NAVIGABILITY ALONG THE NATURAL CHANNEL OF THE VERDE RIVER, AZ

Detailed analysis from Sullivan Lake to the USGS gage near Clarkdale. and
General analysis from Clarkdale gage to mouth.

An assessment based on history, Federal GLO surveys, hydrology, hydraulics and morphology

By

Hjalmar W. Hjalmarson, PE

February 5, 2015

SECOND ADDENDUM
TO REPORT OF OCTOBER 4, 2014

Corrigendum

Hjalmarson, H. W.; ANSAC, NAVIGABILITY ALONG THE NATURAL CHANNEL OF THE VERDE RIVER, AZ, Oct. 4, 2014

I made a book-keeping error of unknown cause when I copied the table of cultivated acres from the Walnut Creek Appendix E and transferred the copied table to the main report where I computed the total cultivated areas and the impact of the settler farming on the base flow of the Verde River (see comment at the end of this corrigendum that explains why this book-keeping error did not affect my analysis of navigability along the Verde River.). This oversight is shown in the first item that follows and the subsequent errors and corrections are the ripple affect of the oversight. I've also carefully checked the corresponding tables for the other sub-watersheds and found no other error. The following corrections should be made to prior main report (X015) of which this 2nd Addendum is part of the publication:

Page 23 Walnut Creek Table
Error

T18N R6W	50
T18N R5W	1180
T18N R4W	55
T18N R3W	110
TOTAL	1395

Corrected (For p. 23 of main report. Same table in Appendix E, p. 24 was/is correct.)

T18N R6W	50
T18N R5W	110
T18N R4W	55
T18N R3W	110
TOTAL	325 acres

Page 26 Total cultivated land Table and also slide 56 of Verde River PowerPoint program.
Error

Location	Acres	Flow, cfs[1]
Granite, Williamson Valley, Walnut, and Big Chino Creeks	8095	35
USGS Clarkdale gage	8215	36

Corrected

Location	Acres	Flow, cfs[1]
Granite, Williamson Valley, Walnut, and Big Chino Creeks	7025	30
USGS Clarkdale gage	7145	31

Page 26 First line of paragraph
Error

It's interesting that the total cultivated land of 8095 acres in the above table is only 45%

Corrected

It's interesting that the total cultivated land of 7025 acres in the above table is only 39%

Page 26 First line of paragraph
Error

The median (Q50) Virgin flow, column 5 (2of2) is column 3 (1of2) adjusted for the losses to ET in column 4 (2of2) and the average annual loss to ET of 5 cfs along the approximately 80 miles of tributary channels (See item 2 Appendix A).

For example:
Q50 Virgin at gage 5037 = 30 + 35 - 5 cfs =   60 cfs
5040 = 86 + 36 - 5cfs =   117 cfs

Column 6 for Q90 is same manner but with average max. (summer) loss to ET long the trib. Channels:

Q90 Virgin at gage 5037 = 30 + 35 - 11 cfs =   54 cfs
5040 = 86 + 36 – 11 cfs = 111 cfs

Corrected

The median (Q50) Virgin flow, column 5 (2of2) is column 3 (1of2) adjusted for the losses to ET in column 4 (2of2)

For example:
Q50 Virgin at gage 5037 = 30 + 30 cfs =   60 cfs
5040 = 86 + 31cfs =   117 cfs

Column 6 for Q90 is same manner but with average max. (summer only) loss to ET along approximately 80 miles of the tributary channels (See items 2 & 3 Appendix A).
:

Q90 Virgin at gage 5037 = 30 + 30 – 6 cfs =   54 cfs
5040 = 86 + 31 – 6 cfs = 111 cfs

Page 20 near top
Error

USGS Gage	Q50 Virgin (F)	Virgin mean annual flow (F)	Average annual ET Fed Survey (G)	Virgin Fed Survey		Virgin mean annual flow (H)
	-------- METHOD 2 --------			-------- METHOD 1 -----------		
	cfs	cfs	cfs	cfs Q50(I)	Q90(J)	cfs
(A)	*	*	*	*	*	*
5037	58	76	35	60	54	78
5040	114	207	36	117	111	210
5060	277	494	*	*	*	*
5100	*	751	*	*	*	*

F - The 100 cfs difference beween the Virgin average annual runoff and the gaged mean annual flow was distributed between the two general areas of cultivated land where base runoff was diverted from stream channels. These two areas are the watershed above gage 5037 and the watershed between gage 5040 and 5060 where losses of base runoff to ET were distributed as a percent of total cultivate lands for these two areas as given in Hayden (1940) on pages 75 and 83.(Hayden, T. S., 1940, Irrigation on upper Verde River watershed from surface waters: unpublished report of SRP, 329 pages. According to Hayden 28 percent of the irrigation was above gage 5027 and 72 percent was in the Verde Valley.

G - Amount is from cultivated lands shown on the original Federal Land Surveys. Water use for the total acres (8385 and 8505 above USGS gages 09503700 and 09504000, respectively, was determined using the weighted irrigtion factor of 3.15 ac-ft/acre (Pool and others page 37, 2011).

H - Amount in column 7 is the pre-development mean annual flow plus the average annual ET in column 4. Again, the average annual ET is from irrigated lands typically watered by diversion from streams using low rock dams and shallow wells located in the stream sediments.

I - Amount in column 5 is the pre-development median plus the average annual ET minus the avg. annual loss to ET (5 cfs) along the 80 miles of trib. channels.

J - Amount in column 6 is the pre-development median plus the avg annual ET minus the summer (maximum) loss to ET (11 cfs) along the tributary channels. (See slide 32 of Appendix A for computation of ET loss along channels).

Corrected

USGS Gage	Q50 Virgin (F)	Virgin mean annual flow (F)	Average annual ET Fed Survey (G)	Virgin Fed Survey		Virgin mean annual flow (H)
	-------- METHOD 2 --------			-------- METHOD 1 -----------		
	cfs	cfs	cfs	cfs Q50(I)	Q90(J)	cfs
(A)	*	*	*	*	*	*
5037	58	76	30	60	54	78
5040	114	207	31	117	111	210
5060	277	494	*	*	*	*
5100	*	751	*	*	*	*

F - The 100 cfs difference beween the Virgin average annual runoff and the gaged mean annual flow was distributed between the two general areas of cultivated land where base runoff was diverted from stream channels. These two areas are the watershed above gage 5037 and the watershed between gage 5040 and 5060 where losses of base runoff to ET were distributed as a percent of total cultivate lands for these two areas as given in Hayden (1940) on pages 75 and 83.(Hayden, T. S., 1940, Irrigation on upper Verde River watershed from surface waters: unpublished report of SRP, 329 pages. According to Hayden 28 percent of the irrigation was above gage 5027 and 72 percent was in the Verde Valley.

G - Amount is from cultivated lands shown on the original Federal Land Surveys. Water use for the total acres (7025 and 7145 above USGS gages 09503700 and 09504000, respectively, was determined using the weighted irrigtion factor of 3.15 ac-ft/acre (Pool and others page 37, 2011).

H - Amount in column 7 is the pre-development mean annual flow plus the average annual ET in column 4. Again, the average annual ET is from irrigated lands typically watered by diversion from streams using low rock dams and shallow wells located in the stream sediments.

I - Amount in column 5 is the pre-development median plus the average annual ET

J - Amount in column 6 is the pre-development median plus the avg annual ET

Page 27 near top
Error

The mean annual Virgin flow, column 7 (2of2) is column 4 (1of2) adjusted for the losses to ET in column 4 (2of2) and adjusted for the average annual loss to ET of 5 cfs along the approximately 80 miles of tributary channels (See item 2 of Appendix A).

Mean annual Virgin at gage 5037 = 48 + 35 - 5 = 78 cfs
5040 = 179 + 36 -5 = 210 cfs

Corrected

The mean annual Virgin flow, column 7 (2of2) is column 4 (1of2) adjusted for the losses to ET in column 4 (2of2).

Mean annual Virgin at gage 5037 = 48 + 30 = 78 cfs
5040 = 179 + 31 = 210 cfs

Addendum page 52 middle of 1st paragraph
Error

of irrigated land and the water use factor (See page 26 of report). At the Clarkdale gage (09504000) the water use was equated to a base flow of 36 cfs, that was adjusted for transmission loss along stream channels, to evapotranspiration (ET) of 5 cfs to yield an addition of 31 cfs to the gaged median discharge of 86 cfs. The resulting estimated natural median

Corrected

of irrigated land and the water use factor (See page 26 of report). At the Clarkdale gage (09504000) the water use was equated to a base flow of 31 cfs to yield an addition of 31 cfs to the gaged median discharge of 86 cfs. The resulting estimated natural median

Addendum page 60 middle of 4th paragraph
Error

above the Clarkdale gage 09504000. This is equivalent to 22,500 ac-ft per year. Considering the losses to ET along the stream channels (5 cfs) the human depletion at the fields (cultivated land) is 36 cfs or 26,100 ac-ft per year. These

Corrected

above the Clarkdale gage 09504000. This is equivalent to 22,500 ac-ft per year. These

<u>Comment:</u> Examination of the above errors and associated corrections shows the computed flows for the Verde River (Q90, median and mean annual) remained unchanged. This is because the rather small error that is equivalent to an incremental reduction in base flow of less than 5 cfs ((1070 acres x 3.15 ac-ft/acre)/725 ac-ft/yr/cfs) along the Verde River was offset by my conservative approach of water budgeting. As I testified on December 18, 2014 (REPORTER'S TRANSCRIPT OF PROCEEDINGS VOLUME 4 Pages 1053-1054) I have studied loss of stream flow to ET (Hjalmarson, H.W., and Davidson, E. S., 1966, anticipated changes in the flow regime caused by the addition of water to the East Verde River, Arizona: Arizona State Land Department, Water Resources Report No. 28, 10 p.) and to be conservative I used a 5 cfs loss of natural runoff along the tributary streams that was greatly in excess of the actual amount of loss, if any, to ET. Because natural tributary headwater streams were perennial, or nearly so, losses of added water would be negligible. Thus, the small oversight was offset and is not a significant factor for the assessment of navigability along the Verde River.

TABLE OF CONTENTS

SUPPLEMENT 1. Regarding reference (B) in Table 1 of 2 on p. 20 of my report. The reference (B) for the median pre-development flow is unclear. The given reference to the GW model by Pool and others is for the model used by Garner, B.D., Pool, D.R., Tillman, F.D., and Forbes, B.T., 2013, Human effects on the hydrologic system of the Verde Valley, central Arizona, 1910–2005 and 2005–2110, using a regional groundwater flow model: U.S. Geological Survey Scientific Investigations Report 2013–5029, 47 p..

The footnote at the bottom of page 20 of my report (below Tables 1 of 2 and 2 of 2) describes the computation for the numbers referenced by (B).

Also, for ANSAC information, for USGS 09507580 EAST VERDE R DIV FROM EAST CLEAR CR NR PINE, AZ, the mean for 1967-2013 = 9.1 cfs. This is water added to the Verde River via a trans-basin diversion from the Little Colorado River watershed. If this added water had been taken into account in my computations the computed loss of 100 cfs to ET from irrigation, stock tanks and other human activity from the Mountain fronts (Hjalmarson report, p. 28 and Appendix G, p. 52) would have been about 103 cfs. This difference of 3 cfs, the result of my avoiding cherry picking by using all the records at appropriate USGS gages whenever appropriate, was considered insignificant but also a factor in the conservative nature of my unbiased assessment of navigability.

A more detailed reference follows:

B – Median pre-development flow from computation of median flow using USGS records of streamflow for the indicated gages with adjustment for the human caused reduction of base flow at the upstream end of the Verde Valley (Clarkdale gage), as of 2005, of about 4,900 acre-feet per year (Garner and others, 2013, p. 19) with an estimated relative change for the period of record using the relation in Figure 11B. (Garner and others, 2013, p. 18). A similar adjustment was also made at the downstream end of the Verde Valley, where base flow had been reduced by about 10,000 acre-feet per year by the year 2005 because of human stresses (Garner and others, 2013, p. 22) with an estimated relative change for the period of record using the relation in Figure 13B. (Garner and others, 2013, p. 21). Garner, B.D., Pool, D.R., Tillman, F.D., and Forbes, B.T., 2013, Human effects on the hydrologic system of the Verde Valley, central Arizona, 1910–2005 and 2005–2110, using a regional groundwater flow model: U.S. Geological Survey Scientific Investigations Report 2013–5029, 47 p..

SUPPLEMENT 2. Fish and Wildlife Service Method (Hyra (1978) for assessment of navigability used by Hjalmarson for the Verde River.

The following is further description of how the Fish and Wildlife Service Method (Hyra (1978)) was used for the assessment of navigability of the Verde River. The method is used on pages 103 and 104 of the main report and is also shown in Figures G4a and G4B on pages 80 and 81 of Appendix G. The method was used to assess navigability along the thalwag of the main channel where the maximum depth, that varied along the pools, riffles and intermediate reaches of the channel, represented a width that could be used for small watercraft such as canoes.

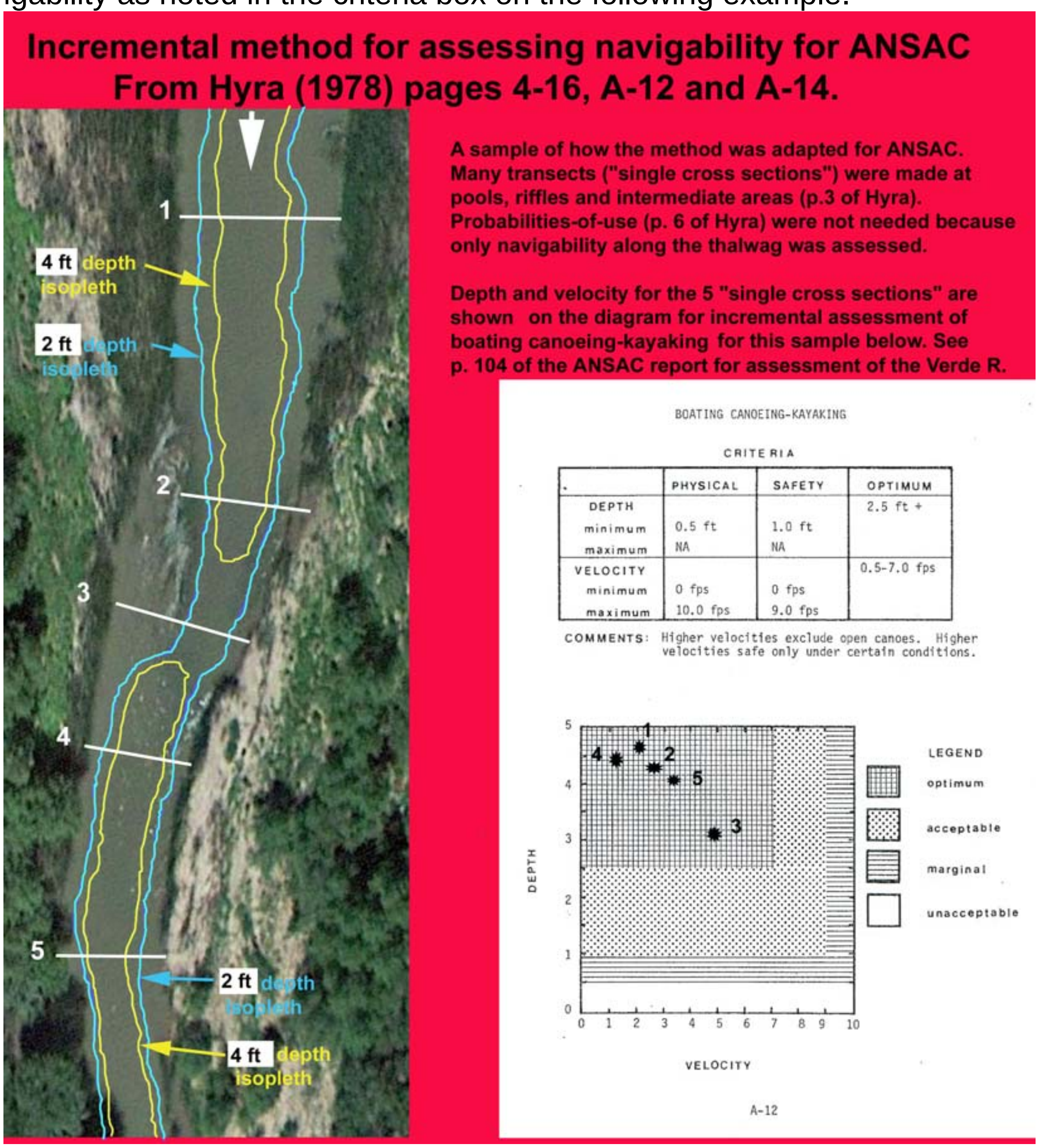
The incremental method, used by the Fish and Wildlife Service of the U.S. Department of the Interior, uses multiple transects across the river. Typically, a transect would be established across a pool, a riffle, and an intermediate area. Together these cross sectional measurements would represent a stream reach which may extend several miles (Hyra, 1978, p.5). For the Verde River many cross sections (e.g. transects) across the river channel were used as shown in the example on the following page.

An excerpt from p. 5 of the Hyra (1978) instructions follows. This excerpt shows that mean depth can be computed for subsections and clearly is not computed for the entire cross section. The use of mean depth (e.g. by Mr. Burtell and Mr. Hood) that includes the main channel and flood plain for an entire cross section is contrary to established hydraulic principles related to the navigability issue.

1. Simulation of the Stream. The stream reach simulation model utilized in this approach uses several cross sectional transects, each of which is subdivided into subsections. For any stage (water surface elevation) the mean depth and velocity of each subsection is calculated. Typically, a transect would be established across a pool, a riffle, and an intermediate area. Together these cross sectional measurements would represent a stream reach which may extend several miles.

Only part of the incremental method was useful for the Verde River and ANSAC because only the area along the thalwag was important for assessment of navigability. The recreational potential option of the incremental method and the weighting of surface area was beyond the scope of the ANSAC assessment. In other words, the isopleths of depth adjacent to the main channel along the river were not needed because boating potential caused by a change in stream depth along the sides of the main channel was not needed and thus not evaluated. Areas of shallow depth (e.g. between the bank and 2 ft. depth shown on the following figure) were of no concern for the navigability assessment. Thus, is was unnecessary to subdivide transects into subsections and calculate the mean depth and velocity of each subsection (Hyra, 1978, p. 5) because only the main channel along the thalwag was important for ANSAC. Thus, because only small watercraft (e.g. no barges) were being evaluated, only a relatively narrow thread of several feet wide along the thalwag was important for the assessment of navigability. In effect, the main channel was “subdivided” from the entire cross section for all cross sections.

