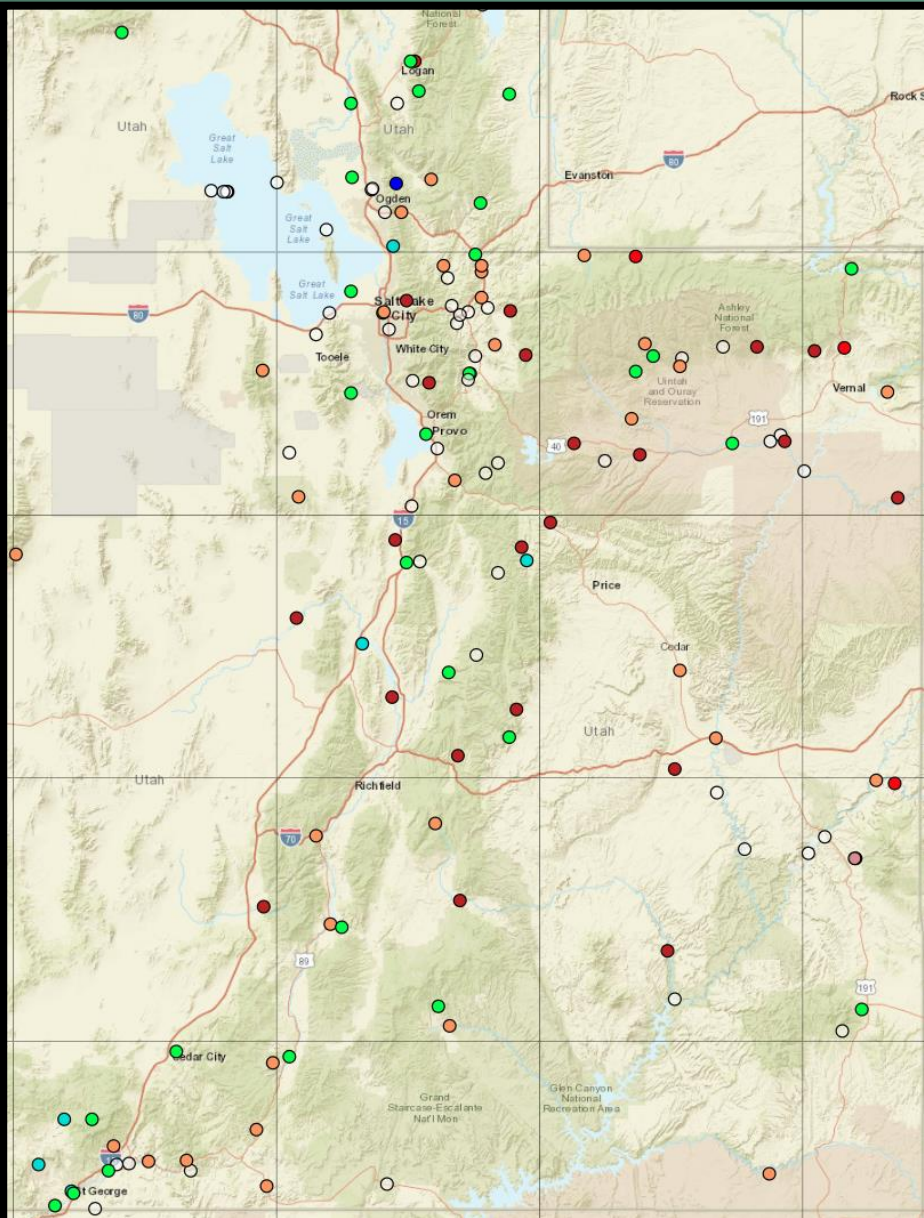
~150 stream gages are operated and maintained by 15 technicians in 3 field offices.



Overview of Utah's Streamgauge Network

Cooperators:

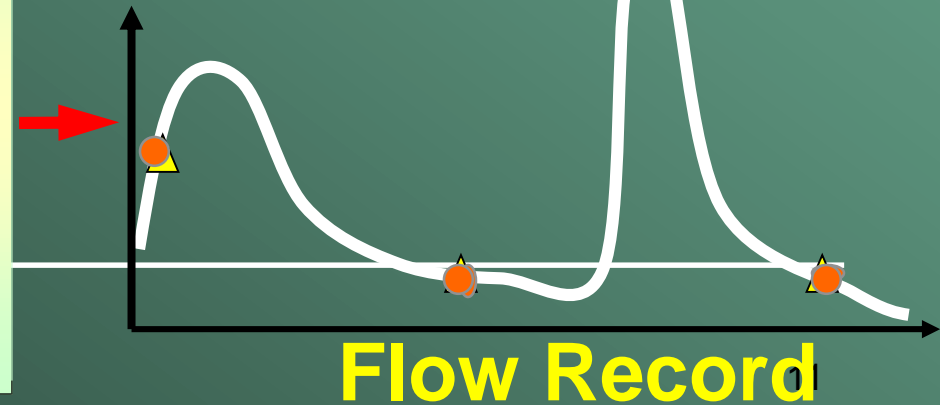
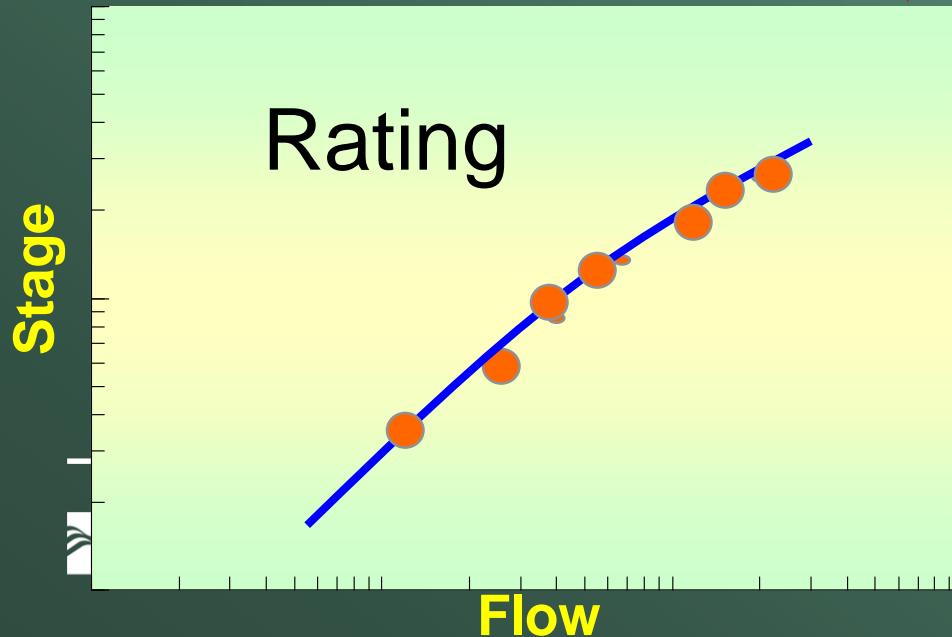
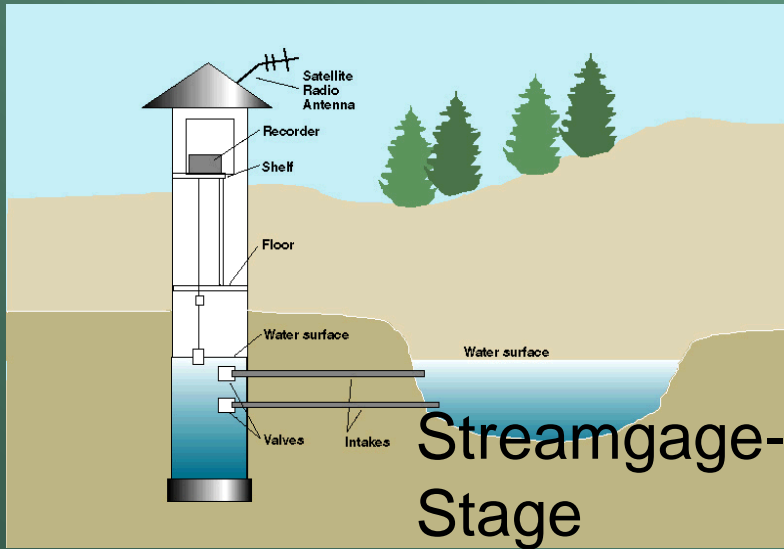
- Utah Department of Natural Resources
- Utah DEQ
- Central Utah Water Conservancy District
- Bear River Commission
- NSIP (USGS funded)
- U.S. Bureau of Reclamation
- BLM
- Other local entities