For the Verde River a rectangle of depth versus velocity that encompassed the computed depths and velocities of each cross section (e.g. the 5 sample points (1 to 5) of the following diagram), was used to facilitate viewing (a convenience of the incremental method of Hyra). The minimum depth defined by the lower part of the rectangle was most important because depth limited navigability along the Verde River. Maximum depth (e.g. the measured 15 ft. depth at USGS gage 09506000 (p. 17 of the Addendum)) was not applicable because it only facilitated navigability as noted in the criteria box on the following example.



	PHYSICAL	SAFETY	OPTIMUM
DEPTH			2.5 ft +
minimum	0.5 ft	1.0 ft	
maximum	NA	NA	
VELOCITY			0.5-7.0 fps
minimum	0 fps	0 fps	
maximum	10.0 fps	9.0 fps	

A note on subdivision of river channels for hydraulic engineering purposes seems appropriate because the Hyra method uses subdivision to describe the distribution of areas of uniform depth and velocity to evaluate "...these physical changes upon a streams desirability for recreation." (Hyra, 1978, p. 6). Thus, the Hyra method recognizes the connection between channel hydraulics and the "safety and pleasure of recreation activities"—e.g. the navigability.

Subdivision of natural channels because of changes in channel shape (also roughness changes) such as where a wide-shallow flood plain is present adjacent to a main channel is common practice for hydraulic engineers in order to avoid deviation from the truth. All hydraulic computations are approximate and various methods such as subdivision based on shape are a known practical means of approximating the true hydraulic condition.

Resistance to the flow (e.g. - vegetation) is accounted for by the n-value, known as Manning's roughness coefficient. Empirical channel roughness coefficients are not easy to correctly ascertain by inexperienced observation, as it is dependent on many physical aspects, including streambed composition, vegetation, cross-section irregularity (along the channel), channel alignment (straight or meandering) and obstructions. The roughness of the channel and flood plain often are markedly different and for this reason and for shape considerations should be considered separately by using subdivision.

As an experienced river engineer (53 years of experience with rivers mostly in the western U. S.), I chose to use the incremental Hyra method to assess navigability because it was convenient and it recognized the importance of channel subdivision. The measured and computed maximum depth along the thalwag (defined by a series of single channel cross sections) simply represents a portion of the main channel that could potentially be used for navigation of small watercraft such as canoes. The Hyra method allowed me to specifically focus on the deeper part of the channel and ignore adjacent shallow areas that have little to do with navigability for ANSAC along the Verde River. I've used the figure on p. A12 of Hyra (1978), that is unique to the incremental assessment of the Hyra Method, for this and other navigability assessments of Arizona rivers.

The hydraulic techniques developed for the Hyra method are briefly discussed using a transect (cross section) with subdivision (Modified from Figure 5 of Milhous and Bovee (1978). The relatively narrow width (w2) of the navigation lane (sub-area 2) with the depth (d2) at the thalwag was most important for my assessment. Information on this transect can be applied to many channel cross sections in the Hydraulics and Channel Geometry section of my report (pages 44-101). For example, the calibration discharge shown below is comparable to the measured discharge of my cross sections (see cross section 15 on p. 88 that is one of many I used for the Hyra Incremental Method). The highest

extrapolated discharge shown below is comparable to the cross section corresponding to the 80 cfs of cross section 15 on p. 88 of my report.
Milhous, R. R. and K. D. Bovee, 1978, Hydraulic Simulation in Instream Flow Studies: Theory and Techniques, Instream Flow Information Paper No.5, Library of Congress Catalog Card # 78-600110 Fish and Wildlife Service, U.S. Department of the Interior, 131p.

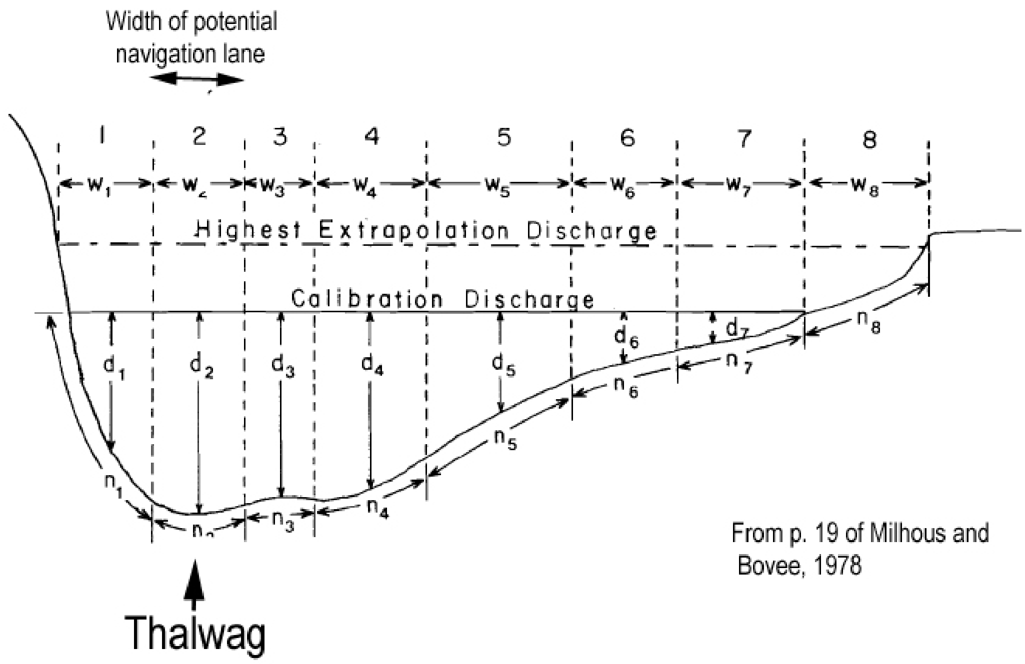


Figure 5: Subdivision of a cross section into a series of channel segments, each with geometric elements particular to the channel segment.

The abstract for the Milhous and Bovee (1978) report is worth presenting because it describes the adaptability of the hydraulic technique to many stream environments. For example, the Hyra method was adapted (used) for a study along Beaver Dam Wash (Fogg, J. L., and others, 1998), a tributary to the Virgin River, in northwestern Arizona to evaluate depth and velocity versus suitability criteria in Hyra (1978) for swimming opportunities. Water contact swimming criteria (Figure A-7 of Hyra) was used to evaluate swimming opportunities (total body emersion) along Beaver Dam Wash (Figure 37, p. 62 of Fogg, J. L., and others, 1998). The water contact swimming criteria (Figure A-7 of Hyra) uses a similar relation between flow depth and velocity for the boating canoeing-kayaking criteria (Figure A-12 of Hyra and p. 104 of my report) for my study.

Fogg, J. L., and others, 1998, BEAVER DAM WASH INSTREAM FLOW ASSESSMENT; U.S. Department of the Interior, Bureau of Land Management, BLM/RS/ST-98/002+7200, 109p.

*A B S T RAC T (*Milhous, R. R. and K. D. Bovee, 1978)

Hydraulic simulation for instream flow studies is defined as the description of the changes in distribution of velocities, depths, and substrates as a function of discharge. ......Several types of techniques for the prediction of the stage discharge relationship and the velocity distribution-discharge relationship are presented...........Study site preparation involves the strategic placement of transects which describe certain types of conditions or habitat areas within the channel. Further, the characteristics of the study site may have profound influences on one's ability to simulate the hydraulics of the stream.

My assessment of navigability is not based only on the Hyra method. The method uses depth and velocity and combinations of depth and velocity based of personal experience for utility and safety of different activities. Experienced river users may consider Hyra's safely criteria that was based on conditions that 50% of the users would consider the depth or velocity safe for use rather useless. Another potential limitation is that depth and velocity are considered the two most important streamflow characteristics for determining recreation quality. While Hyra's incremental method has been applied on the Chattahoochee River in Georgia, the Salmon in New York, American River in California (Shelby and others,1992, p.14), experienced river users may not consider depth and velocity very important when encountering the effects of rocky, uneven surface formations at various flow levels on boating quality. Also, hydraulic computations (modeling) of flow based on selected transects will often inadequately describe the complex nature of water movement in rapids (Shelby and others, 1992, p.22).

Shelby, B, Brown, T. C. and Taylor, J. G., 1992, Streamflow and Recreation, General Technical Report RM-209 revised, U. S. Dept. of Agriculture, Forest Service; 27 p.

My assessment places considerable weight on the fact that boating activity has been popular on the entire Verde River for the past 25 years (Factor C, p. 106, of my report). Both inexperienced and experienced boaters have enjoyed the river. Consider the following from the local newspaper in the Verde Valley:

NOTE: Limits on boating needed to avoid over use of the Verde River.

Verde Independent

Thursday, January 15, 2015

Clarkdale establishes limits on Verde River commercial users

Yvonne Gonzalez
Staff Reporter

Thursday, January 15, 2015

The following from p. 101 of my report of Oct. 4, 2014 is worth repeating because it discusses the navigation lane that is segmented from adjacent shallow areas along the river channel. *The depths represent the expected range that would have been encountered along the natural pool-riffle channel for normal conditions. It's important to keep in mind that most of the Upper Verde River is pools and that riffles occupy a much smaller portion of the river. Thus, typical depths for natural conditions along the reach from mile 3.3 downstream to the USGS Clarkdale gage are at least 3.5 ft (mean annual), 3.0 ft (median, Q50) and 2.9 ft. (Q90). Also, the depths closely represent depths along a potential navigation lane (or corridor) used for small water craft.*

For navigability of the Verde River, that is—for susceptibility of navigation, the natural flow depths must have been sufficient to accommodate small watercraft. Flow depth is a major factor of the Hyra Method. Obviously, flow depths are dependent on the channel morphology, hydraulics and most importantly, the amount of base flow in the Verde River. Consider the following:

- There is no question that small rafts, canoes and kayaks presently are used all along the river (even human depleted flow depths are sufficient). See for example the NOTE below.

- Also, there is considerable evidence the channel hydraulics and morphology have not changed above Horseshoe Reservoir since human settlement.

- There is also evidence the natural base flow along the entire Verde River was greater than the present base flow.

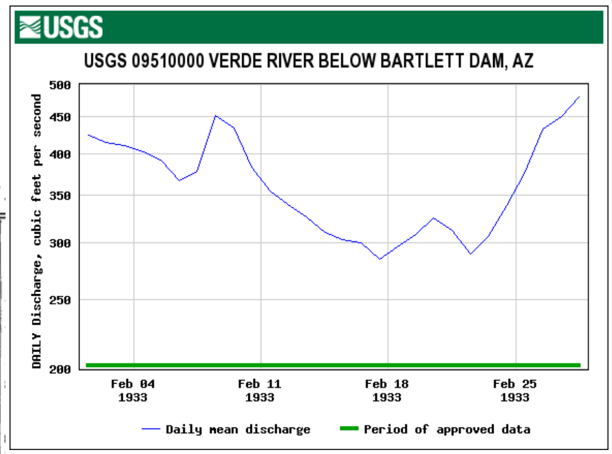
- Evidence shows that potential use of early small watercraft required similar depths of water as modern small watercraft (e. g. DSL, 2005, pp. 8, 29-34, and other pages.)

  Oregon Department of State Lands (DSL), 2005, JOHN DAY RIVER FINAL NAVIGABILITY REPORT; concerning the ownership or "navigability" of a 174-mile segment of the John Day River extending from Kimberly at River Mile (RM) 184 to Tumwater Falls at RM 10, study of October 2002 , after receiving a request in early 1997 from the John Day River Chapter of the Association of Northwest Steelheaders ("Steelheaders", 44p.)

SUPPLEMENT 3. Samples of February streamflow for Verde River that show the wide range of daily flow for the month.

The following is an example of the variable nature and wide range of daily flow of the Verde River during February. This example uses (1) USGS streamflow data at USGS gage 09510000 and Weather Bureau precipitation and temperature data for 1934-37 (before Bartlett Dam) with a general summary for each year, (2) graphs showing highly variable precipitation and temperature for February since 1895 and (3) hydrographs of daily flow at gages 09504000 and 09506000 from a USGS study that include base flow for early Feb. 2011. The data show periods of base flow as well as periods of snowmelt and storm runoff during February that clearly contradict the unsupported claims made by Mr. Hood when questioning Mr. Fuller and Mr. Hjalmarson during the ANSAC hearings of Dec. 2014.

February 1933



CLIMATOLOG

WBO, Reno, 4-11-33—960

2 **ARIZONA SECTION**

WALTER B. HARE, Meteorologist

VOL. XXXVII PHOENIX, ARIZ., FEBRUARY, 1933 No. 2

GENERAL SUMMARY

The month was the coldest February in 57 years of record with a mean temperature of 41.7°, 7.2° below normal. Every station in the State reported temperatures below normal and average daily deficiencies from 2° at Parker in the southwestern corner to 15° at Kayenta in the northeastern uplands. The month opened with four days of cold, clear weather. This was followed by two days of cloudiness and rain attended by normal temperatures. On the 7th, a cold spell in the wake of brisk, northerly winds lowered temperatures to record breaking levels. 21 of the 90 stations reporting had below zero temperatures. At Phoenix, a temperature of 24° on the 8th, the lowest recorded so late in the winter, caused extensive damage to citrus and a 20 per cent loss in the lettuce crop. Following this came ten days of clear, comparatively warm weather. Benefits to plant growth were more than offset, however, by the unseasonably cold nights which continued to prevail. On the 25th, a 3 day cycle of rains began. Precipitation in all parts of the State aided plant and cattle growth. Cold weather continued but minimum temperatures were somewhat higher. The last day of the month was its warmest and gave promise of better weather to come.

Precipitation for the month averaged 0.67 inch, about one-half the usual amount and less than one-fourth the February, 1932, fall. Snowfall was much below normal. Run-off from watersheds in the State was less than one-tenth that of a year ago but the amount of stored water was about the same. Wind movement was above normal and relative humidity percentages concomitantly low. A thunderstorm was noted at 7 localities in the central portion of the State on the 25th. Moderate hail fell on the same date at Castle Hot Springs and light hail one day later at Bowie, but no damage was reported. R.B.E.

TEMPERATURE.—The monthly mean for the State, as shown by the records of 90 stations, was 40.4°. The mean departure from the normal for 78 stations having a record of ten or more years was —7.2°. The highest monthly mean was 55.0° at Red Rock; the lowest, 19.0°, at Fort Defiance. The highest temperature reported was 89° at Parker on the 23d; the lowest was —26° at Fort Defiance on the 7th. The greatest daily range was 60° at Fort Valley on the 11th. There was an average of 19 clear days, 5 partly cloudy days and 4 cloudy days.

PRECIPITATION.—The average precipitation for the State, as shown by the records of 122 stations, was 0.67 inch. The mean departure from the normal for 102 stations having a record of ten or more years was —0.66 inch. Rucker Canyon reported the greatest monthly amount, 3.29 inches. Lakeside reported the greatest 24-hour fall, 1.90 inches, on the 26th. Five stations reported no precipitation during the month. There was an average of 2 rainy days for the month.

Weather Bureau, 1933, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 37, Phoenix, AZ, Feb. 1934. No. 2, 10 p. (page 2)

Daily Precipitation for February, 1933

Stations	Drainage basin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
Aguila	Desert																									.33							0.33
Ajo **	....do																									T.	.35						0.35
Alamo Ran. Sta.	Salt						.09																			.60	.45						1.14
Apache Powd'r Co **	San Pedro						.15	.06															.02		.04	.37							0.64
Ashdale Ran. Sta.	Agua Fria					T.	.13																			*	.76						0.89
Ashfork	Verde																										.19						0.19
Bagdad**	Williams						T.								T.											T.	.30						0.30
Benson **	San Pedro								.38																	.40							0.78
Bisbee	Desert					.03	.34	.13																	.80	.62							1.92
Bowie	Gila						.04	.34																	.06	.24	.33						1.01
Buckeye	....do																									.10							0.10
Camel Back	Salt						.06																			.20							0.26
Canille **	San Pedro							.60																.18		.21	.07						1.06
Casa Grande **	Santa Cruz						.10																										0.10
Castle Hot Springs**	Agua Fria						.10																			.67							0.77
Cedar Glade	Verde																								.03	.44							0.47
Childs**	....do					T.	T.																			.50	T.						0.50
Cibecue	Salt						.20	.08																	T.		.13						0.41
Clemenceau **	Verde																										.40						0.40
Clifton	Gila						.04	.27																		.55	1.00						1.86
Cordes	Agua Fria						T.																			.36	.06						0.42
Crown King	Agua Fria																									.57	.07						0.64
Douglas**	Yaqui						.36	.12																	.55	.58	.08						1.59
Eagle Creek R. S.**	Gila						T.	.34																		T	1.54						1.88
Elgin (near)**	San Pedro					.16																				.58							0.74
Fairbank	....do					.05	.15	.06																	.20	.25	T.						0.71
Flagstaff ***	Little Colorado						.04			T.				.01											.07	.46	.33						0.91
Ft. Apache**	Salt							.67																			1.10						1.77
Ft. Defiance**	Little Colorado													T			T.																T.
Fort Grant**	Desert						T.	.02																		.54							0.56
Fort Mojave**	Colorado																																0.00
Ganado	Little Colorado						T.	.11			.09			T.				.15							.09		T.						0.44
Gila Bend	Gila																																0.00
Gisela**	Salt																																
Globe	Salt						.29	.10																		.71	.09						1.19
Goodyear**	Gila																																
Grand Canyon	Colorado							T.		T.			.06	.04												T.							0.10
Helvetia**	Santa Cruz					.32	.08	.21																	.08	.04							0.73
Henry's Camp**	Salt						.47	1.16																	.04	.29	.98						2.94
Holbrook	Little Colorado																									.20	1.01	.06					1.27
Intake**	Salt																																
Jerome **	Verde																									.03	.32						0.35
Kayenta	San Juan	T.					.02	.03		T.				.07													.35						0.47
Kingman	Colorado																								.05								0.05
Lee's Ferry**	....do													T.																			T.
Leslie Canyon**	San Pedro						.27	.17	.10																.41	.46	.67						2.08
Lewis Springs	San Pedro						.05																				.48						0.53
Maricopa **	Gila						.03																			.02							0.05
Marinette**	Agua Fria																																
Mesa (Expt. Farm)**	Salt					T.	.04																		T.	.22							0.26
Miami **	Salt							.47																			.75						1.22
Mt. Trumbull	Colorado								.06									.03							.12								0.21
Naco**	San Pedro						.75																			.76							1.51
Natural Bridge	Verde						.03																			.63	.11						0.77
Nogales **	Santa Cruz					.22		.09																	.02	.01	T.						0.34
Palmers Ranch**	Williams																																
Paradise	Desert							.73																	.61	.45	.17						1.96
Parker	Colorado																																0.00
Patagonia	Santa Cruz					T.	.19	.23																	.05	.01	.02						0.50
Phoenix***	Salt					T.	.03																			.12	T.						0.15
Pinal Ranch **	Gila							.98																			1.14						2.12
Pinedale	Little Colorado						.08				.05														T.	.43	.52						1.08
Portal	Gila						.06	.28																	.40	.95	.26						1.95
Prescott **	Verde																									T.	.20						0.20
Quartzsite	Colorado																									T.	T.						T.
Redrock	Santa Cruz																									.06							0.06
Reno Ranger Station	Tonto					.50																					.85	.03					1.38
Roosevelt**	Salt						.02	.39																		T.	.77	T.	T.				1.18
Ruby**	Santa Cruz					.09	.28	.12																.09		.01	.03						0.62
Rucker Canyon	Desert						.28	.49																	1.27	.97	.28						3.29
Sacaton**	Gila	T.						.06																			.21						0.27
St. Johns	Little Colorado										.08															.03	.55						0.66
Salome (near)	Desert																									.37	.17						0.54
San Rafael**	Santa Cruz					.30	.33																	.08	.20								0.91
San Simon	Gila							.10																	.10	.35							0.55
San Vicente**	San Pedro							.14																									0.14
Santa Marguerita **	Santa Cruz																																
Seligman	Verde																										.20						0.20
Snowflake	Little Colorado							T.																		.44	.43						0.87
Springerville**	Little Colorado							.18																		T.		1.05					1.23
Stephens Ranch	San Bernardino						.26	.05																	.75	.61	.16						1.83
Supai	Colorado																																0.00
Superior**	Gila					.04	.77																			1.01							1.82
Sycamore R. S.	Agua Fria																									.25							0.25
Tempe No. 2 **	Salt						T.	.07																		.03	.19						0.29
Thatcher **	Gila							.10																			.77	T.					0.87
Tombstone	San Pedro						.25	.10																	.19	.60	.02						1.16
Tonto Ranger Sta.**	Williams																																
Truxton	Desert																								T.	T.							T.
Tuba City	Little Colorado						T.																										T.
Univ. of Arizona**	Desert					T.	.03	.18																	T.	.03	T.						0.24
Wallace Ran. Sta.**	Verde					.30																					.80						1.10
Walnut Creek**	Verde																										.20						0.20
Walnut Grove	Hassayampa																									.38	.14						0.52
Wickenburg **	Williams																										.43						0.43
Wikieup	Santa Cruz																									T.							T.
Willcox (near)**	Desert						.14	.30																	.05	.05	.65	.08					1.27
Williams **	Colorado														.07			T.								.01	.24						0.32
Winslow***	Little Colorado																	T.							T.	.15	.51						0.66
Wittmann	Hassayampa																										.10						0.10
Yeager Canyon	Verde																										.30						0.30
Young**	Salt							.31																	T.	.27	.63						1.21
Yuma Wea. Bur. ***	Colorado																									.12							0.12

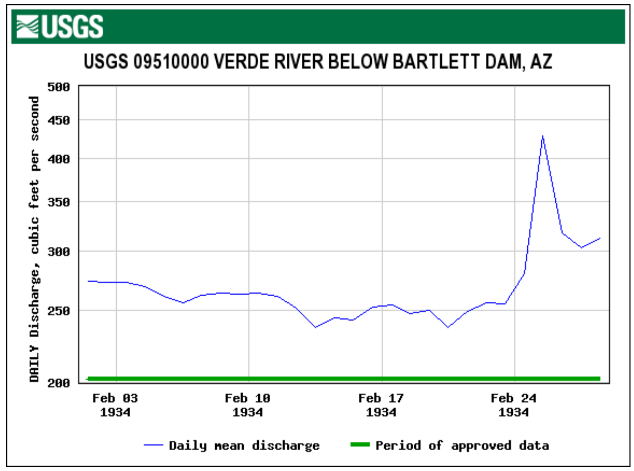
Weather Bureau, 1933, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 37, Phoenix, AZ, Feb. 1934. No. 2, 10 p. (page 9)

Daily Temperatures for February, 1933

Stations.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean
Ajo	Maximum	63	60	60	61	62	76	72	....	....	....	....	....	....	70	71	76	71	74	61	60	62	64	72	70	62	55	63	77	....	....	....	66.5
	Minimum	37	36	34	35	38	42	40	....	....	....	....	....	....	48	48	56	41	45	40	38	40	40	42	46	42	38	44	45	....	....	....	41.6
Ashfork	Maximum	40	40	35	46	44	46	39	33	39	34	44	45	47	45	49	53	50	47	50	48	56	60	59	55	48	60	64	63	....	....	....	47.8
	Minimum	5	5	5	2	20	22	3	−9	8	−4	5	10	17	10	7	14	23	19	14	12	15	18	18	22	31	21	30	25	....	....	....	13.1
Bisbee	Maximum	57	55	56	56	52	50	41	44	58	57	64	64	62	59	64	69	67	63	63	62	69	70	68	66	50	47	64	73	....	....	....	59.6
	Minimum	33	32	30	29	41	33	22	12	23	28	27	34	40	32	32	36	35	41	29	32	33	35	39	41	36	30	29	38	....	....	....	32.2
Clifton	Maximum	52	52	51	54	59	56	50	37	48	45	48	58	59	58	62	65	65	65	57	60	66	68	71	65	57	51	61	66	....	....	....	57.4
	Minimum	31	32	37	35	40	44	30	17	25	28	25	28	29	30	32	34	38	35	36	37	30	33	35	50	45	36	32	44	....	....	....	33.9
Douglas	Maximum	61	59	60	57	56	51	41	45	60	54	63	69	66	62	66	72	67	65	59	64	70	71	72	54	57	49	65	72	....	....	....	61.0
	Minimum	21	22	20	25	40	40	28	12	16	26	17	23	22	26	25	21	28	28	25	17	20	25	28	44	41	34	27	32	....	....	....	26.2
Flagstaff	Maximum	35	28	20	26	35	35	14	28	29	21	41	38	33	35	44	44	35	36	34	36	48	50	49	39	38	40	50	54	....	....	....	36.2
	Minimum	2	−8	−9	12	10	14	−12	−17	0	−17	−4	8	10	−4	−6	14	11	5	0	8	3	6	11	20	28	26	12	11	....	....	....	4.6
Fort Apache	Maximum	53	51	52	50	52	53	55	48	50	52	54	52	52	53	51	50	51	53	52	54	52	60	64	64	51	50	57	65	....	....	....	53.6
	Minimum	11	11	12	14	13	20	19	8	2	1	15	19	20	19	14	16	17	19	14	17	18	20	19	18	24	35	33	29	....	....	....	17.0
Ganado	Maximum	32	26	24	23	34	36	26	24	34	24	34	36	34	36	38	42	36	38	28	32	45	46	51	43	46	44	51	58	....	....	....	36.5
	Minimum	2	1	−13	−12	1	14	9	−25	10	−19	−11	3	11	−2	1	8	21	9	0	0	5	9	15	32	27	32	26	21	....	....	....	6.2
Globe	Maximum	50	49	46	52	59	55	42	38	47	43	48	55	57	56	58	62	60	59	52	58	63	66	66	64	58	47	60	67	....	....	....	54.9
	Minimum	23	23	25	20	29	38	28	13	17	17	17	20	25	22	21	24	25	28	22	24	25	22	25	41	33	32	27	35	....	....	....	25.0
Grand Canyon	Maximum	37	33	34	35	45	42	34	33	29	27	39	36	37	43	50	51	47	46	46	43	50	54	54	53	51	49	58	57	....	....	....	43.3
	Minimum	11	4	7	12	19	19	−1	−10	10	−14	1	16	20	8	11	22	18	19	2	10	12	14	23	26	27	26	22	24	....	....	....	12.8
Holbrook	Maximum	42	42	36	31	36	46	42	38	44	38	45	48	50	45	46	58	56	51	49	43	57	59	61	58	55	43	53	60	....	....	....	47.6
	Minimum	18	13	8	4	15	25	12	2	16	1	6	12	22	13	11	19	25	20	14	11	12	15	19	32	27	30	25	27	....	....	....	16.2
Jeddito	Maximum	38	37	26	38	44	40	34	31	31	24	45	47	43	46	46	50	47	38	33	41	51	51	54	50	44	44	51	57	....	....	....	42.2
	Minimum	6	5	0	0	10	21	0	0	5	0	0	8	10	3	8	15	17	15	2	7	12	14	21	26	28	31	20	24	....	....	....	11.0
Kayenta	Maximum	40	31	28	34	28	41	34	15	31	26	19	25	40	37	33	43	42	37	36	40	38	48	52	52	46	47	55	50	....	....	....	37.4
	Minimum	19	5	−6	−2	5	10	0	−13	−3	−15	−6	−4	10	11	4	15	17	10	7	9	10	16	17	30	23	30	27	26	....	....	....	9.0
Lee's Ferry	Maximum	50	44	39	40	38	55	27	32	43	30	36	40	49	48	48	52	49	51	51	48	51	55	55	60	56	62	65	62	....	....	....	47.7
	Minimum	26	25	17	16	19	19	15	8	20	6	13	14	21	20	18	21	29	21	22	21	21	22	23	29	32	37	29	31	....	....	....	21.2
Natural Bridge	Maximum	44	47	42	48	55	48	40	35	41	41	48	52	48	52	58	58	57	52	51	60	61	64	62	55	49	40	61	64	....	....	....	51.2
	Minimum	21	22	24	15	33	36	18	10	16	11	24	26	25	25	24	31	30	27	25	24	26	33	34	31	33	33	29	34	....	....	....	25.7
Nogales	Maximum	66	60	60	57	54	49	44	49	60	55	62	66	63	62	71	71	68	63	60	72	70	74	78	62	54	55	71	79	....	....	....	62.3
	Minimum	29	29	28	26	35	38	37	15	21	26	24	26	29	28	28	31	34	33	28	24	25	33	34	34	37	32	27	36	....	....	....	29.5
Parker	Maximum	67	62	70	63	74	70	75	54	68	72	64	70	72	71	78	76	79	78	78	72	77	84	89	79	70	82	80	82	....	....	....	73.4
	Minimum	34	32	38	27	38	36	35	20	28	21	24	26	39	33	31	32	31	33	30	34	35	36	37	37	40	40	40	37	....	....	....	33.0
Phoenix	Maximum	58	59	58	63	70	59	48	48	58	51	58	62	63	66	72	70	71	66	63	70	73	74	69	66	57	60	68	78	....	....	....	63.5
	Minimum	35	35	35	29	45	48	35	24	28	28	26	31	35	33	32	38	36	39	36	32	34	38	39	46	42	40	38	43	....	....	....	35.7
Pinedale	Maximum	38	37	38	40	39	39	38	29	35	26	36	46	41	37	47	47	38	41	33	40	48	53	53	47	38	47	49	62	....	....	....	41.5
	Minimum	7	12	8	10	9	20	8	−18	20	−12	−7	20	20	0	−2	20	14	11	7	0	7	22	26	32	26	24	4	9	....	....	....	10.6
Prescott	Maximum	38	40	34	40	48	45	24	37	41	40	53	46	45	46	52	54	48	46	40	50	57	58	60	48	41	48	61	67	....	....	....	46.7
	Minimum	9	2	−3	−7	14	26	9	−5	7	−8	5	14	21	7	5	16	18	19	10	7	10	15	16	31	22	29	18	19	....	....	....	11.6
Red Rock	Maximum	80	80	78	74	76	70	74	76	74	74	74	76	72	70	74	72	78	76	78	78	78	82	84	80	82	74	78	....	....	....	....	76.4
	Minimum	32	36	32	30	32	34	30	36	34	32	34	36	34	32	38	32	38	36	34	32	38	31	32	36	32	36	32	....	....	....	....	33.7
Sacaton	Maximum	56	58	56	65	70	54	45	50	58	49	56	63	63	64	71	71	71	65	61	71	74	76	66	66	59	61	70	82	....	....	....	63.2
	Minimum	32	33	28	25	41	42	38	19	24	21	22	26	21	29	26	29	35	35	33	23	27	31	34	40	34	36	33	34	....	....	....	30.8
Salome (*near*)	Maximum	60	57	52	61	67	63	41	47	57	46	60	61	61	66	70	71	66	62	57	71	74	73	74	67	54	64	70	74	....	....	....	62.4
	Minimum	30	31	36	28	39	36	31	18	20	20	23	24	26	28	29	27	33	26	37	35	29	29	28	42	36	38	33	40	....	....	....	30.4
St. Johns	Maximum	42	38	30	33	35	46	34	35	40	30	49	50	47	43	52	57	49	47	39	48	60	57	61	57	50	42	55	66	....	....	....	46.1
	Minimum	15	10	7	1	12	15	8	−5	18	−10	0	9	13	12	4	11	25	12	9	4	7	12	11	32	24	28	25	27	....	....	....	11.8
Tombstone	Maximum	58	60	58	55	56	50	51	44	59	58	63	66	65	61	65	65	65	64	58	63	71	72	71	65	53	48	66	68	....	....	....	60.5
	Minimum	26	28	26	25	38	33	24	14	21	22	24	32	31	27	32	32	33	35	27	25	34	38	38	41	38	30	28	40	....	....	....	30.1
University of Arizona	Maximum	58	58	53	55	63	57	52	48	58	60	59	63	63	63	71	72	68	66	65	68	77	74	75	68	66	56	67	80	....	....	....	63.3
	Minimum	34	30	29	27	40	45	32	18	23	27	22	27	29	29	26	30	34	32	28	24	37	32	33	54	40	35	30	41	....	....	....	31.7
Wickenburg	Maximum	57	60	56	64	67	58	39	45	55	49	63	61	60	65	71	67	67	64	60	68	72	68	74	62	52	60	68	75	....	....	....	61.7
	Minimum	26	24	28	22	36	40	28	15	15	17	24	22	24	25	25	27	30	24	32	26	25	26	25	30	31	38	30	37	....	....	....	26.9
Williams	Maximum	35	30	28	40	51	37	11	31	32	29	44	42	38	37	51	41	42	29	32	47	51	50	51	42	39	45	52	58	....	....	....	39.8
	Minimum	5	0	0	0	15	25	0	0	0	0	0	8	14	0	4	13	12	19	0	5	10	5	12	14	20	19	11	16	....	....	....	5.2
Winslow	Maximum	44	38	31	32	36	49	25	38	43	24	43	50	48	43	44	57	46	50	40	45	57	58	67	56	47	41	51	57	....	....	....	45.0
	Minimum	24	17	12	9	20	23	8	4	18	1	9	9	20	14	24	20	29	21	15	11	12	15	19	29	32	32	26	28	....	....	....	17.9
Yuma	Maximum	64	62	57	62	68	66	52	54	63	49	57	65	66	68	70	73	68	69	64	69	74	76	76	64	61	68	73	78	....	....	....	65.6
	Minimum	40	41	44	42	50	44	34	29	30	32	35	33	41	43	45	39	43	37	46	45	42	38	43	45	39	42	41	46	....	....	....	40.3

Weather Bureau, 1933, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 37, Phoenix, AZ, Feb. 1934. No. 2, 10 p. (page 10)

February 1934



2 **ARIZONA SECTION**

W. B. HARE

VOL. XXXVIII PHOENIX, ARIZ., FEBRUARY, 1934 No. 2

GENERAL SUMARY

The current month was the warmest February since 1907 and its mean temperature, 52.0°, was quite a contrast to the remarkably low average of 40.4 which occurred a year ago. Abnormally high temperatures persisted during the entire month, with very little variation in temperature, although maxima were generally recorded during the first week and minima during the period 8-12th.

Precipitation was only 67 per cent of the normal amount and confined to two periods, light scattered rain or snow falling in the northeastern quarter of the State 7-10th, and general precipiation falling 19-28th, Heavy amounts were recorded in central portions on the 23rd and 24th. Stored water in all reservoirs showed a slight decrease during the month and the higher elevations only a very small covering of snow, which removed them as a usually potential factor in the replenishment of the depleting water supply. At the close of the month a few communities were still greatly in need of water and were planning to drill new wells or seek water at some distant source.

Livestock were in generally fair to good condition. The mild weather was favorable for cattle but water was low in some sections and feeding of cattle was necessary owing to a shortage of grass. Shipping of citrus and lettuce continued. The warm weather hastened the growth of lettuce and the crop was ahead of normal.