Screenshot of streamflow conditions for 10/19/2020 at 17:00

Poll Questions

Streamgauge Operation



Streamgage Operation: Stage

- Most streamgages directly measure stream stage (also called gage height) every 15 minutes
- Stage is the height of the water surface above a reference level or datum (more on this in a jiffy)
- Accuracy = +/- 0.01 ft or 0.2% of effective range



Streamgage at the Snake River near Moran, Wyoming

Measuring Stage (gage height)



Radar and Wire weight



Staff Plate and CSG



Float and encoder



Acoustic Velocimeter

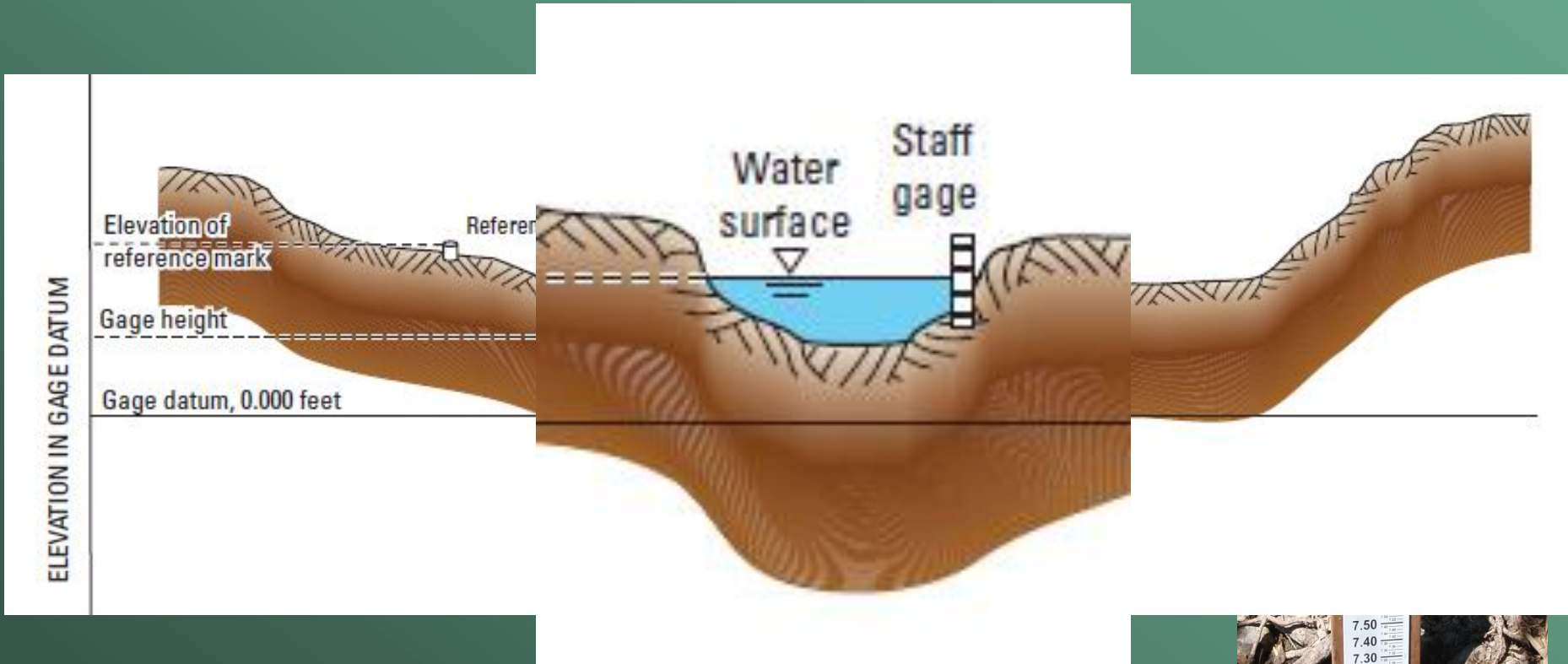


Pressure Transducer



Electronic Tape Gage

Stage and Gage Datum

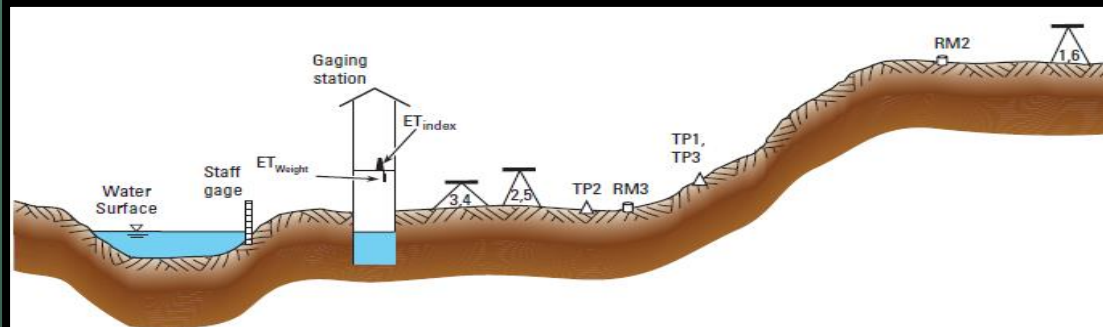


- Gage datum is an arbitrary elevation assigned based on a stream's potential for scour. River stage is elevation relative to this arbitrary gage datum. River stage shouldn't be confused with depth of water in the river.



Stage and Gage Datum

- Stable reference marks established at each gage
- Survey run every 1 to 3 years
- Deviation from gage datum usually caused by frost heave, shelter movement, and/or flood damage.