H. B. H.

Weather Bureau, 1934, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 38, Phoenix, AZ, Feb. 1934. No. 2, 8 p. (page 2)

Daily Precipitation for February, 1934

Stations	Drainage basin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
Aguila	Desert																								.40								0.40
Ajo **	do																					T.	T.		.11								0.11
Alamo Ran. Sta.	Salt																																.....
Apache Powd'r Co **	San Pedro																							.04		.68			.16				0.88
Ashdale Ran. Sta.	Agua Fria																								1.23	.51							1.74
Ashfork	Verde																				T.		.03	.88	.20	.02		.05					1.18
Bagdad**	Williams																							.22	.77	.05							1.04
Benson **	San Pedro																				.02				.10	.70			.10				0.92
Bisbee	Desert															.01						.01			.34	.27			.09				0.72
Bowie	Gila																				.01				.05	.35			.30				0.71
Buckeye	do																								.33								0.33
Camel Back	Salt																								1.29								1.29
Canille **	San Pedro																				.04				.33	.61			.10				1.08
Casa Grande **	Santa Cruz																							.55									0.55
Castle Hot Springs **	Agua Fria																																.....
Cedar Glade	Verde																						.05	.79	.42								1.26
Childs**	do																			T.			T.	.55	.14	T.							0.69
Cibecue	Salt																								1.55								1.55
Clemenceau **	Verde																							.01	.15	.03	.01						0.20
Clifton	Gila																								.10				.52				0.62
Cordes	Agua Fria																						T.	.10	.29	.02							0.41
Crown King	Agua Fria													T.							T.	T.		‡	‡	1.43							1.43
Douglas**	Yaqui															T.									.06	.09			.12				0.27
Eagle Creek R. S.**	Gila																					.10			.01	.52			.09				0.72
Elgin (near)**	San Pedro																			.03				.20	.56			.03	.05				0.87
Fairbank	do																				T.	.04			.18	.25			.08				0.55
Flagstaff ***	Little Colorado									T.											.02		.05	.50	.20		.03		T.				0.80
Ft. Apache**	Salt																				.15				.83	.21			.24				1.43
Ft. Defiance**	Little Colorado																						.27	.21			.02						0.50
Fort Grant**	Desert																				T.				.22				.37				0.59
Fort Mojave**	Colorado																							.18	T.								0.18
Ganado	Little Colorado								T.	.02											T.		T.	.10	.51			.24					0.87
Gila Bend	Gila																							.30									0.30
Gisela**	Salt																				T.		T.	1.81	.29				.10				2.20
Globe	Salt																				T.				.63	.17			.02				0.82
Grand Canyon	Colorado																				T.	.09	.24	.35	.31		.19						1.18
Helvetia**	Santa Cruz																				.10			.22	.79			.02	.02				1.15
Henry's Camp**	Salt										T.										.22	.08			1.22	.14		.02					1.68
Holbrook	Little Colorado										.06										T.		.04		.88								0.98
Intake**	Salt																																.....
Jerome **	Verde																					T.		.08	.55	.10	T.	T.					0.78
Kayenta	San Juan									.10	.14										.11			.06	.05								0.46
Kingman	Colorado																							.65									0.65
Lee's Ferry**	do							T.		T.											T.	.02		.08	.17		T.						0.27
Leslie Canyon**	San Pedro																				T.					.25							0.25
Maricopa **	Gila																								.55								0.55
Marinette**	Agua Fria																																.....
McNary	Salt																																.....
Mesa (Expt. Farm)**	Salt																				T.			.76	.03				T				0.79
Miami **	Salt																				.02	.03			.45	.68			.02				1.20
Mt. Trumbull	Colorado								T.														.05	.45				.03					0.53
Naco**	San Pedro																								.15	.12							0.27
Natural Bridge	Verde																			T.	T.		.02		1.67								1.69
Nogales **	Santa Cruz																					T.			.53				.01				0.54
Paradise	Desert																					.08			.30	.31							0.69
Parker	Colorado																						.20										0.20
Patagonia	Santa Cruz																				T.				.59	.14			T.				0.73
Phoenix ***	Salt																				T.			.24	.75								0.99
Pinal Ranch **	Gila																				.13	.18			.85	1.18							2.29
Pinedale	Little Colorado																				T.				1.23				.10				1.33
Portal	Gila																					.31	T.		.20	.40			.82				1.23
Prescott **	Verde																							.03	.78	.16		.02					0.99
Quartzsite	Colorado																							T.									T.
Redrock	Santa Cruz																		T.	.07	.14			T.									0.21
Reno Ranger Station	Tonto										T.														1.76	.66			.01				2.43
Roosevelt**	Salt																				.02	.02			1.85	.41			T.				2.30
Ruby**	Santa Cruz														T.						T.	.01			.46	.40			.02				0.89
Rucker Canyon	Desert																					.09			.21	.50			.21				1.01
Sacaton.**	Gila																				T.				.64	.02							0.66
St. Johns	Little Colorado																								.44				.09				0.53
Salome (near)	Desert																							.12	.23								0.35
San Rafael.**	Santa Cruz																							.25	.35	.04							0.64
San Simon	Gila																					.03			.22	.14		.23	.06				0.68
San Vicente**	San Pedro																																.....
Santa Marguerita **	Santa Cruz																								.37								0.37
Seligman	Verde																							.33	.33								0.66
Snowflake	Little Colorado									T.	.10														.88	.10							1.08
Springerville**	Little Colorado										.05																.21						0.26
Stephens Ranch	San Bernardino																								.07				.06				0.13
Supai	Colorado																																.....
Superior**	Gila																			.06	.03			.67	.94			.07	.02				1.79
Sycamore R. S.	Agua Fria																							.84	.14	T.							0.98
Tempe No. 2 **	Salt																					T.			.54	.06							0.60
Thatcher **	Gila																									.08							0.08
Tombstone	San Pedro																					.05			.08	.29			.05				0.47
Tonto Ranger Sta.**	Williams																																.....
Truxton	Desert																							.62	.02	T.	T.						0.64
Tuba City	Little Colorado								.02															.29	.15		.05						0.51
Univ. of Arizona**	Desert					T.															T.	.02			.02	.26							0.30
Wallace Ran. Sta.**	Verde																																.....
Walnut Creek**	Verde																							.12	.51	.02							0.65
Walnut Grove†	Hassayampa																																.....
Wickenburg **	Williams																								.53								0.53
Wikieup	Santa Cruz																						.20	T.	T.			T.					0.20
Willcox (near)**	Desert																								.12	.40							0.52
Williams **	Colorado																							.27	1.44	.05	T.	.10	T				1.86
Winslow***	Little Colorado										.01												.05	T.	.09		T.	T.	.27				0.42
Wittmann	Hassayampa																							.41	.02								0.43
Yeager Canyon	Verde																						*	*	.88								0.88
Young**	Salt																								1.65	.35							2.00
Yuma Wea. Bur., ***	Colorado																			T.				.18	T.								0.18

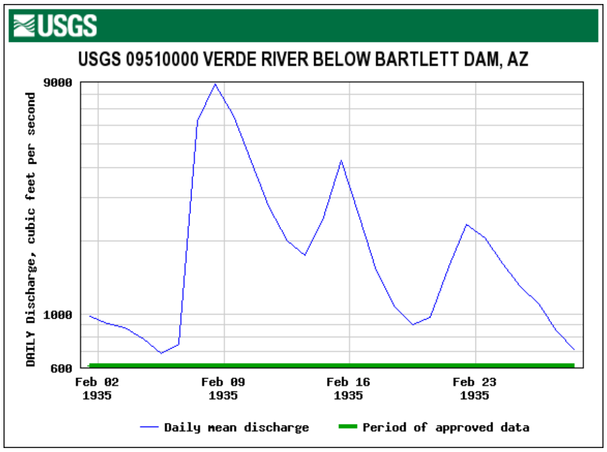
Weather Bureau, 1934, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 38, Phoenix, AZ, Feb. 1934. No. 2, 8 p. (page 7)

Daily Temperatures for February, 1934

Stations		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean
Ajo	Maximum	75	76	82	82	81	83	77	77	76	70	71	70	78	78	80	81	80	80	78	77	79	74	76	70	71	70	72	70	...	...	...	76.2
	Minimum	47	46	47	46	45	47	48	47	46	38	42	42	47	48	48	48	45	44	43	43	49	50	56	48	45	43	42	50	...	...	...	46.0
Ashfork	Maximum	70	71	70	69	70	68	62	61	59	54	61	63	67	65	62	61	59	61	59	58	62	59	46	52	52	51	51	56	...	...	...	60.7
	Minimum	28	29	27	27	26	25	24	25	24	16	21	22	28	28	29	19	20	23	21	38	23	29	39	31	30	29	26	32	...	...	...	25.9
Bisbee	Maximum	67	70	73	76	76	74	72	68	68	64	58	64	71	71	71	75	67	66	69	68	66	72	71	65	58	63	63	60	...	...	...	68.1
	Minimum	33	37	38	32	43	42	39	36	40	38	35	35	36	41	39	49	35	39	36	42	36	38	46	28	30	33	36	35	...	...	...	37.2
Clifton	Maximum	75	79	81	79	83	81	76	74	73	68	68	72	78	80	79	77	71	74	71	67	70	74	76	69	64	70	70	66	...	...	...	73.8
	Minimum	31	37	40	41	44	50	44	41	43	38	39	40	40	45	49	55	45	43	45	48	48	47	44	45	41	43	39	43	...	...	...	43.1
Douglas§§	Maximum	70	73	76	77	79	77	71	71	73	63	61	70	74	74	74	71	69	70	71	63	69	76	77	59	61	66	66	51	...	...	...	69.7
	Minimum	27	29	45	31	39	34	29	27	29	35	24	31	33	34	33	45	36	27	33	48	36	35	38	45	34	31	32	42	...	...	...	34.4
Flagstaff	Maximum	60	61	60	61	62	54	54	52	44	41	44	47	58	56	53	53	52	53	53	41	50	46	44	38	43	44	45	43	...	...	...	50.4
	Minimum	22	23	27	24	26	26	21	19	26	17	23	18	16	23	26	28	24	16	18	34	27	27	33	29	27	31	21	31	...	...	...	24.4
Ganado	Maximum	54	66	65	65	66	60	54	56	46	41	46	50	57	57	60	53	50	51	57	49	53	53	52	44	46	48	48	46	...	...	...	53.3
	Minimum	20	22	25	24	29	27	23	19	30	27	19	37	17	21	20	37	21	17	23	33	17	27	37	31	23	19	28	33	...	...	...	25.2
Globe	Maximum	65	68	70	66	71	71	65	69	65	58	60	63	66	70	70	73	65	64	64	63	64	68	68	50	60	63	63	60	...	...	...	65.1
	Minimum	28	30	33	30	33	35	30	27	33	26	26	31	33	29	35	45	32	27	43	42	39	40	43	42	36	36	33	40	...	...	...	34.2
Grand Canyon	Maximum	60	63	53	54	57	54	50	52	40	43	40	48	54	53	53	51	47	42	52	39	48	47	40	35	42	38	39	48	...	...	...	48.0
	Minimum	28	29	33	29	31	30	27	28	28	23	22	22	27	27	31	34	29	30	24	27	28	29	29	28	28	29	24	26	...	...	...	27.9
Henry's Camp	Maximum	63	68	65	64	66	62	59	56	56	46	56	59	61	61	61	59	54	57	58	44	51	53	58	43	48	51	55	51	...	...	...	56.6
	Minimum	22	25	23	26	26	28	22	20	28	16	15	18	21	24	26	32	20	18	25	32	32	27	36	32	30	30	26	30	...	...	...	25.4
Holbrook	Maximum	61	65	70	69	70	68	65	60	57	50	50	59	62	63	64	66	68	57	64	63	60	65	61	60	54	57	53	52	...	...	...	61.0
	Minimum	20	19	24	23	26	26	25	20	26	23	15	17	16	20	25	37	23	19	22	37	25	28	38	30	28	29	28	35	...	...	...	25.1
Jeddito	Maximum	53	71	66	66	68	62	59	58	47	41	50	57	60	60	61	61	51	55	58	50	53	52	53	44	48	52	51	48	...	...	...	55.5
	Minimum	24	26	30	29	31	33	24	26	29	27	20	26	26	24	30	34	21	21	26	30	25	25	36	30	25	27	26	25	...	...	...	27.0
Kayenta	Maximum	63	59	60	60	60	62	58	57	53	40	47	50	54	59	57	61	55	58	58	53	53	56	52	44	51	51	53	51	...	...	...	54.6
	Minimum	28	27	28	30	32	30	28	26	32	30	25	23	24	26	31	33	33	25	25	35	34	32	40	34	33	33	29	35	...	...	...	30.0
Lee's Ferry	Maximum	62	63	64	61	68	67	66	64	55	59	60	62	61	60	64	68	66	64	65	62	67	63	56	58	64	60	59	66	...	...	...	62.6
	Minimum	29	28	31	32	35	36	32	32	40	43	30	29	28	31	35	40	39	34	33	37	39	35	41	40	40	39	34	39	...	...	...	35.1
Natural Bridge	Maximum	68	69	69	70	72	68	64	68	60	57	61	64	67	68	65	65	62	63	63	57	60	53	57	52	52	55	55	59	...	...	...	62.1
	Minimum	34	39	40	42	42	41	39	35	35	29	30	29	33	41	41	42	33	34	34	42	40	38	46	32	35	34	34	40				36.9
Nogales	Maximum	75	79	79	62	73	76	71	75	72	62	67	74	77	76	77	74	68	76	75	63	70	76	71	...	...	68	66	59	...	...	...	71.6
	Minimum	34	36	38	40	43	41	35	33	38	36	30	36	38	40	40	46	39	33	37	46	41	42	44	45	...	...	37	39	...	...	...	38.7
Parker	Maximum	74	78	76	75	72	80	76	78	76	74	72	78	80	78	76	73	70	71	68	70	73	72	70	76	76	74	76	76	...	...	...	74.6
	Minimum	34	36	38	40	40	40	40	42	42	38	36	40	45	40	36	38	40	40	38	35	55	55	55	55	50	50	49	50	...	...	...	42.8
Phoenix	Maximum	76	79	78	79	81	79	75	74	78	68	73	77	81	78	74	76	74	71	77	73	73	77	74	64	66	71	71	76	...	...	...	74.6
	Minimum	44	45	47	46	47	47	47	44	44	39	39	43	44	49	49	54	44	46	42	58	50	55	55	51	47	49	48	61	...	...	...	47.1
Pinedale	Maximum	57	62	64	62	68	62	56	58	58	45	46	53	62	64	60	64	52	60	56	52	52	54	54	55	52	49	50	47	...	...	...	56.0
	Minimum	20	20	23	20	22	20	22	15	28	14	13	14	15	19	22	33	15	17	26	32	34	35	38	32	20	25	23	29	...	...	...	23.1
Prescott	Maximum	64	72	51	70	69	67	61	65	58	58	57	56	65	63	61	60	59	61	62	51	61	51	50	47	53	53	55	54	...	...	...	58.7
	Minimum	23	25	25	24	28	26	25	23	28	19	12	21	19	26	27	33	20	20	20	35	27	34	37	29	22	28	24	29	...	...	...	25.3
Red Rock	Maximum	60	60	...	...	...	...	...	...	...	...	...	...	...	...	...	62	62	60	58	62	68	68	62	64	68	68	70	72	...	...	...	64.3
	Minimum	38	38	38	36	38	38	38	36	40	40	42	42	40	40	42	44	40	36	32	34	36	36	38	36	37	36	36	38	...	...	...	38.0
Sacaton	Maximum	75	77	79	78	79	80	75	72	72	68	74	78	84	77	78	78	74	78	78	70	74	79	75	63	68	73	69	73	...	...	...	74.8
	Minimum	38	40	42	39	41	40	39	38	39	34	31	32	40	42	44	49	38	39	40	44	45	47	51	52	43	44	43	46	...	...	...	41.4
Salome (near)	Maximum	80	78	78	79	82	78	77	76	68	70	75	76	81	77	72	78	72	78	74	68	72	73	68	61	66	71	72	73	...	...	...	73.7
	Minimum	35	37	35	39	41	40	35	36	40	41	38	37	38	42	40	42	37	40	35	45	35	49	52	43	37	40	40	50	...	...	...	40.0
St. Johns	Maximum	59	66	70	71	69	65	57	61	53	36	59	57	61	63	61	64	63	57	62	48	56	55	61	50	56	54	49	44	...	...	...	58.1
	Minimum	11	15	19	18	18	22	21	14	20	21	17	9	10	14	19	18	19	13	14	31	32	27	32	29	28	27	30	27	...	...	...	20.5
Tombstone	Maximum	68	73	76	77	80	76	68	70	72	63	68	66	73	78	75	72	65	70	72	66	66	74	71	65	58	65	65	58	...	...	...	69.3
	Minimum	35	39	40	42	45	44	37	35	38	31	31	36	39	42	40	47	37	34	39	42	35	40	44	40	30	34	35	39	...	...	...	38.2
University of Arizona	Maximum	74	82	78	82	81	79	71	72	71	62	68	76	81	82	74	72	67	75	77	66	69	76	71	57	67	68	67	63	...	...	...	72.4
	Minimum	35	36	38	41	42	43	36	34	38	31	28	43	45	42	40	52	38	33	38	52	39	43	47	47	42	40	39	46	...	...	...	40.3
Wickenburg	Maximum	78	77	78	78	80	76	76	74	67	67	72	74	77	74	74	75	70	71	72	66	70	70	68	60	60	69	66	70	...	...	...	71.8
	Minimum	33	36	33	35	37	36	37	34	33	32	33	34	35	38	36	42	35	34	32	38	32	39	48	43	36	37	37	45	...	...	...	36.4
Williams	Maximum	64	69	63	66	67	55	52	52	45	51	51	56	60	54	59	55	54	55	56	45	51	47	40	42	42	43	48	48	...	...	...	53.2
	Minimum	18	19	23	19	25	20	16	16	24	15	13	21	19	18	24	29	17	17	18	17	28	26	33	20	24	21	13	23	...	...	...	20.2
Winslow	Maximum	60	62	68	64	66	67	59	57	55	48	51	55	60	60	62	65	56	55	64	56	60	55	60	49	54	57	52	53	...	...	...	58.2
	Minimum	21	24	28	27	29	29	30	21	30	28	19	18	19	24	29	37	28	19	22	42	31	33	42	34	31	33	28	34	...	...	...	28.2
Yuma	Maximum	80	80	79	79	83	77	78	81	75	71	75	79	81	81	76	78	78	77	76	71	76	78	72	67	71	75	77	79	...	...	...	76.8
	Minimum	49	45	44	48	49	49	44	44	50	45	45	48	54	48	48	50	47	47	44	55	46	56	56	50	42	45	45	60	...	...	...	48.3

Weather Bureau, 1934, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 38, Phoenix, AZ, Feb. 1934. No. 2, 8 p. (page 8)

February 1935



ARIZONA SECTION

W. B. HARE

VOL. XXXIX PHOENIX, ARIZ., FEBRUARY, 1935 No. 2

GENERAL SUMMARY

The mean temperature for February was near normal but the average precipitation was 84 per cent above normal.

Unseasonably warm weather occurred during the first few days of the month, preceding a series of storms beginning on the 5th and continuing through the 15th. The showers were frequently accompanied by light hail or sleet, and thunderstorms were recorded on the 6th, 7th, 8th, 10th, 12th, 13th and 14th. Precipitation was especially heavy over a large area in the central part of the State and diminished in intensity toward the borders. Fair weather with increasing temperature obtained 16-22nd, followed by light scattered precipitation, mostly in the higher areas of the State and in the form of snow or sleet, 23-25th. Clear weather with sub-normal temperatures prevailed during the remaining three days of February.

Reports from all sections of the State indicated the water supply and range conditions to be much better that at the same time last year but only average or somewhat below normal. Snowfall was decidedly below normal and at the close of the month only the regions above 7,500 feet were snow covered. Run-off from the watersheds was comparatively poor as most of the moisture soaked into the dry ground. However, the heavy rains of the central sections provided a very substantial increase to the stored water of the Salt River Valley and to the reservoirs of the various cities of this region. A sudden flood on the San Carlos River on the 7th caused Indians of the San Carlos Reservation, near Globe, to abandon their brush tepees and flee to higher ground; only slight flood damage occurred.

The comparative absence of snowfall and extremely cold weather fostered the growth of range forage, and livestock were surviving the winter in good to excellent condition. In the lower desert regions, an abundance of sheep pasturage was available. Lettuce and citrus shipments continued in the Salt River and Yuma Valleys, and at the latter section carrot shipping and cotton planting were also progressing.