Gage Datum and and NAVD88

- New policy mandates that water surface elevations, including stage, must be reported relative to NAVD88 by 9/30/2022



United States Department of the Interior

U.S. GEOLOGICAL SURVEY

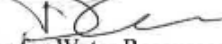
Reston, Virginia 20192

In Reply Refer to:
Mail Stop 436

January 27, 2020

Memorandum

Distribution: Regional Directors, Water Science Center Directors, and WMA Management

From: Donald W. Cline 
Associate Director for Water Resources

WATER MISSION AREA MEMORANDUM 2020.02 – Technical Policy

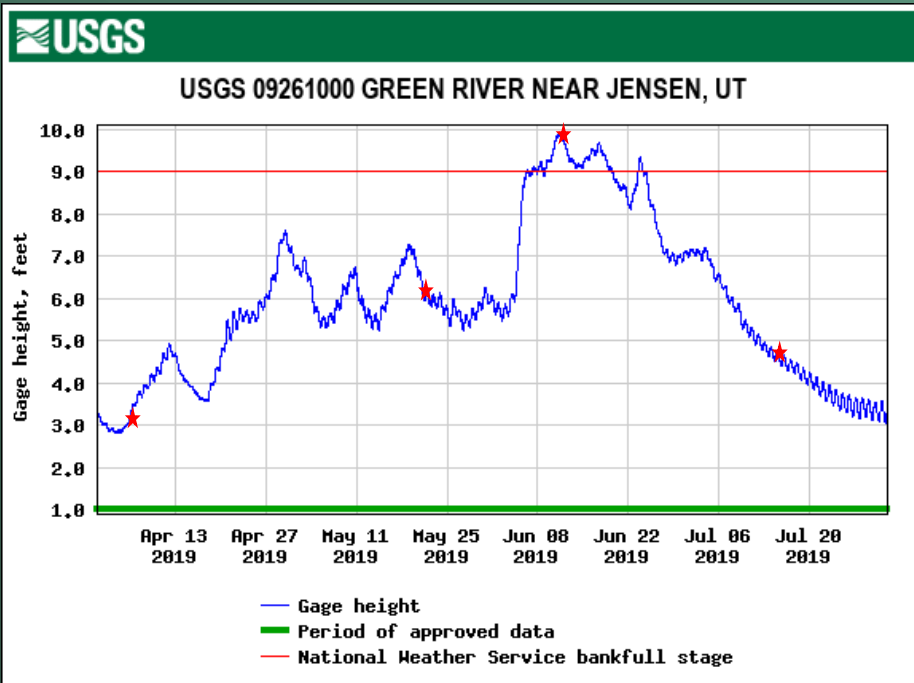
Subject: Policy on Accurate Geodetic Vertical Datum Establishment and/or Conversion for Continuous Water-Surface Elevation Data for Streamgage, Tide, Lake and Reservoir, and Groundwater-Level Stations

Purpose: The purpose of this memorandum is to require that all active United States Geological Survey (USGS) continuous-record streamgages, tide gages, lake and reservoir sites, and groundwater wells be represented by the most current vertical datum. As of the release of this policy memorandum, the North American Vertical Datum of 1988 (NAVD88) is the most current vertical datum in the contiguous United States and Alaska. Hawaii and United States Territories have other independently defined current vertical datum representations. The desired uncertainty for datum establishment and a timeline to achieve compliance are presented to assure consistency, preparation, and transferability to the future vertical datum identified as the North American-Pacific Geopotential Datum of 2022 (NAPGD2022).

Scope: The scope of this policy is to establish a reliable and consistent process for determining true geodetic elevations for all active USGS continuous-record stations that measure water-surface elevation that is reported and published using the National Water Information System (NWIS) Web interface (NWISWeb). The policy is intended to be in effect for the foreseeable future and it is applicable to all Water Science Centers (WSCs) and Water Mission Area (WMA) Divisions. Determining geodetic elevations at active USGS continuous-record stations shall begin with the release of this policy memorandum and be completed by September 30, 2022. Conformity and execution of this policy is reliant upon WSC Data Chiefs and Field Office Chiefs, WMA Branch Chiefs, and applicable Project Chiefs and Project Managers.

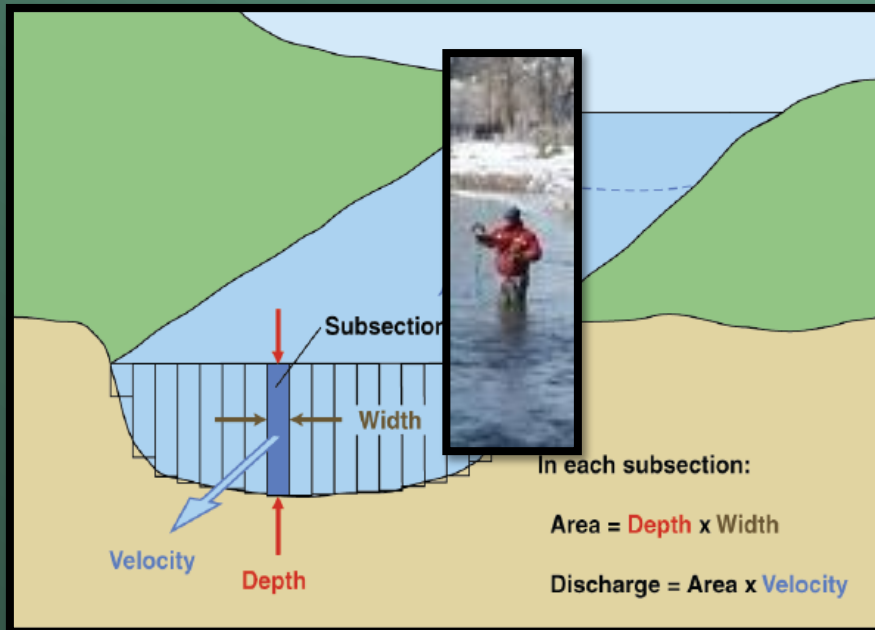


Streamgauge Operation: Discharge

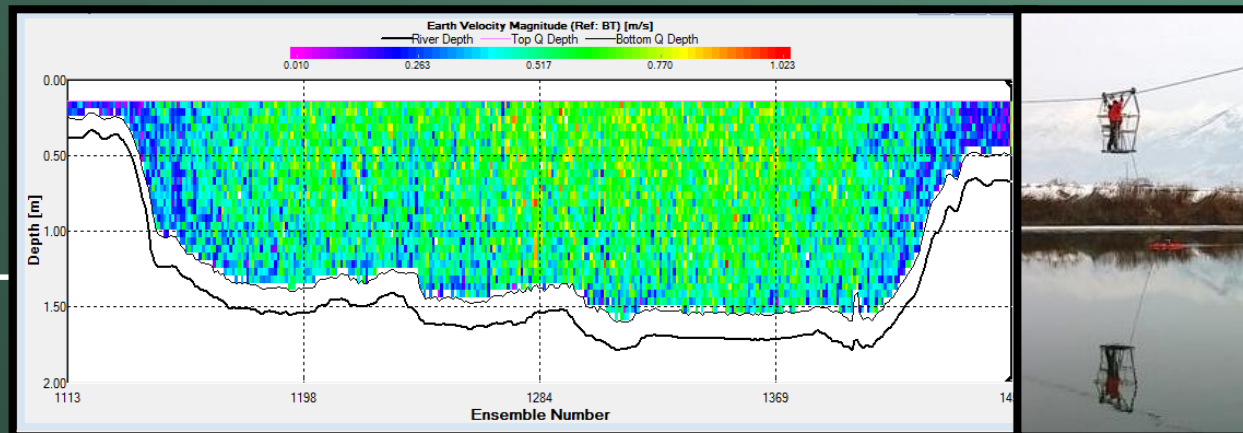


- Discharge measurements are made over the range of stage observed at a site
- A Stage-Discharge relationship (Rating) is developed
- Stage is the surrogate parameter used to compute discharge

Measuring Discharge



- Discharge measurements are made on a routine basis (~6 weeks) and during flow events (if possible; e.g., annual run-off) to determine impacts to the stage/discharge relationship.