H. B. H.

Weather Bureau, 1935, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 39, Phoenix, AZ, Feb. 1935. No. 2, 8 p. (page 2)

Daily Precipitation for February, 1935

Stations	Drainage basin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
Aguila	Desert					.28	1.27	1.59	.71	.21	.02	T.	.35																				4.43
Ajo **	do					.05	.74	.28	.12	.12	.19	.01	.04																				1.55
Alamo Ran. Sta.	Salt						.86	1.10		.20		.12	.08																				2.36
Apache Powd'r Co **	San Pedro					.45	.35	.03	.04		.18	.15	.05		.01										.12	.16							1.49
Ashdale Ran. Sta.	Agua Fria					‡	‡	2.59	.41		.40	.42	.04	.06	.27	.84																	4.59
Ashfork	Verde					.03	.87	.63	.24	.05		T.	.07	T.	.01	.08									T.								1.48
Bagdad**	Williams					.14	.97	1.47	.51	.39	.11	.19	.74	.03	.02	.02										T.							4.59
Benson **	San Pedro						.25	.40			.15	.10	.10													.10							1.10
Bisbee	Desert					.20	.57	.66	.10		.06	.18	.26													.05							2.07
Bowie ††	Gila						.20	.20	.17	.02	.03	.07	.02		.05											.06							0.81
Bright Angel R. S.	Colorado						‡	‡	‡	‡	‡	‡	‡	‡	4.00										.70								4.70
Buckeye	Gila					.35	.67	.18	.43	.04	.02		.16																				1.85
Camel Back	Salt						1.11	.79	.11	.11	.01		.15		T.	.11																	2.39
Canille **	San Pedro					.10	.81	.81	1.00	.12	.59	.09	.01	T.												.10							3.63
Casa Grande **	Santa Cruz					.95	.10	.45	.40	.05																							1.95
Castle Hot Springs **	Agua Fria					1.10	.62	.64	.90	.16			.28			.22																	3.92
Cedar Glade	Verde						1.06	.04	1.02		.03			.03	.04									.02									2.24
Childs **	do					1.02	1.10	.29	.25	T.	.03	.32	.05	.34	.14										T.								3.54
Cibecue	Salt						.85	1.14	.05	.06	.27	.14	.22	.14	.13	.04									.04	.04							3.12
Clemenceau **	Verde						.56	.97	.10	.08			.28		.01	.02																	2.02
Clifton	Gila						.80	.24	.12		.22	.04			.02	.21																	1.65
Cordes	Agua Fria					T.	1.02	1.14	.24	.12	.03		.27	.01	.13	.02									T.								2.93
Crown King	Agua Fria					T.	2.26	1.53	.20	.43	.06	.04	.09	.07	.06	.30								T.	T.	T							5.04
Douglas**	Yaqui					T.	.22	.18	T.			.38		.22												.03							1.03
Eagle Creek R. S.**	Gila						.80	.35	.18	.18	.02	.05	.06		.10	.28										T.							2.02
Elgin (near) **	San Pedro				.57		.61	.09			.40															.07							1.74
Fairbank	do					.13	.31	.18	.03	T.	.25	.07	.04	T.												.05							1.06
Flagstaff ***	Little Colorado					.01	.70	.22	.12		T.	.07	.12	.12	.19									.02	.05	T.							1.62
Florence	Gila					.09	.89	.90	.04	.10	.05		.03			.15																	2.25
Ft. Defiance**	Little Colorado					.04	.07	.03	.05	.17	.30	.04	.07	.52	.09									.15	.28								1.81
Fort Grant**	Desert					1.08	.50	.08		.20	.20	T.	T.	T.	.45										.03	.05							2.59
Fort Mojave**	Colorado																																
Ganado	Little Colorado						.17	.32	.07	.09	.12	.03	T.	.13	.24	.01									.01	.04							1.23
Gila Bend	Gila					.09	.04	.02	T.	T.	.01		.01																				0.17
Gisela**	Salt					T.	.52	1.54	.56	.08	.14	.16	T.	.18	.06									T.	.07								3.31
Globe	Salt					T.	1.14	1.19	.16	.12	.50	.02		.06	.11	.03									T.	.01							3.34
Grand Canyon**	Colorado						.12	.06	.07	.08	.03	.07	.07	.06	.22	.16									.18	.04							1.16
Helvetia**	Santa Cruz					.53	.42	.40	.02		.42		.17		.01										.27								2.24
Henry's Camp**	Salt					.60	.38	1.09	.50	.07	.39	T.	1.07	.11	.79	T.									.49								5.49
Holbrook	Little Colorado						.23	.05	T.	.05	.10	.36	.08	T.	T.	.10	T.								T.	T.							0.97
Intake** ††	Salt					.50	.32	.49	.07	.23	.13	T.		.05	.15										.02								1.96
Jeddito	Little Colorado						.20	.16	.02	.39	.01	.08		.11	.20	.01									.05								1.23
Jerome **	Verde						.45	1.08	.21	.39			.08	.09	.05	.09									T.	T.							2.44
Kayenta	San Juan						T.	T.		.04	.07	.05	.03	.02	.14	.11									.03	.02							0.51
Kingman	Colorado					.40	1.30	.44	.41				.30		T.										.03								2.88
Lee's Ferry**	do						.16			.35	.01				.02	.26																	0.80
Leslie Canyon**	San Pedro						.64	.34	.05	T.	.14	.20																					1.37
Leupp	Little Colorado						.27	T.	T.	.13	.09	.20	T.																				0.69
Maricopa **	Gila					.85	.08	.10	.03	.08	.01	T.	T.			.05																	1.20
Marinette**	Agua Fria						.64	1.06	.25	.29			.12		.01	.07																	2.44
McNary	Salt						.38	.91	.38	.16	.31	.06	.03	.15	.61	.22	.02								.02	.36	T.						3.61
Mesa (Expt. Farm)**	Salt						.54	.41	.43	.11			.11	T.		.15																	1.75
Miami **	Salt						1.05	.85	.80	.12	.20	.05	.05		.05	.25										T.							3.42
Mt. Trumbull	Colorado					.03	.47	.15	.08			T.	.12												.24								1.09
Natural Bridge	Verde						1.43	1.41	.53	.24	.31	.10	.15	.12	.88	.30									.08	.10							5.65
Nogales **	Santa Cruz					.08	.54	.92	.28	.02		.72	.04	.02												.03							2.65
Paradise	Desert						.38	.22	.04		.16	.05	.03			.32										.18							1.38
Parker	Colorado																																
Patagonia	Santa Cruz				T.	.50	.14	.48	.11		.04	.38													T.								1.65
Phoenix ***	Salt					.82	.92	.74	.12	.01	T.		.45		.12	T.									T.								3.18
Pinal Ranch **	Gila						.85	1.12	1.20	.28	.26	.24	.02			.30										.07							4.34
Pinedale	Little Colorado						.54	.66		.05	.25	.02	.01		.12	.06								.04									1.75
Portal	Gila					T.	.62	.18	T.	T.	.14	.05	.03													.04							1.06
Prescott **	Verde					T.	1.00	1.25	.38	.13	.04	.03	.09	.08	.05	.23									.03								3.31
Quartzsite	Colorado					.25	1.00	.30	T.	T.	.43													T.									1.98
Redrock	Santa Cruz					.27	.97	.48	.06	.04	.23	T	.03	T.	T.	.02									T.								2.10
Roosevelt** ††	Salt					.54	.37	.88	.18	.19	.08	.01		.04	.18																		2.47
Ruby**	Santa Cruz					.10	1.03	1.36	.69	T.	T.	.21	.06	.27												.08							3.80
Rucker Canyon	Desert						.73	.58	.03	.04	.26		.04													.25							1.93
Sacaton **	Gila					T.	.59	.32	.43	.04	.03		T.	T.		.04																	1.45
St. Johns	Little Colorado						.03	.32		.12	.20	.36				.30									.15	.04							1.57
Salome (near) ††	Desert				T.	1.00	1.85	1.17	.17	.05	.30	T.	.52											T.									5.06
San Rafael **	Santa Cruz				.04	.82	.52	.11	.05		.58	.06	.18												.03								2.39
San Simon	Gila						.29	.08	.29	.08	.05					.06									T.	.15							1.00
San Vicente**	Santa Cruz																																
Santa Marg. **	Santa Cruz				.35	1.24	.54	.42	.02	.48	.19	.02	.21	.02												.25							3.74
Seligman	Verde						.25	.10	.25						.10																		0.70
Snowflake	Little Colorado							.03	T.	T.	T.	.34	T.	T		.10									.12		.30						0.89
Springerville**	Little Colorado						T.	.05		T.		.20	.42			.30	.10			.20						.20							1.47
Stephens Ranch	San Bernardino					.47	.17				.21																						0.85
Superior**	Gila					.78	.70	.73	.22	.18	.22	T.	T	T.	.36										.03								3.22
Sycamore R. S.	Agua Fria						1.10	1.50	.52	T.	.21		.62		.22																		4.17
Tempe No. 2 **	Salt						.75	.58	.33	.29			.10	T.		.24																	2.29
Thatcher **	Gila					.35	.37	.35	.08		.10				.25																		1.45
Tombstone	San Pedro					.29	.36	.24		.01	.34	.14	.03													.11							1.52
Tonto Ranger Sta.**	Williams																																
Truxton	Desert					.27	1.37	.30	.66		.01		.54		.03									.14	T.								3.32
Tuba City	Little Colorado					T.	.28	.03	.07	T.	T.		.08		.03																		0.47
Univ. of Arizona**	Santa Cruz					.15	.83	.88	.15		.35	T.	T.			.08										.04							2.43
Wallace Ran. Sta.**	Verde																																
Walnut Creek**	Verde						.84	.95	.14	.20			.12			.12									T.								2.37
Walnut Grove	Hassayampa					.10	1.65	1.00	.55	.30	.20	.10	.05	.02	.03																		4.00
Wickenburg**	do																																
Wikieup	Williams					1.77	.81	.08		.32	.64																						3.62
Willcox (near)**	Desert						.60	.24	.23	.07		.12				.10										.15							1.51
Williams **	Colorado						.38	.60	.04	.15		T.	.16	T.	.12	.15									.06								1.66
Winslow***	Little Colorado					.11	.33	T.	.08	.02	.26	.34	.02		.03										T.								1.19
Wittmann	Hassayampa						.85	.14	.62	.28		.02		.21		.03																	2.15
Yeager Canyon	Verde					‡	‡	‡	‡	1.80	.02	‡	.12	‡	‡	.11									.04								2.09
Young**	Salt																																
Yuma Wea. Bur.***	Colorado		T.		.06	.08	.22	.07	T.	.11			.12												T.								0.66

‡ Included in following measurement.

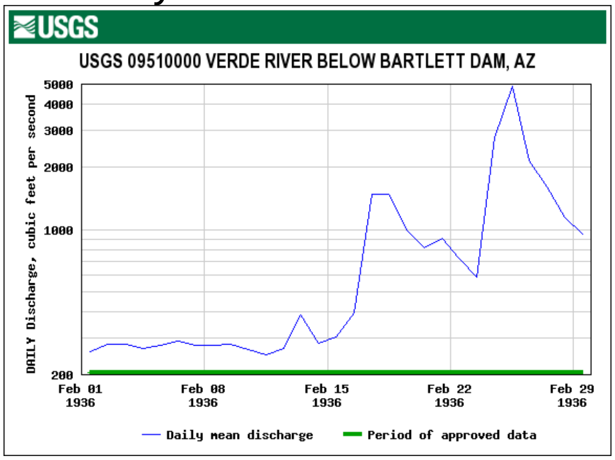
Weather Bureau, 1935, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 39, Phoenix, AZ, Feb. 1935. No. 2, 8 p. (page 7)

Daily Temperatures for February, 1935

Stations		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean
Ajo	Maximum	77	75	76	77	67	63	61	68	58	62	63	58	62	64	58	54	67	76	88	84	79	78	88	59	57	65	74	81	....	....	....	68.7
	Minimum	51	68	53	54	56	54	49	47	46	43	45	43	44	45	46	40	41	40	48	52	53	51	54	42	40	40	41	46	....	....	....	47.6
Ashfork	Maximum	66	60	69	65	63	52	44	41	46	49	47	49	49	46	41	50	71	75	77	73	70	68	67	46	44	58	68	63	....	....	....	57.8
	Minimum	31	30	28	23	35	38	31	33	32	31	29	33	34	35	21	17	26	30	30	31	33	27	34	24	16	14	15	22	....	....	....	28.0
Bisbee	Maximum	61	57	63	67	66	57	51	51	59	53	49	46	51	55	50	50	63	67	74	75	77	72	72	63	47	52	59	72	....	....	....	60.0
	Minimum	44	41	40	37	47	42	38	37	32	28	34	32	29	37	38	28	29	45	39	40	42	42	40	38	26	25	29	33	....	....	....	36.1
Clifton	Maximum	77	72	73	76	74	67	63	59	65	64	57	59	55	56	56	60	67	75	80	83	81	80	78	70	57	60	71	75	....	....	....	68.2
	Minimum	45	41	34	45	45	50	41	44	38	42	41	36	36	45	39	31	34	36	41	48	48	48	48	39	37	30	35	40	....	....	....	40.6
Douglas§§	Maximum	59	59	66	69	63	60	56	55	58	54	51	52	56	61	57	52	63	70	74	76	77	73	69	54	49	58	64	71	....	....	....	61.6
	Minimum	48	47	36	33	48	47	45	38	37	36	39	35	32	40	40	28	24	29	31	34	37	38	33	37	32	24	25	28	....	....	....	35.6
Flagstaff	Maximum	46	46	52	54	48	39	35	34	37	39	38	41	35	37	32	41	54	59	59	60	56	56	45	33	29	45	50	53	....	....	....	44.8
	Minimum	35	37	18	17	27	32	31	27	25	21	21	26	30	28	15	14	14	23	22	25	28	21	25	19	1	3	11	20	....	....	....	21.8
Ganado	Maximum	51	52	52	57	59	52	42	37	39	39	42	40	40	36	32	30	44	50	58	65	60	56	54	46	35	42	51	57	....	....	....	47.1
	Minimum	27	21	19	20	22	35	31	28	31	26	30	27	26	27	15	10	17	22	25	29	32	23	28	24	16	7	14	36	....	....	....	23.9
Globe	Maximum	66	62	63	66	64	58	49	55	55	46	51	51	50	55	49	53	62	65	73	71	70	71	64	56	49	52	60	63	....	....	....	58.9
	Minimum	40	42	30	32	41	43	39	36	42	36	37	37	34	41	29	24	25	31	31	36	35	34	36	37	28	23	28	35	....	....	....	34.4
Grand Canyon	Maximum	41	42	44	46	41	36	38	35	35	38	42	38	37	38	36	45	47	49	60	62	55	56	47	31	38	32	45	54	....	....	....	42.8
	Minimum	32	32	35	34	32	33	29	28	27	25	26	24	25	22	16	11	17	27	28	30	35	33	32	20	12	6	16	18	....	....	....	25.2
Henry's Camp	Maximum	57	61	63	61	57	52	40	44	47	47	47	47	37	42	33	45	57	61	69	66	62	62	55	38	38	47	58	60	....	....	....	51.9
	Minimum	28	22	18	20	26	35	32	32	32	26	23	26	38	16	7	16	22	24	27	27	26	26	26	9	7	12	18	32	....	....	....	23.1
Holbrook	Maximum	57	62	57	61	58	52	48	45	49	45	42	48	47	48	41	44	52	57	60	68	65	64	63	52	38	48	56	64	....	....	....	53.2
	Minimum	24	23	20	21	24	36	38	33	33	34	36	32	36	38	25	22	24	28	35	42	38	33	38	31	25	21	28	36	....	....	....	30.4
Jeddito	Maximum	58	57	63	59	62	51	45	46	48	44	42	47	43	40	39	42	50	60	65	68	60	62	57	49	45	45	55	59	....	....	....	52.2
	Minimum	22	17	31	26	29	31	32	25	26	26	29	25	26	27	15	12	16	23	27	31	35	25	28	22	15	6	15	25	....	....	....	23.8
Kayenta	Maximum	58	55	55	54	52	53	49	46	46	44	46	44	44	43	37	43	52	62	66	62	63	58	57	52	39	45	47	45	....	....	....	50.4
	Minimum	25	23	22	21	23	33	36	25	31	31	31	29	30	25	21	18	22	27	30	29	39	27	31	26	20	15	18	21	....	....	....	26.0
Lee's Ferry	Maximum	61	63	64	62	59	54	54	60	56	57	59	58	59	58	52	52	55	57	62	65	65	74	66	68	47	49	56	58	....	....	....	58.9
	Minimum	26	27	26	25	27	37	36	39	39	37	37	38	39	36	33	25	26	28	30	32	36	32	35	37	31	21	23	26	....	....	....	31.6
Natural Bridge	Maximum	65	65	68	67	62	55	45	44	52	47	47	52	49	42	46	50	64	69	75	71	69	69	63	51	43	54	62	63	....	....	....	57.5
	Minimum	40	42	31	32	44	42	34	37	34	32	35	34	35	39	28	25	30	34	35	41	42	37	38	32	23	19	28	31	....	....	....	34.1
Nogales	Maximum	64	66	74	75	61	57	52	57	61	51	56	55	56	60	57	55	65	75	80	81	75	77	69	54	53	62	70	77	....	....	....	64.1
	Minimum	51	49	40	41	44	46	44	40	35	36	35	35	33	36	41	29	27	32	38	41	40	41	39	34	31	26	29	31	....	....	....	37.8
Parker	Maximum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	......
	Minimum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	......
Phoenix	Maximum	79	77	78	79	71	67	64	62	62	61	65	65	64	63	61	63	68	75	81	83	79	78	75	60	58	63	73	74	....	....	....	69.6
	Minimum	56	60	50	45	55	55	48	48	45	47	46	49	46	52	41	40	36	43	45	50	49	47	50	42	37	36	35	41	....	....	....	46.2
Pinedale	Maximum	52	57	54	60	59	50	40	43	43	45	45	45	40	40	35	33	47	56	60	65	64	64	61	45	43	45	53	59	....	....	....	50.1
	Minimum	22	21	17	18	24	37	32	25	30	31	27	27	31	33	14	17	20	21	25	26	27	27	26	8	9	15	11	19	....	....	....	22.8
Prescott	Maximum	60	58	64	65	54	39	43	41	50	41	46	49	42	44	40	41	60	66	72	71	65	68	55	44	40	55	62	64	....	....	....	53.5
	Minimum	32	20	21	35	40	32	31	27	42	27	30	30	36	20	12	18	23	26	27	32	25	30	27	15	10	14	20	34	....	....	....	26.3
Red Rock	Maximum	78	75	78	79	72	62	61	63	63	61	59	63	63	64	58	59	66	74	80	85	79	78	74	68	57	63	73	79	....	....	....	69.1
	Minimum	51	53	47	44	54	54	50	45	45	47	44	45	42	45	44	35	29	34	40	42	42	42	40	37	34	30	29	41	....	....	....	42.3
Sacaton	Maximum	79	77	80	82	73	66	58	62	62	60	65	65	64	63	59	59	67	74	80	83	79	78	76	60	58	64	75	78	....	....	....	69.5
	Minimum	40	55	53	47	52	53	48	39	42	44	42	45	42	45	41	34	29	33	41	44	46	48	43	40	34	27	28	44	....	....	....	41.9
Salome (*near*)	Maximum	76	73	76	76	59	61	61	58	58	59	62	64	61	66	57	61	70	80	83	79	77	81	68	59	58	66	72	70	....	....	....	67.5
	Minimum	44	50	40	38	52	53	48	46	38	46	42	42	40	41	43	41	38	37	40	42	42	42	41	39	32	26	30	35	....	....	....	40.8
St. Johns	Maximum	57	62	67	64	64	59	57	49	48	50	50	52	49	48	37	42	50	62	63	74	67	63	61	51	31	43	61	62	....	....	....	55.1
	Minimum	18	19	18	16	20	36	35	28	30	32	25	28	28	34	16	8	20	20	23	28	28	22	35	38	22	14	10	25	....	....	....	23.6
Tombstone	Maximum	61	60	68	69	63	57	55	54	60	52	52	49	55	58	51	50	62	68	72	74	75	76	67	56	47	55	62	71	....	....	....	60.7
	Minimum	46	46	37	42	47	44	40	38	36	34	34	35	32	38	41	26	27	37	38	40	44	44	44	33	28	27	32	35	....	....	....	39.3
University of Arizona	Maximum	67	68	75	78	71	58	56	59	60	55	60	80	62	65	54	58	61	72	82	85	77	78	75	62	58	61	68	73	....	....	....	66.7
	Minimum	58	56	50	54	54	50	48	44	40	44	42	43	40	47	47	32	29	33	38	43	43	41	41	38	36	29	43	46	....	....	....	43.2
Wickenburg	Maximum	....	....	....	....	....	....	....	....	....	66	65	63	62	61	63	63	69	79	88	82	81	79	71	57	57	66	76	74	....	....	....	69.6[1]
	Minimum	....	....	....	....	....	....	....	....	....	34	40	37	39	34	34	31	34	36	38	38	38	37	29	27	27	24	27	32	....	....	....	33.5[1]
Williams	Maximum	57	49	57	58	52	46	42	40	40	44	39	44	36	40	34	42	52	62	66	63	59	62	48	36	30	47	55	59	....	....	....	48.5
	Minimum	24	35	34	22	27	34	31	29	22	19	20	22	29	31	12	12	20	24	23	28	31	22	30	21	9	6	12	20	....	....	....	23.2
Winslow	Maximum	60	56	55	60	58	54	49	48	49	44	47	50	49	50	42	42	55	60	64	75	65	61	60	44	39	46	56	62	....	....	....	53.6
	Minimum	24	22	20	20	25	29	35	33	31	34	35	32	36	39	23	18	21	24	25	30	38	26	30	29	21	12	16	22	....	....	....	26.8
Yuma	Maximum	81	78	80	78	63	69	68	69	62	65	68	66	70	72	65	66	73	81	85	85	81	83	74	64	64	69	78	74	....	....	....	72.5
	Minimum	57	63	59	56	56	57	51	52	51	51	48	50	44	47	58	47	43	45	49	49	50	48	49	45	43	43	41	44	....	....	....	49.7