Measuring Discharge



Acoustic Doppler Current Profiler – Bank Cableway



Acoustic Doppler Current Profiler – Towed Boat



AA Meter - Cableway



ADCP - Ice



FlowTracker - Wading



Salt Slug Injection



Indirect – Slope Conveyance

Quantifying Peak Stage and Discharge for Large Flood Events

- High water marks and channel cross-sections are surveyed
- Survey data provides peak stage channel geometry, and slope
- Slope Area Conveyance method provides peak discharge



The Stage/Discharge Relation (Rating)

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

STATION:10164500 AMERICAN FK AB UPPER POWERPLANT NR AMERICAN FK, UT TYPE:STREAM AGENCY:USGS STATE:49 COUNTY:049
 LATITUDE: 402652 LONGITUDE: 1114053 NAD27 DRAINAGE AREA:51.1 CONTRIBUTING DRAINAGE AREA: DATUM:5950.00 NGVD29

Date Processed: 2016-03-15 13:27 By swreview

Rating for Discharge (ft³/s)

RATING ID: 5.0 TYPE: stage-discharge EXPANSION: logarithmic STATUS: approved
 Created by sjgerner on 06-18-2015 @ 10:47:17 MDT, Updated by angeroth on 12-23-2015 @ 11:11:35 MST

RATING REMARKS: straight-line extension to lower end of 3.0

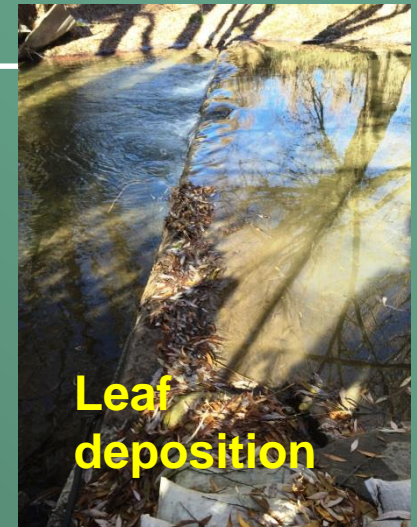
OFFSET: 5.53 BREAK,OFFSET: (6.89,6.56)

EXPANDED RATING TABLE

Gage height, feet	Discharge (ft ³ /s)										DIFF IN Q PER PER UNITS
	.00	.01	.02	.03	.04	(EXPANDED PRECISION)		.07	.08	.09	
						.05	.06				.1
5.70				1.25*	1.41	1.59	1.77	1.97	2.18	2.40	1.99
5.80	2.64	2.89	3.15	3.43	3.72	4.03	4.35	4.69	5.04	5.40	3.15
5.90	5.79	6.18	6.60	7.03	7.47	7.93	8.41	8.91	9.42	9.95	4.71
6.00	10.50	11.06	11.65	12.25	12.87	13.50	14.16	14.83	15.53	16.24	6.47
6.10	16.97	17.72	18.49	19.28	20.09	20.92	21.78	22.65	23.54	24.45	8.41
6.20	25.38	26.34	27.31	28.31	29.33	30.37	31.43	32.51	33.62	34.74	10.51
6.30	35.89	37.06	38.26	39.48	40.72	41.98	43.27	44.58	45.91	47.27	12.76
6.40	48.65	50.05	51.48	52.93	54.41	55.91	57.44	58.99	60.56	62.16	15.14
6.50	63.79	65.44	67.12	68.82	70.54	72.30	74.07	75.88	77.71	79.56	17.66
6.60	81.45	83.36	85.29	87.25	89.24	91.26	93.30	95.37	97.47	99.59	20.25
6.70	101.7	103.9	106.1	108.4	110.6	112.9	115.2	117.6	120.0	122.4	23.10
6.80	124.8	127.3	129.8	132.3	134.8	137.4	140.0	142.6	145.3	148.0*	27.80
6.90	152.6	157.2	161.8	166.3	170.9	175.5	180.1	184.7	189.3	193.9	45.90
7.00	198.5	203.2	207.8	212.4	217.0	221.6	226.2	230.9	235.5	240.1	46.20
7.10	244.7	249.4	254.0	258.6	263.3	267.9	272.5	277.2	281.8	286.5	46.40
7.20	291.1	295.8	300.4	305.1	309.7	314.4	319.0	323.7	328.3	333.0	46.50
7.30	337.6	342.3	347.0	351.6	356.3	360.9	365.6	370.3	375.0	379.6	46.70
7.40	384.3	389.0	393.6	398.3	403.0	407.7	412.3	417.0	421.7	426.4	46.80
7.50	431.1	435.8	440.4	445.1	449.8	454.5	459.2	463.9	468.6	473.3	46.90
7.60	478.0	482.7	487.3	492.0	496.7	501.4	506.1	510.8	515.5	520.2	46.90
7.70	524.9	529.6	534.3	539.1	543.8	548.5	553.2	557.9	562.6	567.3	47.10
7.80	572.0	576.7	581.4	586.1	590.9	595.6	600.3	605.0	609.7	614.4	47.20
7.90	619.2	623.9	628.6	633.3	638.0	642.8	647.5	652.2	656.9	661.7	47.20
8.00	666.4	671.1	675.8	680.6	685.3	690.0	694.8	699.5	704.2	708.9	47.30
8.10	713.7	718.4	723.1	727.9	732.6	737.4	742.1	746.8	751.6	756.3	47.30
8.20	761.0	765.8	770.5	775.3	780.0*						

"*" indicates a rating descriptor point

Issues Affecting the Rating

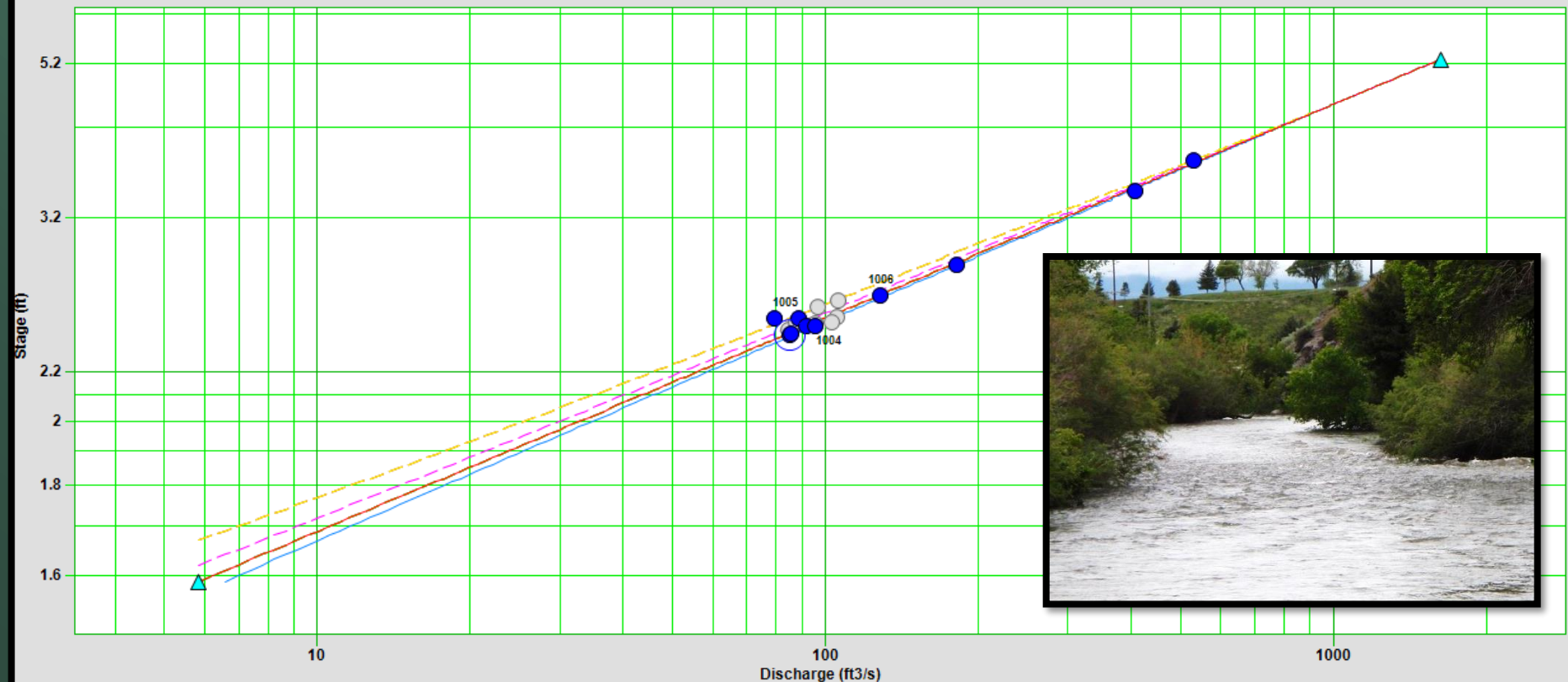


Rating Shifts

- Changes (or “shifts”) in the stage discharge relation occur when the control is impacted or the channel scours or fills.

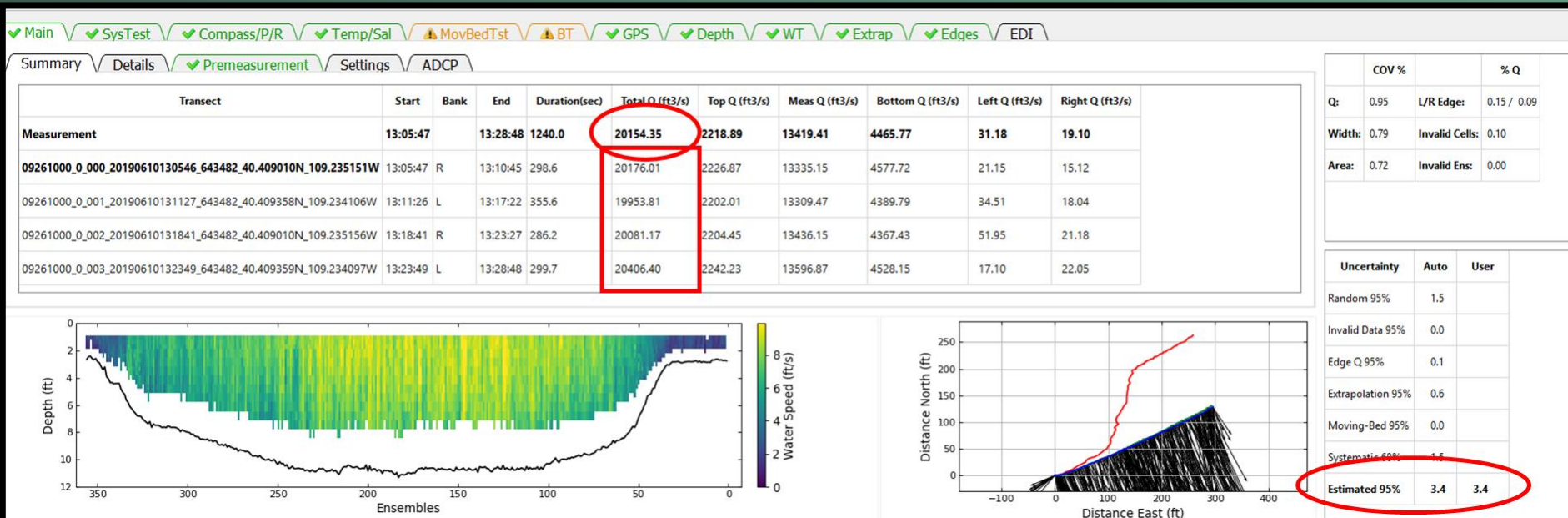
10109000 - LOGAN RIVER ABOVE STATE DAM, NEAR LOGAN, UT - DD: 1 Rating: 14.0

Rating period from 01/05/2016



Discharge Measurement Accuracy

- USGS software Qrev, or manufacturer software, provides estimate of error associated with Acoustic Doppler Velocity discharge measurements
- Error associated with other discharge measurement methods is assigned by Hydrographer and reviewed by Approver and Auditor



Qrev error analysis

Gage Height Uncertainty

- Accuracy of gage height readings assigned to discharge measurement is considered when assessing overall measurement uncertainty.
- Can have greater uncertainty at higher flows
 - Wave action
 - Drawdown



Overall Measurement Uncertainty

All sources of uncertainty are considered when measurement quality rating is assigned