Weather Bureau, 1935, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 39, Phoenix, AZ, Feb. 1935. No. 2, 8 p. (page 8)

February 1936



WBO.Reno, 4-2-36—960

2 **ARIZONA SECTION**

W. B. HARE

VOL. XL PHOENIX, ARIZ., FEBRUARY, 1936 No. 2

GENERAL SUMMARY

Temperatures during February averaged somewhat below normal while precipitation was decidedly above normal. The number of cloudy days and days with rain was considerably above normal, but clear, dry weather during the latter part of the month brought the average relative humidity down to approximately normal figures.

The month was characterized by extremes. Temperatures during the first few days were quite cold, with killing frosts generally over the State on the 4th, 5th and 6th and with a minimum as low as five degrees below zero recorded at Ft. Valley; while during the latter part of February increasing temperatures obtained until the last day of the month, when a maximum of 87° was reached at Gould's Ranch. Great variation in precipitation occurred, as only a trace fell at Agua Caliente and Mohawk but 8.48 inches was recorded at Junipine. However, good soaking falls of great benefit to ranges and water supply covered the State, with heaviest falls in the central highlands and very little rain in the southwest and Painted Desert country of the northeast.

Snowfall was the greatest of the season, although the average of 1.8 inches was 0.6 inch below normal. Some heavy amounts occurred: Ft. Valley, 43.0; McNary, 40.0; Grand Canyon, 23.0; Henry's Camp, 18.7; Alpine, 19 0. At the close of the month the ranges were generally bare but considerable snow remained unmelted on the higher peaks of the east-central and north-central sections so as to make excellent prospects for an adequate water supply during the months following.

Agricultural activities flourished. Lettuce developed well and harvesting was about to begin. Shipments of carrots, cabbage, cauliflower and other vegetables were made, as well as many carloads of citrus fruit. Numerous fruit trees were in bloom in the lower valleys. Livestock continued in good condition and range grass was up in most sections. H. B. H.

Weather Bureau, 1936, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 40, Phoenix, AZ, Feb. 1936. No. 2, 8 p. (page 2)

Daily Precipitation for February, 1936

Stations	Drainage basin	Day of month																															Total
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Northern Arizona																																	
Ashfork	Verde	.02	.40	.14								.11	.22	.03	.02	.26	.32		.04	.19	.01			.14	.06								1.96
Bagdad**	Williams		.19	.31									.13	.12	.05	.41	.69	.27		.38	.09				.02								2.66
Bright Angel R. S.	Colorado																																
Cedar Glade	Verde	.03	.31									.12	.31	.06	.07	.41	.25		.37	.01													1.94
Childs**	do	.05	.39									.04	.04	.01	.22	.55	.45		.26	.15				.68									2.84
Cibecue	Salt		.08	.61								T.	.26	.86	.38	.60	.31	.61	.11	.21	.08				.21	.09							4.40
Clemenceau**	Verde																																
Cordes	Agua Fria		.03	.15								T.	.02	.01	.03	.51	.18	.09	.10	.13	.05	.05		.02	.29	T.							1.66
Crown King	Agua Fria	.54														.70	.59				.61												2.44
Flagstaff*** ††	Little Colorado	.12	.48	.19								.23	.24	.11	.14	.26	.43		.26	.02				.46	.06								2.78
Ft. Defiance**	Little Colorado			.15								.23		.09	.12		.25	.12	.05	.16				T.	.45	.06							1.68
Fort Valley	Little Colorado	T.	.48	.79								.03	.69	.28	.38	.28	.41	.51	.04	.27	.08			T.	.38								4.52
Ganado	Little Colorado	T.	T.	.15								.06	.08	.04	.14	.08	.05	.07	.06	.29				T.	.40								1.45
Gisela**	Salt	.15	.29									.12	.10	.05	T.	.83	.24	.04	.07					.26	T								2.15
Grand Canyon**	Colorado	.06	.33									.07	.33	.17	.11	.19	.26	.26	.07	.21	.03				.59								2.72
Holbrook	Little Colorado			T.							.09		.06	.03	.01	.14	.16	.04							.16								0.69
Jeddito	Little Colorado			.13								.16	.24	.08	.04	.14	.12	.13	.21	.08					.08								1.31
Jerome**	Verde			.60									.43	.07	.18	.21	.51	.35	.02	.14	.07				.41	.01							2.95
Junipine	Verde	.04	.81	.65								T.	.79	.22	1.36	1.12	1.65	.40	.05	.56	.17			.15	.51								8.48
Kayenta	San Juan			.23								T.	.06												.02	.23							0.54
Kingman	Colorado		.65									.20	.34	.12	.26	.38	.25		.21	.07		.02			.03								2.47
Lee's Ferry**	do			.19									.04				T.	.16	T.	.09	T.			.05	.31								0.84
Leupp	Little Colorado		T.	.15									T.				.18	.01		T.				T.	.04								0.83
McNary	Salt	.11	.50	.71									.42	1.52	.62	.12	.83	.49	.10	.23	.23					.89							6.77
Mt. Trumbull	Colorado											.03	.20	.41	.11	.16	.51		.08		.03			.45									1.98
Natural Bridge	Verde		.25	.48								T.	.15	.15	.08	.93	1.05	.25		.34	.30				1.01								4.99
Pinedale	Little Colorado		T.	.79								.04	.27			.05		.39	.02	.06	.01				.80								1.93
Prescott**	Verde		.07	.74									.39	.15	.08	.88	.49	.67		.28	.07				.18								3.50
St. Johns	Little Colorado											T.		.41				.09	.05					.08	.09								0.72
Seligman	Verde																																
Snowflake	Little Colorado			.14										.18		T.																	0.32
Springerville**	Little Colorado													.60				.52				.15											1.27
Sycamore R. S.	Agua Fria		.27		.18									.05	.05	.83		.42			.10				.94								3.14
Tonto Ranger Sta.**	Williams																																
Truxton	Desert	.06	.38									.20	.20	.18	.08	.40	.31		.20	.24				.10									2.25
Tuba City	Little Colorado															.08	.04		.06	.19													0.37
Wallace Ran. Sta.**	Verde												.10	.09	.18	.12	.25	.48		.03	.08				1.57	.05							1.90
Walnut Creek**	Verde	.13	.33										.82	.07	.16	.32	.17	.23		.17					.31								2.21
Walnut Grove	Hassayampa		.75											.04	.14	1.06	.36		.21	.23				.07	.14								3.00
Wikieup	Williams												1.13					.13					.45	.10	T.								1.81
Williams**	Colorado		.28	.41									.42	.08	.15	.24	.87	.39	.09	.51	.25		.01		.22								3.37
Winslow***	Little Colorado		.06	T.								T.	.08		.01	T.	.12		.06	T.				.10	.10								0.54
Yeager Canyon	Verde			.29									.30			.47		.44			.39			.11									2.00
Young**	Salt											.25	.65	.40	.10	.25	.20	.35	.20						.65	.10							3.15
Southern Arizona																																	
Aguila	Desert		T											.04		.15	.13		.07	.06													0.45
Ajo**	do			.03									T.				.03	T.		.25													0.31
Alamo Ran. Sta.	Salt		.20										.20	.60	.30	.50	.32			.16	.16				.28								2.67
Apache Powd'r Co**	San Pedro			.06								.01				.17			.52	.02													0.78
Ashdale Ran. Sta.	Agua Fria	.05	.92									T.		.86		.90	1.01		.24	.31					.82								4.61
Benson**	San Pedro			.11													.30	.02		.72	.02												1.17
Bisbee	Desert	.03		.04								.01	.10	.03		.32	.15	.01		.15													0.84
Bowie	Gila															.30																	0.30
Buckeye	Gila			.04									.12	.11		.26	.04		.04	.02													0.63
Camel Back	Salt			.10									.02	.27	.03	.17	.09	.05	.03			.12			.10								1.08
Canille**	San Pedro																																
Casa Grande**	Santa Cruz										.05	.12		.05	.20			.20	.05						.08								0.75
Castle Hot Springs**	Agua Fria																																
Clifton	Gila												.38	.27	.04	.13	.24	.24															1.30
Douglas**	Yaqui											T.				.04																	0.04
Eagle Creek R.S.**	Gila																																
Elgin (near)**	San Pedro		.18										.05	.03		.30				.40													0.96
Fairbank	do			.02								T.		.02		T.	.25			.15										T.			0.44
Florence	Gila			.32									.25	.24		.48			.05	.20	.06				.02								1.57
Fort Grant**	Desert											.14	.31	T.		.65			.09			.12											1.31
Gila Bend	Gila												.22	.25	T.	T.																	0.47
Globe	Salt		.02	.16									.38	1.28	.07	.41	.17	.33		.36	.03				.09	.02							3.32
Helvetia**	Santa Cruz	T.	.25									.08	T.	.05		.50			.99														1.87
Henry's Camp**	Salt	.08	.48			T.						.18	.71	.80	.04	.42	1.13	.32	.31	.35	.19				.68	.12							5.81
Intake**	Salt			.09									.22	.57	.07	.03	.72	.31		.16	.13				T	.35							2.65
Leslie Canyon**††	San Pedro															.24			.15														0.39
Maricopa**	Gila		T.										.23			.27	T.		.04	.02					T.								0.56
Marinette**	Agua Fria																																
Mesa (Expt. Farm)**	Salt		.01	.06									.09	.56	.01	.03	.07	.09		.17	.08				T.								1.17
Miami**	Salt			.25									.37	1.95	.08	.10	.72	.58		.32	.20				T.	.20							4.77
Nogales**	Santa Cruz			.16								.06	.12		.21	.05																	0.59
Paradise	Desert	.04		.12									.13		.06	.29	.22	.05		.63													1.54
Patagonia	Santa Cruz			.46								.04		.11	.08	.27	.07	.18															1.21
Phoenix***	Salt		T.	.12								T.	.55	.01		.17	.06		.03	.02					.05								1.01
Pinal Ranch**	Gila			.66									.64	1.32	.12	.73	1.53	1.25		.48	.40					.28							7.41
Portal	Gila			.12								T.	T.	.13	.06	.12	.43	.03			.47												1.36
Quartzsite	Colorado																.15																0.15
Redrock	Santa Cruz																																
Roosevelt**	Salt			.19									.29	.80	.13	.02	.65	.65		.26	.07				.12	.03							3.21
Ruby**	Santa Cruz			.40									.08	.10	.04	T.	.24	.03		.03													0.92
Rucker Canyon	Desert	.11														.79				.66													1.56
Sacaton**	Gila			.11										.59			.85			.66			.08	.07		.02							1.72
Salome (near)	Desert	T.	T.									T.		.07		.21	.06		.04	.05	.02				.15								0.60
San Rafael**	Santa Cruz			.18								.06	.04	.18		.33	.05		.18														1.02
San Simon	Gila			.12										T.	.01		.55			.14	.06												0.88
Santa Marg.**	Santa Cruz	T.	.52									.01	T	T.	T.	.17			.95														1.65
Stephens Ranch	San Bernardino	.03															.15																0.18
Superior**	Gila	.88										.84	.50	.04	.03	.94	.75		.43	.25	.01			.06	.15								3.87
Tempe No. 2**	Salt	T.		.09									.07	.56	T.	.04	.12	.04	.10	.09					T.								1.11
Thatcher**	Gila											.16		.04	.08	.36			.16	.17													0.97
Tombstone	San Pedro													.12			.42			.21	.04												0.79
Univ. of Arizona**	Santa Cruz	T.		.26								T.	.06	T.		.30	.15			.04	.12												0.92
Wickenburg**	Hassayampa				.03									.05		.26	.16	.05		.16	.06				.13								0.90
Willcox (near)**	Desert																																
Wittmann	Hassayampa			.21									.03			.21	.15	.15		.10	.03				.26								1.14
Yuma Wea. Bur.***	Colorado	T.										T.	T.			.08			.07					.03									0.18

‡ Included in following measurement

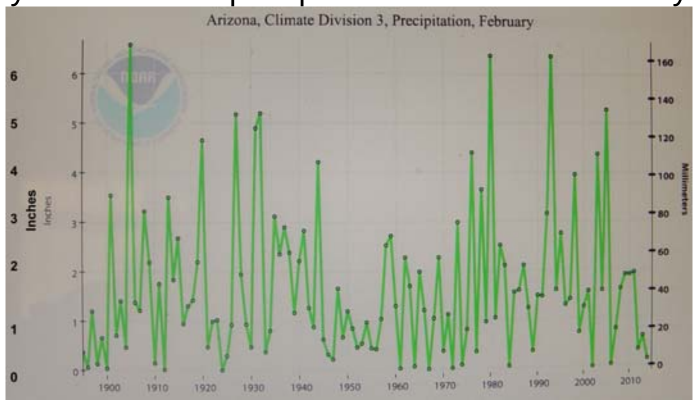
Weather Bureau, 1936, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 40, Phoenix, AZ, Feb. 1936. No. 2, 8 p. (page 7)

Daily Temperatures for February, 1936

Stations		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Mean
Ajo	Maximum	68	66	59	60	59	61	67	68	70	71	72	70	68	67	65	67	70	66	64	66	73	78	78	62	60	69	76	80	78	....	....	68.0
	Minimum	48	50	42	41	38	36	36	41	41	42	43	51	49	49	49	48	41	41	44	44	45	44	45	49	48	46	47	50	52	....	....	44.8
Ashfork	Maximum	48	46	40	44	43	52	51	56	62	62	58	55	54	47	45	50	54	49	41	47	57	58	57	49	54	62	67	67	70	....	....	53.3
	Minimum	37	34	16	11	14	12	16	18	16	21	33	33	32	36	31	29	22	29	30	32	24	29	35	34	24	21	21	17	32	....	....	25.4
Bisbee	Maximum	52	59	54	56	50	52	59	61	62	62	61	60	55	50	52	52	58	58	52	53	62	70	70	62	60	57	63	68	68	....	....	58.6
	Minimum	44	38	33	29	34	23	29	31	32	31	35	42	38	36	36	35	37	38	33	34	31	36	45	43	41	31	31	35	37	....	....	35.0
Clifton	Maximum	60	64	67	60	59	60	64	78	69	69	70	63	61	60	60	54	65	67	62	59	71	80	77	70	66	71	74	78	81	....	....	66.9
	Minimum	44	44	39	38	30	29	28	29	32	34	37	43	42	42	37	39	36	41	40	40	36	41	42	41	46	35	40	41	44	....	....	38.3
Douglas§§	Maximum	64	67	57	64	57	57	67	67	67	67	68	67	61	63	58	68	64	68	59	62	69	75	72	72	61	65	68	74	74	....	....	65.4
	Minimum	50	33	39	32	26	21	24	24	23	24	29	43	40	41	42	35	40	38	35	39	29	32	39	44	42	26	24	26	30	....	....	33.6
Flagstaff	Maximum	38	36	30	34	35	38	40	46	51	52	39	43	36	38	36	35	42	37	37	40	50	53	39	38	41	45	53	57	54	....	....	41.8
	Minimum	35	24	10	4	5	7	18	16	19	14	30	32	29	32	30	27	11	24	26	20	12	25	33	30	22	12	12	12	23	....	....	20.5
Ganado	Maximum	48	48	42	33	33	38	45	46	50	52	39	49	45	40	41	44	45	44	41	44	52	57	49	42	43	45	53	60	57	....	....	45.7
	Minimum	31	36	16	8	10	9	16	17	15	14	21	33	30	31	30	30	17	28	17	23	21	27	37	31	27	15	17	17	19	....	....	22.2
Globe	Maximum	60	60	56	49	50	54	55	57	59	60	60	58	58	54	52	55	56	60	51	55	60	63	68	61	58	61	64	65	70	....	....	58.1
	Minimum	45	48	35	29	25	26	25	25	26	27	32	44	42	43	39	40	37	40	39	39	32	32	40	48	39	31	31	29	33	....	....	35.2
Grand Canyon	Maximum	37	35	28	31	31	37	41	42	44	47	35	43	34	38	32	33	41	37	32	39	45	49	43	35	39	43	51	47	48	....	....	39.2
	Minimum	26	31	12	8	8	12	16	19	18	22	23	30	26	26	28	28	19	20	25	24	23	26	31	25	19	17	17	20	25	....	....	21.5
Henry's Camp	Maximum	47	49	39	43	41	42	47	51	53	55	51	51	37	42	44	40	47	48	41	41	57	62	55	42	47	54	59	61	60	....	....	48.5
	Minimum	33	36	22	15	14	14	13	17	18	18	22	29	32	32	30	32	17	25	30	25	19	22	28	33	32	17	17	17	24	....	....	23.6
Holbrook	Maximum	52	51	52	45	45	48	52	51	56	59	59	55	51	50	53	54	52	50	50	50	61	66	65	56	51	61	57	65	65	....	....	54.2
	Minimum	36	32	21	16	15	16	20	20	19	19	26	39	34	37	33	30	27	35	30	29	25	27	36	40	35	22	21	21	25	....	....	27.1
Jeddito	Maximum	49	49	46	47	36	41	46	46	51	51	49	48	46	51	43	45	46	46	45	45	56	58	56	54	51	51	53	63	60	....	....	49.2
	Minimum	31	32	16	7	10	8	16	14	16	18	26	31	26	30	28	26	16	27	27	23	23	28	36	31	28	19	19	23	31	....	....	22.9
Kayenta	Maximum	58	50	44	37	40	40	40	43	53	55	56	51	50	52	46	45	50	46	43	47	53	56	52	44	45	47	48	57	59	....	....	48.3
	Minimum	28	35	20	18	22	20	25	18	20	22	33	31	38	35	33	32	29	31	32	29	30	30	39	32	29	33	35	23	25	....	....	28.2
Lee's Ferry	Maximum	49	55	61	47	50	50	56	60	56	59	43	56	68	61	63	59	61	62	56	55	62	63	62	58	55	58	52	64	61	....	....	57.3
	Minimum	32	39	30	23	24	25	32	33	24	23	34	39	41	43	44	41	35	41	37	36	33	39	44	42	30	32	30	30	30	....	....	34.0
Natural Bridge	Maximum	52	52	49	47	46	48	50	57	58	60	53	55	50	45	46	44	55	50	46	48	60	63	57	52	53	59	64	66	69	....	....	53.6
	Minimum	38	44	26	25	24	24	25	28	29	29	34	40	39	40	34	36	31	33	33	33	32	38	40	42	36	29	29	35	40	....	....	33.3
Nogales	Maximum	61	64	57	62	56	61	65	68	69	66	69	65	68	61	55	60	67	65	59	78	75	78	72	72	60	69	74	76	75	....	....	65.9
	Minimum	46	40	39	32	30	26	26	29	29	31	35	39	45	41	42	41	39	40	38	34	33	35	39	44	46	31	31	32	35	....	....	36.1
Parker	Maximum	71	76	74	71	65	75	70	73	72	73	75	72	72	73	71	73	71	68	63	72	77	78	72	72	71	75	80	83	83	....	....	73.1
	Minimum	44	52	36	31	29	28	35	32	32	34	46	48	43	46	51	51	39	44	38	41	44	49	46	47	37	36	37	36	42	....	....	40.5
Phoenix	Maximum	72	71	61	60	61	62	65	69	69	70	65	69	67	67	64	67	68	64	62	68	72	77	69	64	68	74	76	78	83	....	....	68.3
	Minimum	52	52	42	39	34	35	36	37	37	40	44	48	48	52	50	50	44	48	45	49	42	46	53	54	50	39	41	41	42	....	....	44.5
Pinedale	Maximum	45	45	40	42	40	44	45	40	53	58	55	41	38	36	40	38	50	47	41	43	55	62	59	46	47	47	57	62	55	....	....	47.2
	Minimum	38	37	20	19	15	13	12	15	20	18	23	30	20	18	32	33	8	26	26	20	21	26	33	33	32	20	17	15	23	....	....	22.9
Prescott	Maximum	51	49	42	40	43	49	49	52	56	59	48	52	43	48	38	41	52	49	41	51	60	60	48	48	51	56	62	66	66	....	....	50.7
	Minimum	37	30	18	12	12	12	23	18	18	17	28	37	32	34	32	31	22	25	28	30	23	27	43	35	26	17	17	17	18	....	....	25.1
Red Rock	Maximum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
	Minimum	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
Sacaton	Maximum	70	68	59	60	59	61	65	67	68	68	69	70	65	67	65	66	67	65	62	65	70	75	74	64	67	69	75	77	75	....	....	67.3
	Minimum	47	47	36	32	29	29	30	30	34	33	37	48	48	50	48	46	40	42	41	44	39	39	44	53	48	33	32	33	36	....	....	39.9
St. Johns	Maximum	53	53	57	44	41	44	52	52	52	61	52	53	47	43	41	41	56	51	47	42	62	72	53	52	52	53	62	67	64	....	....	52.4
	Minimum	36	37	30	15	14	15	20	21	16	21	26	28	32	26	27	26	26	32	31	30	22	32	37	34	25	20	16	15	20	....	....	25.2
Salome (*near*)	Maximum	68	66	59	60	61	65	64	71	72	74	67	70	72	68	65	67	68	62	59	70	73	74	65	67	65	72	80	82	84	....	....	68.6
	Minimum	45	47	34	28	26	24	25	28	30	31	38	43	42	40	48	42	35	38	34	37	36	43	52	48	35	33	37	33	38	....	....	36.9
Tombstone	Maximum	60	64	54	57	52	55	61	62	61	64	64	64	56	60	55	59	60	64	56	55	66	74	71	67	64	62	67	72	72	....	....	62.0
	Minimum	46	38	33	30	30	24	28	32	33	32	35	30	42	38	39	37	37	40	35	35	33	38	45	42	36	30	37	37	41	....	....	35.6
University of Arizona	Maximum	67	70	56	60	59	60	65	65	65	68	72	72	63	66	62	66	66	68	62	63	70	79	75	70	69	68	74	80	79	....	....	67.6
	Minimum	49	45	44	32	27	27	28	28	29	30	34	48	48	45	45	45	42	42	42	44	35	39	48	49	46	30	32	32	36	....	....	38.7
Wickenburg	Maximum	64	64	56	59	59	62	63	69	71	71	65	65	61	65	61	58	66	59	54	64	71	72	60	58	60	77	78	76	76	....	....	65.0
	Minimum	43	44	32	26	23	25	24	26	26	28	36	41	37	42	46	39	35	36	36	36	34	38	44	46	44	32	34	33	36	....	....	35.3
Williams	Maximum	43	38	30	33	34	39	41	46	49	51	42	46	36	42	39	37	43	41	38	43	50	52	42	40	42	46	53	58	56	....	....	43.1
	Minimum	29	34	14	5	6	6	8	15	15	12	14	33	28	29	31	30	13	20	26	26	14	23	37	31	24	18	19	14	18	....	....	20.4
Winslow	Maximum	58	54	39	43	41	49	53	52	56	58	55	58	51	53	51	51	54	54	48	58	63	68	63	53	53	53	59	63	63	....	....	54.1
	Minimum	38	40	28	16	15	17	26	23	20	20	31	40	34	38	38	29	27	33	23	25	24	29	36	36	36	23	21	22	27	....	....	28.1
Yuma	Maximum	72	75	64	65	65	67	69	73	74	74	77	75	72	71	71	75	72	66	69	72	76	82	76	67	71	76	80	84	83	....	....	72.9
	Minimum	48	47	43	42	37	32	36	41	38	41	48	49	51	53	52	50	46	45	44	44	48	52	56	54	47	47	49	44	59	....	....	46.8

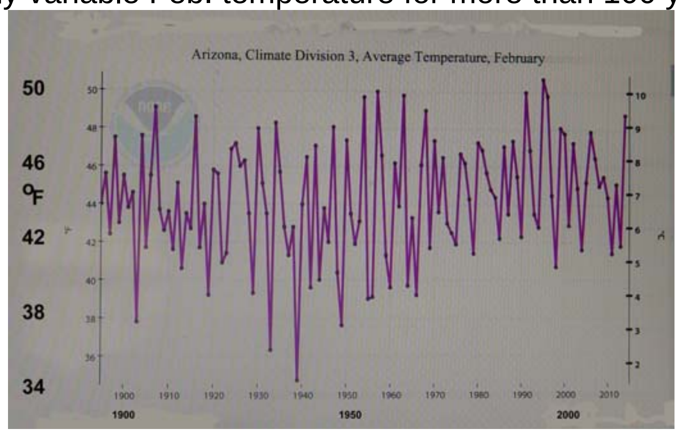
Weather Bureau, 1936, CLIMATOLOGICAL DATA, USDA, Arizona Section, ARIZONA; Volume 40, Phoenix, AZ, Feb. 1936. No. 2, 8 p. (page 8)

Highly variable Feb. precipitation for more than 100 years.



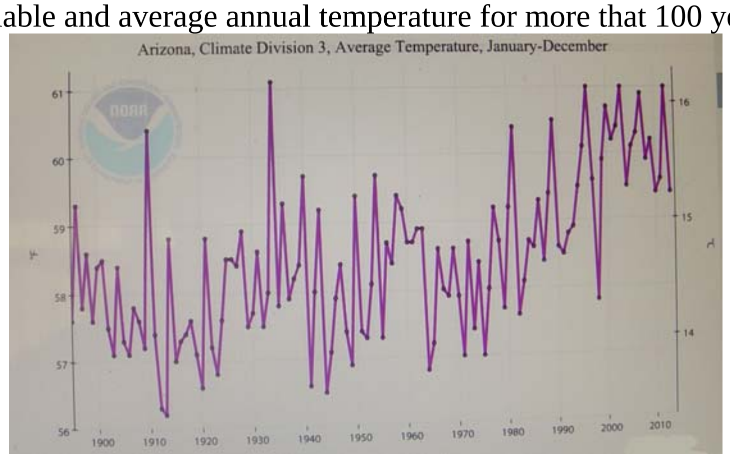
http://www.ncdc.noaa.gov/cag/time-series/us

Highly variable Feb. temperature for more than 100 years.



http://www.ncdc.noaa.gov/cag/time-series/us

Variable and average annual temperature for more that 100 years.



http://www.ncdc.noaa.gov/cag/time-series/us

As part of a USGS study of base flow in the Verde Valley stream flow records at the Clarkdale and Camp Verde gages were used that showed base-flow conditions (See figure below from Garner, B.D., and Bills, D.J., 2012, (page 10). There was no evidence of precipitation, storm-related runoff, or substantial snowmelt-related runoff during any survey that included a February 2011 survey.

Garner, B.D., and Bills, D.J., 2012, Spatial and seasonal variability of base flow in the Verde Valley, central Arizona, 2007 and 2011: U.S. Geological Survey Scientific Investigations Report 2012–5192, 33 p.

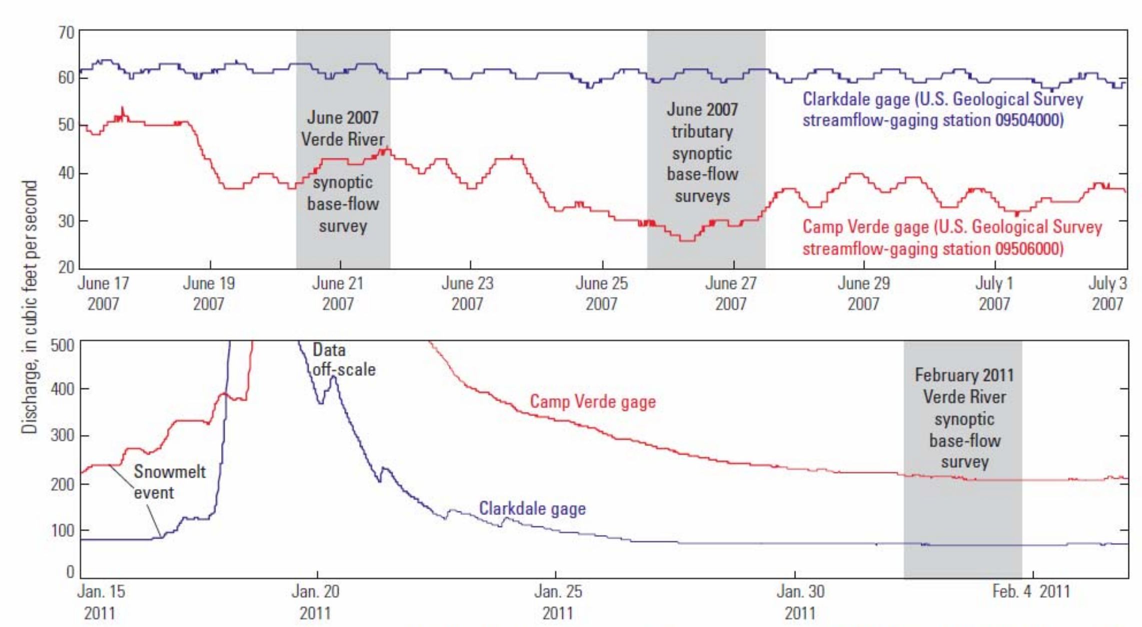


Figure 7. Instantaneous discharge at U.S. Geological Survey streamflow-gaging stations 09504000 and 09506000, June-July 2007 and January-February 2011, central Arizona.

By the way, note the relative amounts of base flow for the summer and winter periods for Clarkdale gage and Camp Verde gages

<u>Summary for this example using annual, USGS and 1933-36 hydrologic data:</u>
The above hydrologic data clearly show the variability of February stream flow, temperature and precipitation of the Verde River and watershed. If I were to select one word to describe precipitation, temperature and especially stream flow in Arizona, the word would be variable. Contrary to assertions by Mr. Hood there are many periods of base flow along the Verde River in the month of February.

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I respectfully submit the above to ANSAC.

SUPPLEMENT 4. Hydrologic data and GLO survey field notes related to GLO surveys of Feb.-Mar. 1911 that show most, if not all, measured depths of flow were for base flow conditions.

The purpose of this supplement is to show how I identified any depths of flow in the Verde River measured during GLO surveys of Feb. and Mar. 1911 that were not for base flow conditions. The reason for this examination is because several depths of flow were measured and there was rain in the watershed in early Feb. 1911 and moderate floods on the upper Verde River on Mar. 6-8, 1911. The following are the hydrologic data related to the GLO land surveys of Feb. and Mar., 1911 for T3N R7E (see p. 11 of my Addendum of Nov. 14, 2014) and T4N R7E (see pp 66-67 of Appendix G3c and p. 8 of Addendum).

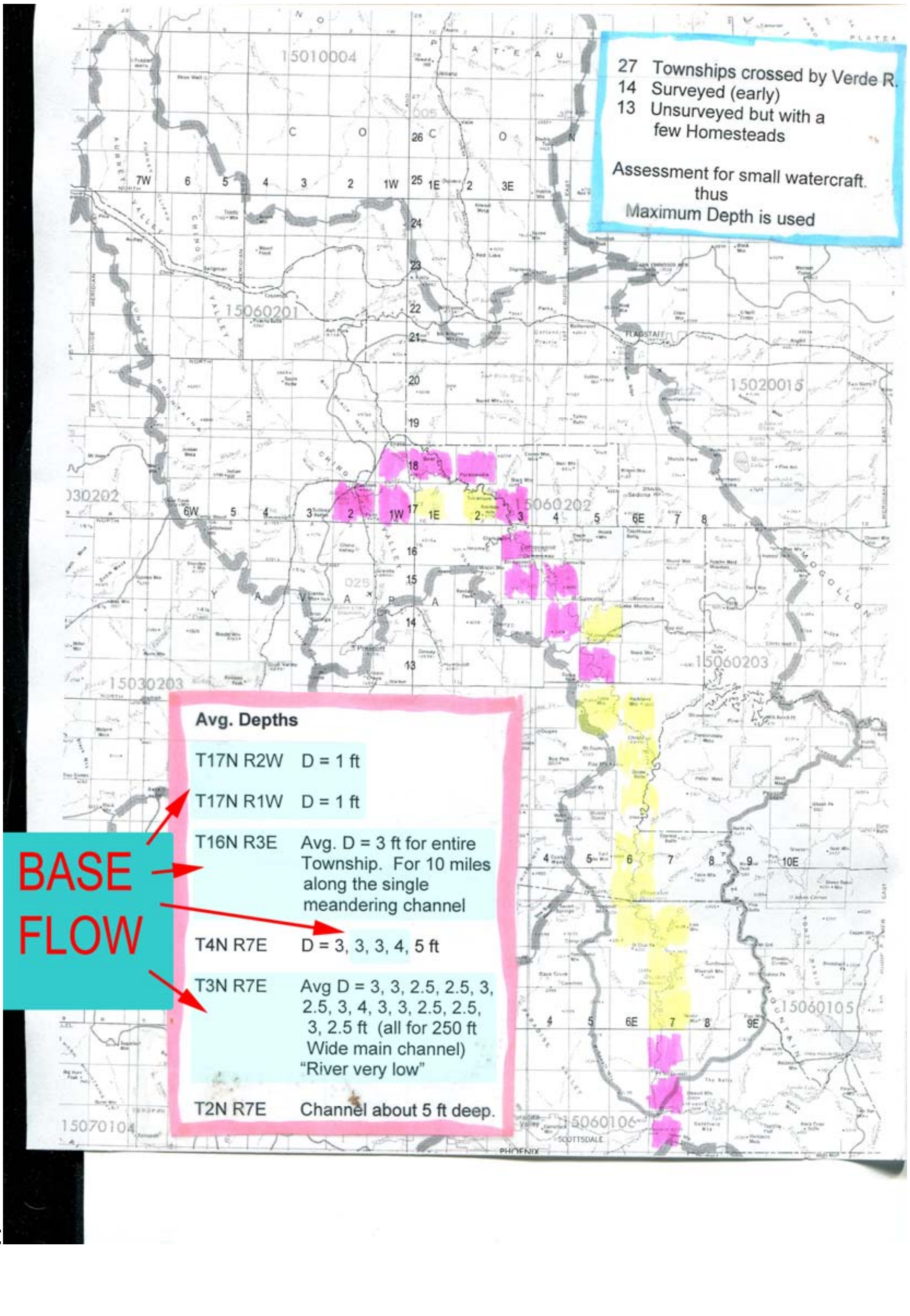
Survey	Date	GLO Book	Temp & Precip data	Streamflow data
T3N R7E	2/18-3/9/1911	2396	USWB Feb. 1911	WSP 309 monthly
T4N R7E	3/1-3/20/1911	2397	USWB Mar. 1911	WSP 309 daily stage & monthly

Pages of the GLO survey books related to early March storm period follow the weather and streamflow data in this supplement. Dates, location along the river and measured depths of flow are noted on the pages of the surveys. The appropriate temperature, precipitation, weather descriptions by the US weather Bureau, and streamflow records can be consulted as you read through the GLO books. For example, the survey for T3N R7E started on Feb. 18, 1911 (p. 40) and a check of the precipitation in the Phoenix-Mesa area (p. 32) shows precipitation stopped on Feb. 16, 1911; thus, the weather conditions were appropriate and the survey commenced.