Excellent: +/- 2% Good: +/-5% Fair: +/-8% Poor: +/-10%

USGS 09261000 GREEN RIVER NEAR JENSEN, UT

Available data for this site: Surface-water: Field measurements

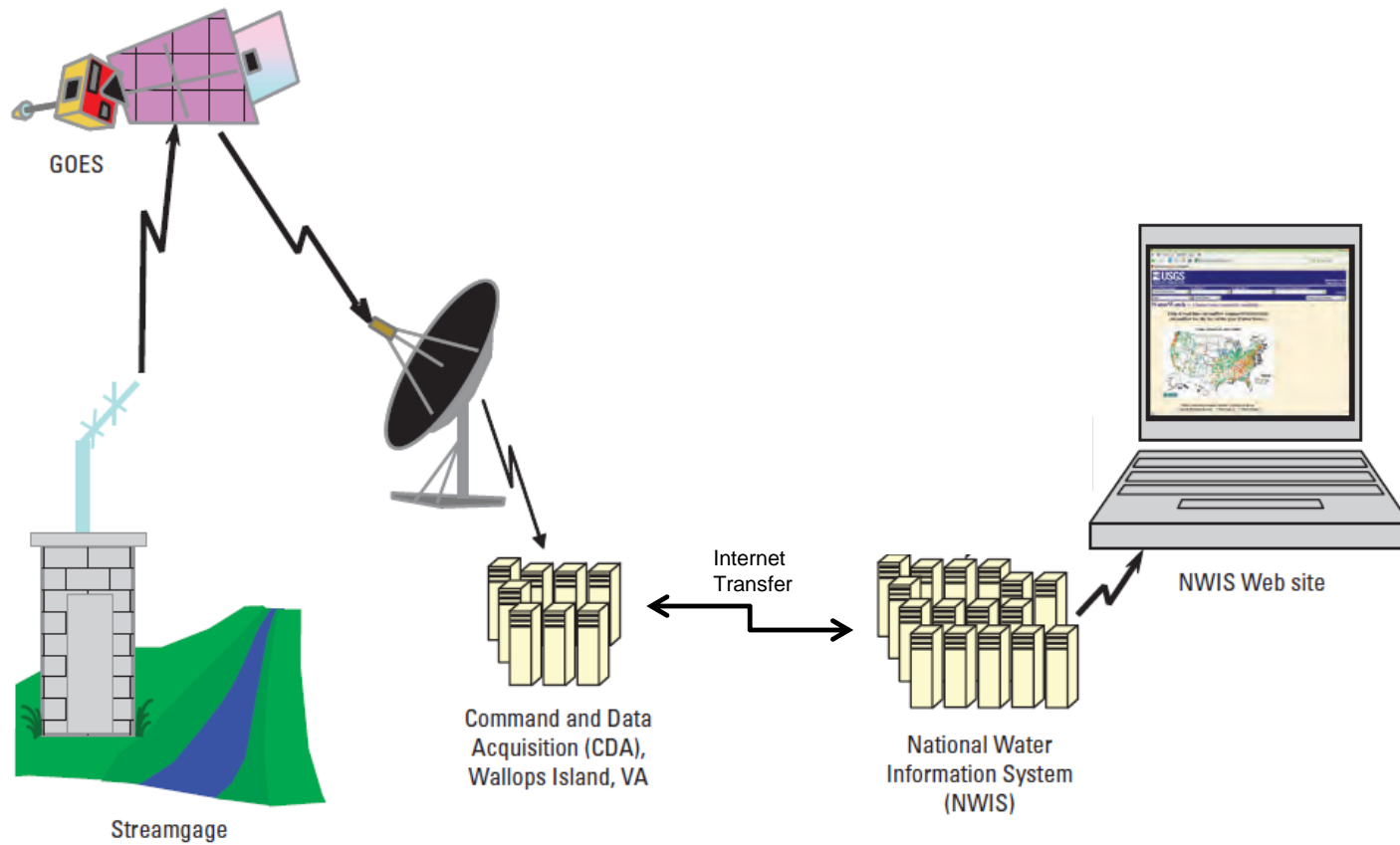
Uintah County, Utah
 Hydrologic Unit Code 14060001
 Latitude 40°24'34", Longitude 109°14'05" NAD27
 Drainage area 29,660.00 square miles
 Contributing drainage area 25,400.0 square miles
 Gage datum 4,758.00 feet above NGVD29

Output formats

- [HTML table with channel data](#)
- [HTML table without channel data](#)
- [Tab-separated data with channel data](#)
- [Tab-separated data without channel data](#)
- [Graph of data](#)
- [Reselect output format](#)

Meas. Number	Date	Time	Time Datum	Measurement Used?	Who	Measuring Agency	Stream flow (ft ³ /s)	Gage Height (ft)	GH Change (ft)	Meas. Duration (hr)	Meas. Rated	Control
1040	2020-03-04	13:54:10	MST	Yes	ELR	USGS	2330	2.99	0.01	0.20	Good	Clear
1039	2020-03-04	13:16:51	MST	Yes	ELR	USGS	2290	2.94	0.01	0.20	Good	Clear
1038	2020-01-23	11:04:32	MST	Yes	ELR	USGS	2410	2.96	0.01	0.30	Fair	Clear
1037	2019-12-17	14:48:54	MST	Yes	ELR/BTR	USGS	2530	3.09	0.06		Good	Clear
1036	2019-11-14	14:28:01	MST	Yes	ELR/BTR	USGS	1640	2.46	0.00	0.50	Good	Clear
1035	2019-10-07	13:38:17	MDT	Yes	ELR/BTR	USGS	1830	2.54	-0.02		Fair	Clear
1034	2019-08-29	09:03:05	MDT	Yes	ELR/BTR	USGS	2110	2.86	0.00	0.30	Fair	Clear
1033	2019-07-23	12:43:33	MDT	Yes	ELR/NML	USGS	3170	3.53	0.00	0.20	Fair	Clear
1032	2019-06-10	13:17:17	MDT	Yes	ELR/MLF	USGS	20200	9.60	0.01	0.40	Good	Clear

Data Pipeline



Data Processing and Review



Continuous stream stage

Periodic discharge measurements

Utah Water Science Center – NWIS data base

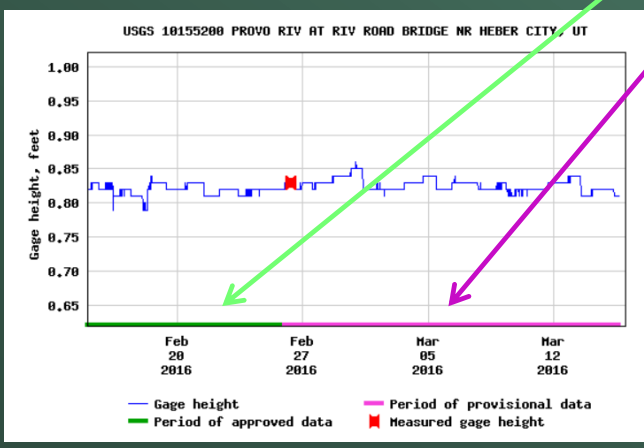
Shifts and corrections applied

Shifts and corrections updated/finalized (Analyzed)

NWISWeb

Record is reviewed for Approval

Record is Audited



Approved

Provisional

Provisional

Provisional

Approved

Provisional

How to Access Data

USGS Water Data for the Nation x +

waterdata.usgs.gov/nwis

USGS
science for a changing world

USGS Home
Contact USGS
Search USGS

National Water Information System: Web Interface

USGS Water Resources (District Access)

Data Category: Home Geographic Area: United States GO

Click to hide News Bulletins

- Introducing The Next Generation of USGS Water Data for the Nation
- Full News

USGS Water Data for the Nation

Search for Sites With Data

Current Conditions Sites with real-time or recent surface-water, groundwater, or water-quality data.

Site Information Descriptive site information for all sites with links to all available water data for individual sites.

Map of all sites with links to all available water data for individual sites.

Frequent Searches By Data Category

Surface Water	Water flow and levels in streams and lakes.
Groundwater	Water levels in wells.
Water Quality	Chemical and physical data for streams, lakes, springs, wells and other sites.
Water Use	Water use information.

Introduction

These pages provide access to water-resources data collected at approximately 1.9 million sites in all 50 States, the District of Columbia, Puerto Rico, the Virgin Islands, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands. Online access to this data is organized around the categories listed to the left.

The USGS investigates the occurrence, quantity, quality, distribution, and movement of surface and underground waters and disseminates the data to the public, State and local governments, public and private utilities, and other Federal agencies involved with managing our water resources.

[About Us](#) [Help](#) [Tutorial](#)



National Water Information System:
waterdata.usgs.gov/nwis

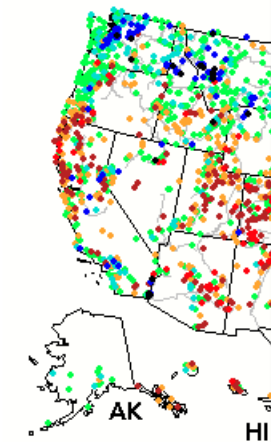
How to Access Data

USGS Current Conditions

Predefined displays - Introduction

Daily Stream

Tuesday



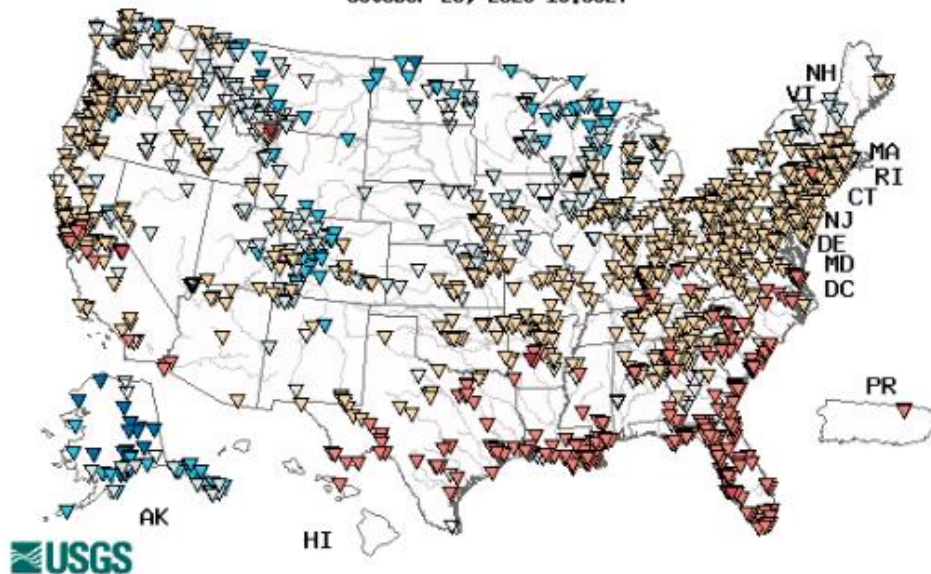
USGS

Explanation

- High
- > 90th percentile
- 76th - 90th percentile
- 25th - 75th percentile
- 10th - 24th percentile
- < 10th percentile
- Low
- Not ranked

Real-Time Water Temperature, in °C

October 20, 2020 13:30ET



USGS

Explanation							
▼	▼	▼	▼	▼	▼	▼	▼*
<1	1-4.9	5-9.9	10-19.9	20-29.9	30-35	>35	No Data

Temp Cond pH D.O. Turb Nitrate Disch Chlorophyll Surrogates

* Site operated on a seasonal basis or currently is not operating. No values are available for the last 6 hours.

The "Real-time" map tracks short-term changes (over several hours) of water quality. Although the general appearance of the map changes very little from one hour to the next, individual sites may change rapidly in response to major rain events or to reservoir releases. The data used to produce this map are [provisional](#).

Animate national map by current [Month](#), or [last 12 months](#)

USGS

Current conditions nationwide can be accessed via <https://nwis.waterdata.usgs.gov/nwis/rt>

How to Access Data

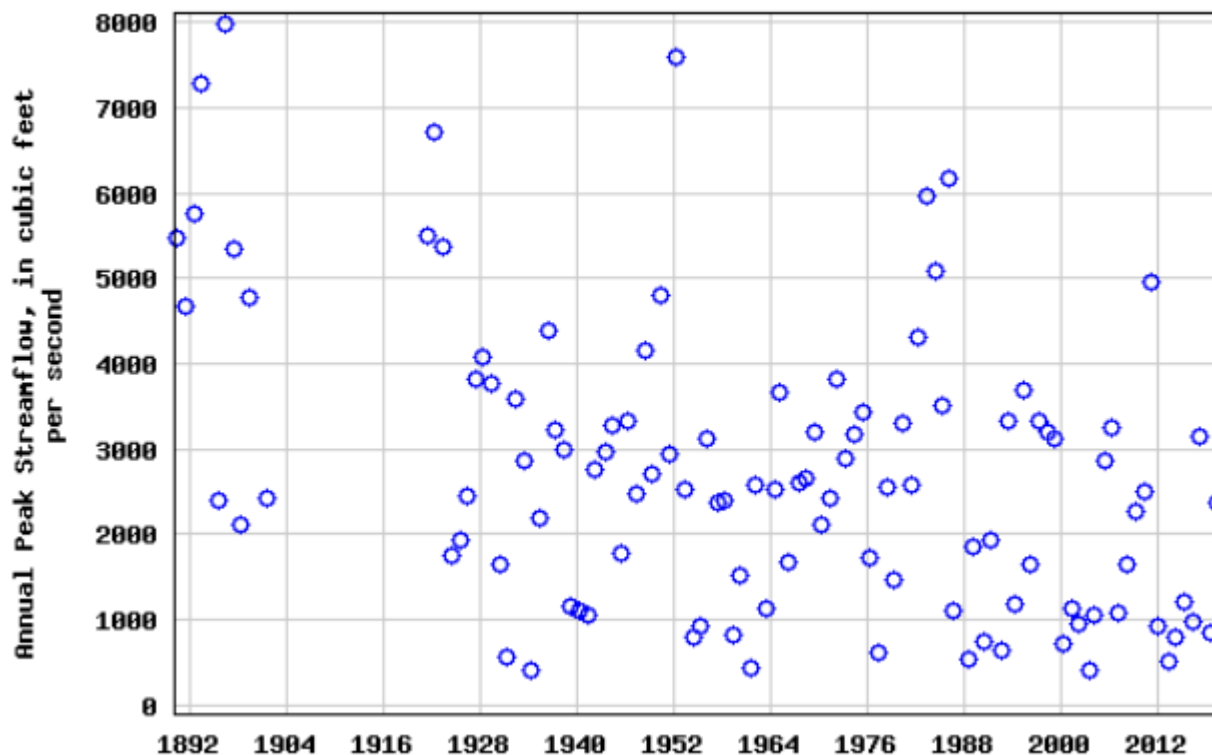
DESCRIPTION:

Latitude 37°09'02.44", Longitude 109°52'00.08" NAD83
San Juan County, Utah, Hydrologic Unit 14080205
Drainage area: 23,000 square miles
Datum of gage: 4

AVAILABLE DATA:

- Data Type
- [Current / Historical Data](#)
- [Daily Data](#)
- Temperature, water
- Temperature, water
- Discharge, cubic feet per second
- Specific conductance
- Specific conductance
- pH, water, unfiltered
- Turbidity, water
- Suspended sediment
- Suspended sediment
- [Daily Statistics](#)
- Temperature, water
- Discharge, cubic feet per second
- Specific conductance
- Turbidity, water
- Suspended sediment
- Suspended sediment
- [Monthly Statistics](#)
- Temperature, water
- Discharge, cubic feet per second
- Specific conductance
- Turbidity, water
- Suspended sediment
- Suspended sediment
- [Annual Statistics](#)
- Temperature, water
- Discharge, cubic feet per second
- Specific conductance
- Turbidity, water
- Suspended sediment
- Suspended sediment
- [Peak streamflow](#)
- [Field measurements](#)
- [Field/Lab water quality](#)
- [Water-Year Summary](#)
- [Revisions](#)

USGS 10136500 WEBER RIVER AT GATEWAY, UT



2005 | 2019 | 15
Available (site:1) (timeseries:0)



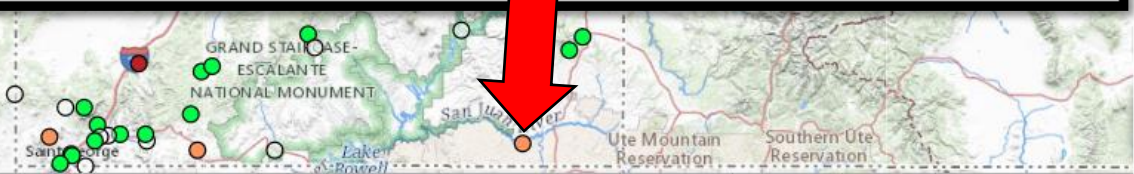
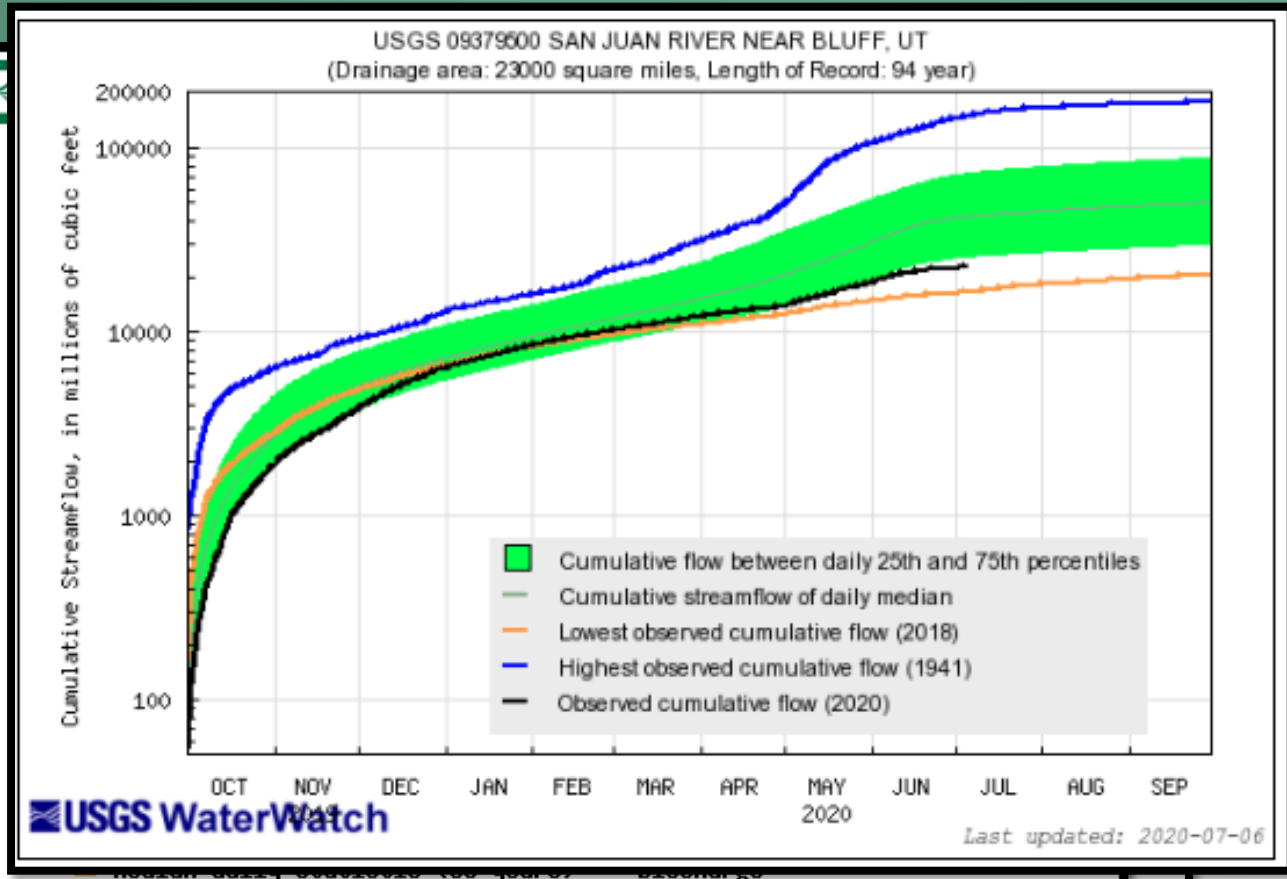
NWIS Mapper is a convenient and intuitive way to access basic hydrologic data collected by USGS

<https://maps.waterdata.usgs.gov/mapper/index.html>

Utah Current Wa



Discharge, cubic feet per second



ID	Station	Stage	Discharge	Class	Percentile	% Median	% Mean	Date
09180000	DOLORES RIVER NEAR CISCO, UT	7.03 ft	81.2 ft ³ /s	Below Normal	11.88%	23.57%	15.48%	2020-07-06 12:45:00
09180500	COLORADO RIVER NEAR CISCO, UT	2.61 ft	4740 ft ³ /s	Below Normal	24.68%	46.7%	40.98%	2020-07-06 12:00:00



Each Water Science Center has a website where our local Federal and State cooperators are likely to access data and publications.

StreamStats

- Provides basin delineations, basin characteristics, and estimates of streamflow statistics
- Provides information for gaged and user-selected ungaged sites on streams

The screenshot displays the USGS StreamStats web application. At the top left is the USGS logo and the text "StreamStats". The main header features the URL <https://streamstats.usgs.gov/ss/> and navigation links for "Report", "About", and "Help".

The interface includes a left sidebar with the following sections:

- SELECT A STATE / REGION**: A dropdown menu.
- Step 1**: A text box explaining the first step: "Use the map or the search tool to identify an area of interest. At zoom level 8 or greater State/Region selection will be enabled."
- Search**: A search bar containing "Utah" and a "Help" link.
- IDENTIFY A STUDY AREA**: A dropdown menu.
- SELECT SCENARIOS**: A dropdown menu.
- BUILD A REPORT**: A dropdown menu.
- POWERED BY WIM**: A link to the Water Information Model.
- Footer**: Links for "USGS Home", "Contact USGS", "Search USGS", "Accessibility", "FOIA", "Privacy", and "Policy & Notices".

The main map area shows a topographic map of the western United States, including parts of Nevada, Utah, Colorado, and New Mexico. Key geographical features labeled include the Great Salt Lake, Great Salt Lake Desert, Shoshone Mountains, Monitor Range, Independence Mountains, and various plateaus and basins. Major cities like Salt Lake City, Denver, and Las Vegas are marked. A "Layers" panel on the right shows "Base Maps" and "National Layers" (checked). A "Zoom Level: 7" and "Map Scale: 1:4,622,324" are displayed at the bottom left of the map.

Summary

- **The USGS Water Resources Mission Area operates streamgages nationwide using consistent, published methods.**
- **Data is available to all and easy to access.**
- **Many partners contribute funding to our streamgaging program.**

Contact Information

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USGS
Utah Water Science
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