This analysis shows that the reported measured depths of flow in the lower Verde River for T3N R7E were for base flows and not for floodwater conditions. During the potential moderate flooding of about Mar. 6-8 the survey was along Sycamore Creek and later along the Salt River and no depths of flow were measured along the Verde River. Also, for T4N R7E two of the four reported average measured depths of flow (4 ft and 3 ft) in were for base flows and the other two depths (each 3 ft.) may also represent some floodwater. During these surveys there was not sufficient floodwater, if any, to prevent access to the river by the GLO surveyors. All of the depth measurements along the Verde River by GLO surveyors were affected by human activities.

Daily precipitation is important for stations: Camp Verde, Cavecreek, Flagstaff, Jerome, Natural Bridge, Payson, Phoenix, Prescott and Seligman.

A map of the surveyed townships showing measured depths follows:



February 1911

US Weather Bureau, 1911, U. S. DEPARTMENT OF AGRICULTURE, CLIMATOLOGICAL SERVICE, DISTRICT No. 9., COLORADO VALLEY, Report for February 1911, 11p. (to left is from page 3).

GENERAL SUMMARY.

The stormy conditions that set in near the middle of January continued with but little interruption during February. While the average precipitation for the month was not much above the normal, yet, combined with that for January, it may be considered as making up generally for the light precipitation that characterized the fall months and the first half of the winter. The total for the months November, December, January, and February, for the basin of the Green, is 4.68 inches, or 1.31 inches less than for the corresponding months a year ago; for the Grand, the amount, 6.33 inches, is practically the same as that of a year ago; for the San Juan the total is 8.54 inches; Little Colorado, 4.70 inches; and the Gila, 5.45 inches. These values are 0.32, 0.69, and 2.38 inches, respectively, more than for the corresponding months in 1909–10.

In western New Mexico water for irrigation is likely to be adequate, except in the southern part. In Arizona it is plentiful, and the supply will last till summer, the season of frequent rains. The range outlook is very favorable in New Mexico and Arizona.

Temperatures in Arizona and Wyoming averaged lower than the normal, but in the remainder of the district a slight excess was general.

The sunshine was deficient, and the relative humidity was somewhat greater than usual.

TEMPERATURE.

The mean of the 134 stations reporting was 36.9°, or 0.5° below the normal. By subdivisions the means and departures were: Western Wyoming, 12.8°, −2.5°; western Colorado, 24.2°, +1.4°; eastern Utah, 30.2°, +1.2°; western New Mexico, 38.1°, +1.4°; Arizona, 46.3°, −2.0°; and southeastern Nevada, 39.8°. The highest monthly mean was 57.6°, at Maricopa, Ariz., and the lowest, 5.4°, at Corona, Colo. Except in the extreme southwestern part of Arizona, the first 11 days were warmer than the normal throughout the district, and in the central part high mean temperatures continued nearly a week longer. From the 15th to the 22d, inclusive, there was a marked daily deficiency of temperature in Arizona and southeastern Nevada, and from the 20th almost to the end of the month in the central and northern parts of the district. By subdivisions the extremes were: Western Wyoming, 48° and −30°; western Colorado, 59° and −25°; eastern Utah, 69° and −27°; western New Mexico, 78° and −12°; Arizona, 82° and −20°; and southeastern Nevada, 67° and 10°.

As explained to the left, the first 11 days of Feb. were warmer than normal and the last part of Feb. 1911 was colder than normal.

PRECIPITATION.

The average for the 177 stations reporting was 1.62 inches, or 0.39 inch above the normal. An excess was noted on all drainage areas except the Grand. By watersheds the means and departures were: Green, 1.41, +0.22; Grand, 1.63, −0.08; San Juan, 2.97, +1.91; Little Colorado, 1.73, +0.43; Gila, 1.71, +0.37; Mimbres, 1.69, +0.86; and Colorado, proper, 1.30, +0.12 inch. The greatest monthly amount was 7.02 inches, at Durango, Colo.; this came largely in the form of snow and is the greatest of record at that station for any month. The least monthly amount was 0.05 inch, at Aztec, Ariz. The average number of days with 0.01 inch or more of precipitation was 4 in western Wyoming, 10 in western Colorado, 7 in eastern Utah, 7 in western New Mexico, 5 in Arizona, and 3 in southeastern Nevada. For the district as a whole the average was 7 days. At the close of the month 97 stations in Colorado having an average elevation of 8,585 feet showed a mean depth of 29 inches of snow. This depth is 5.6 inches less than that reported for the corresponding date last year. Heavy rain fell in the central and northern parts of Arizona on the 4th and 5th, causing a moderate freshet in the rivers from the 4th to the 6th.

US Weather Bureau (1911), page 3.

Heavy rain in central and northern AZ on Feb. 4 and 5, 1911.

Below is extract from section snowfall bulletins. US Weather Bureau (1911), page 3.

Arizona.—The snowfall for February was one and one-half times greater than the total for the preceding two months. The average depth at 8,000 feet elevation is about 14 inches. Over the upper watershed of the Gila the depth averaged 27 inches, and for that of the Little Colorado the average was 49 inches.

TABLE 2.—*Daily precipitation for February, 1911. District No. 9, Colorado Valley.*

Stations.	Watershed.	Day of month.																												Total.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Wyoming.																														
Arizona.																														
Allaires Ranch	Sonora	T.				T.							.08			.24	.01	.25	.03						.11			.68	.16	1.56
Aztec	Gila			.05																										0.05
Benson	San Pedro	.05											.13				.24		.47						.10				.70	1.69
Bisbee	....do				T.								.20				.85		1.20	.02						.02		T.	1.41	3.70
Bonita	Desert																													
Bowie	Gila													.35			.20		.80										1.30	2.65
Buckeye	....do		T.	.75	.01								T.				.10													0.86
Camp Verde	Verde																													
Canille	San Pedro	.04	T.		T.							T.	.08			.58	T.	.12	.02							.07			.99	1.90
Casa Grande	Gila				.45								.15																	0.60
Casa Grande Ruins	....do	.04		.01	.63								.10			T.	.15		.07									.03	.01	1.04
Cavecreek	Verde				1.75								.08		.04		.04													1.91
Chin Lee	San Juan	.01			.73	.02							.08	T.		.04	.09	.08	.01	.16	.04	.01	.12			.02	.01	T.	.02	1.44
Chiarsons Mill	Gila				.62								.30			.80	1.00		1.20							.40			.60	4.92
Clifton	....do				.04	.09							.02				.09		.62										.66	1.52
Cline	Salt																													
Cochise	Desert																												.40	0.40
Columbia	Agua Frio			1.25									.01		.01		.65										.10			2.02
Congress	Hassayampa				.76	.11							.01				.26											.02		1.16
Courtland	White											.70				.50		1.10									1.15	.90	.12	4.47
Dos Cabezos	Desert												.40	.66			.42		1.23							.20			.85	3.76
Douglas	Sonora																													
Dudleyville	Gila			T.	.23					.02	.32	T.	.04	T.	T.		.42	.02	.19	.02								.01	.16	1.43
Fairbank	San Pedro																													
Flagstaff	Little Colorado	.04		.25	.93	.01						T.	.35	.01	.08	.19	.09	T.	T.	.21	.04				T.	.30	.25	T.		2.75
Flagstaff (1)	....do																													
Flagstaff (2)	....do	.23			1.30								.30		.06	.19	.03			T.	.11					.25	T.			2.47
Florence	Gila			.10	1.00								.02			.03														1.15
Fort Apache	Salt			.22	.70							T.	.30			.62		T.							.10		.40	T.		2.34
Fort Huachuca	San Pedro	.10											.15			.20	.10											.03	.15	0.73
Fort Mohave	Colorado																													
Gilabend	Gila	T.			.38																									0.38
Globe	Salt	.09		.02	1.00	.04							.02			.09	.20									.03		.04	.10	1.63
Grand Canyon	Colorado	.02			.70							T.	.30	T.	.10	.15	.10	T.	T.	.15	.05					.10	.40	T.		2.07
Grand Canyon (1)	....do	.31			1.08	.13							T.		.23			.07		T.	T.	.11				.07	.17			2.17
Granite Reef Dam	Salt	.02	.04		.69	.07							.03		.01		.11										.01			0.98
Greer	Little Colorado																													
Heber	....do																													
Hereford	Gila												.09				.38		.52										.51	1.50
Holbrook	Little Colorado				.55								.10				.40			.05	T.	T.	T.							1.10
Indian Oasis	Desert											.10	T.															.32		0.42
Intake	Salt																													
Jerome	Verde	.23			1.18								.20		.08	.10	.42										T.		.26	2.47
Keams Canyon	Little Colorado				1.15								.06			.01	.22	.10		.10	.12	.13					.03			1.92
Kingman	Colorado																													
Lewis Springs	San Pedro													.07				.03	.95							.03			.35	1.43
Maricopa	Gila				.43										T.															0.43
McNeal	Desert													.05			.11		1.01							.04			.82	2.03
Mesa	Salt	.14		.35	.20								T.			.02	T.										T.			0.71
Mohawk Summit	Gila				.34																									0.34
Naco	San Pedro																.74			.55									.90	2.19
Natural Bridge	Verde	.28		.05	1.78	.05							.45		.40		.32											.25		3.58
Oracle	San Pedro			T.	.92								.28			.20	.65	T.	.50							.24		.12	.22	3.13
Osborn	....do	T.											.01				.55		.48										.50	1.54
Paradise	Desert												T.	.03					1.40										.08	1.51
Parker	Colorado				.78	.09																								0.87
Payson	Verde	.20		.05	1.25	T.							.31		.34	.05	.45									T.	T.	.15	.22	3.02
Phoenix	Salt	.04		.01	.59								.01			.01	T.											T.		0.66
Phoenix (1)	....do	.07		T.	.65	.06							T.	T.	T.		T.													0.78
Phoenix (2)	....do				.90																									0.90
Pinal Ranch	Gila	.15		.65	1.93								.04	.29			.35	.08	.06							.09			.46	4.10
Pinto	Little Colorado				.50	.15						T.	.25				.55		.05		T.	.04	.02							1.56
Prescott	Hassayampa	.23		.03	1.11								.07		.20		.10			T.	T.						.07	T.	T.	1.81
Quartzsite	Colorado	.20			.71																									0.91
Redrock	Santa Cruz			.02	.05								.12			.14		.04	.14						.02			.22		0.75
Roosevelt	Salt	.72			1.35	.17							.05				.35											.19		2.83
Sacaton	Gila				.52								.08				.06	.03												0.69
St. Johns	Little Colorado				1.10								.07			T.	.70		.07			.21								2.15
St. Michaels	....do				1.10								.12			.03	.50	.08	.15	.15	.15	.08								2.36
Salome	Colorado				.65	.12																					.02	T.		0.79
San Carlos	Gila	.13			.50	.07							.12			.10	.25		.03									T.	.18	1.38
San Simon	....do													.22			T.	T.	.94										1.12	2.28
Seligman	Verde																													
Sentinel	Gila				.31	.01																								0.32
Show Low	Little Colorado																													

TABLE 2.—*Daily precipitation for February, 1911. District No. 9*—Continued.

Stations.	Watershed.	Day of month.																												Total.
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Arizona—Continued.																														
Silverbell	Santa Cruz																													
Snowflake	Little Colorado	T.			.55								.08				.41			T.	.05			T.		T.			.03	1.12
Supai	Colorado																													
Tempe	Salt	.06	.09	T.	.51								T.				.04										T.			0.70
Thatcher	Gila					.01							.10		T.		.18		1.12										.56	1.97
Tombstone	San Pedro												.33			.58		.96	.05						.08			.52	.09	2.61
Truxton	Colorado		.12	.98									T.		.02		.03										.03	T.		1.18
Tuba	Little Colorado			.40	.22												.15	.15		T.	T.	.12					.10			1.14
Tucson	Santa Cruz																													
Tucson (1)	....do												.35	.01		.10	.30		.20										.25	1.21
Tucson (2)	....do																													
Vail	....do	.50			.14											.02	.03	.03												0.72
Walnut Grove	Hassayampa				.90								.05	.25			.40										.03			1.63
Wickenburg	....do					.80											.04													0.84
Wilcox	Desert	.20			T.									.05			.05		.50									.78		1.58
Williams	Colorado	.40			1.00								.15							.25	T.					.14	.16			2.10
Winslow	Little Colorado	T.			.70							T.					.40	T.				.10	.15							1.35
Yarnell	Hassayampa																													
Yuma	Colorado			.64																										0.64
Yuma (1)	....do	.04		.21	.38																				T.					0.63

TABLE 3.—*Maximum and minimum temperatures at selected stations, February, 1911. District No. 9, Colorado Valley.*

Date.	Arizona.																						Logan, Nev.	
	Bisbee.		Flagstaff.		Fort Apache.		Grand Canyon.		Parker.		Phoenix.		Prescott.		St. Michaels.		San Carlos.		Tucson.		Yuma.			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	63	48	46	27	55	35	46	32	70	39	71	51	67	25	54	34	67	50	74	50	73	40	63	36
2	63	46	44	29	57	30	44	30	72	40	68	45	52	21	49	28	70	40	73	48	70	42	61	33
3	62	41	46	32	57	35	49	28	60	40	64	54	46	21	54	34	61	42	68	52	61	53	54	33
4	62	51	40	30	50	42	46	30	70	50	62	51	42	34	56	35	62	50	65	50	66	51	60	33
5	58	35	42	24	51	32	47	28	69	37	66	45	72	28	48	30	65	38	67	46	68	42	62	37
6	59	38	47	20	59	26	44	29	69	36	62	42	73	22	50	32	62	32	69	43	70	45	63	36
7	57	48	48	20	58	28	46	28	73	32	66	40	74	22	50	25	64	33	65	39	70	43	64	35
8	59	40	45	18	59	23	46	20	76	34	66	40	53	22	51	21	69	30	67	38	71	48	63	29
9	58	39	45	16	58	21	47	24	76	34	69	40	57	19	50	24	61	32	68	38	71	48	67	29
10	62	43	48	17	60	25	40	22	74	34	71	37	56	19	50	17	69	35	76	36	74	40	67	30
11	64	38	46	31	60	24	44	28	72	40	75	44	58	28	56	35	73	30	78	42	68	42	67	31
12	56	34	37	20	42	21	46	29	66	36	59	41	48	29	44	31	66	43	70	40	64	46	61	37
13	51	26	31	18	47	24	44	20	60	35	60	35	42	22	38	22	55	30	60	34	63	38	56	29
14	58	38	32	24	48	27	40	21	59	24	59	45	38	32	44	35	61	29	62	42	61	46	67	29
15	50	40	30	18	46	36	38	18	61	25	55	44	39	27	38	28	55	38	60	43	59	41	52	26
16	46	30	30	4	37	30	26	10	58	22	49	37	37	16	38	23	54	36	51	36	58	37	49	26
17	46	26	33	−7	41	6	34	−5	63	24	62	31	39	6	41	21	58	25	55	28	62	37	58	32
18	44	33	43	9	47	12	32	14	69	21	63	41	47	19	38	27	60	42	66	36	72	36	62	26
19	50	30	33	20	45	23	28	−4	67	22	64	37	45	27	38	28	61	26	64	35	70	35	56	23
20	54	32	34	−2	47	33	28	−2	67	24	65	37	45	18	32	13	61	29	67	34	66	40	56	29
21	48	26	38	−5	48	30	28	3	68	24	65	38	47	14	33	13	56	33	67	39	66	42	58	23
22	45	25	34	3	48	20	30	6	72	22	64	40	47	14	36	14	56	31	65	40	68	47	59	24
23	48	28	38	9	46	20	34	12	70	29	65	44	54	29	32	4	52	35	64	41	72	43	66	23
24	59	35	37	17	52	27	34	18	67	26	68	47	42	33	44	14	68	28	66	46	65	39	64	24
25	51	28	28	22	44	29	34	22	67	26	62	37	44	21	42	31	61	37	68	36	68	41	62	29
26	55	37	29	19	53	29	36	24	67	28	60	43	37	24	44	31	64	28	62	42	62	40	53	29
27	58	43	33	26	53	26	36	28	67	30	60	43	40	27	46	28	62	33	62	42	58	45	58	35
28	52	41	42	23	54	30	38	26	69	30	68	47	50	30	50	32	61	41	69	44	70	45	58	30
Mns	54.9	36.4	38.5	17.2	50.8	26.6	38.8	19.2	67.8	30.9	63.9	42.0	49.7	23.2	44.5	25.4	61.9	34.9	65.9	40.7	66.6	42.6	59.9	29.9

Weather data for March 1911 follow.

US Weather Bureau, 1911, U. S. DEPARTMENT OF AGRICULTURE, CLIMATOLOGICAL SERVICE, DISTRICT No. 9., COLORADO VALLEY, Report for March 1911, 11p.

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

CLIMATOLOGICAL SERVICE

DISTRICT No. 9. COLORADO VALLEY

FREDERICK H. BRANDENBURG
DISTRICT EDITOR

REPORT FOR MARCH, 1911

Prepared under direction of WILLIS L. MOORE, Chief U. S. Weather Bureau

GOVERNMENT PRINTING OFFICE
WASHINGTON
1911

GENERAL SUMMARY.

The mean temperature throughout the district was materially higher than the normal, but not so high as that of March a year ago, which month it resembled in respect to the slight variability of temperature from day to day. It was very favorable as regards the amount and distribution of the precipitation and the lack of any severe conditions. The storms were about the average as regards number and occurred at short and regular intervals. Everything considered, the conditions were fine for March.

TEMPERATURE.

The mean of the 140 stations reporting was 48.3°, or 3.2° above the normal. By subdivisions the means and departures were: Western Wyoming, 30.7°, +1.9°; western Colorado, 36.0°, +3.3°; eastern Utah, 43.1°, +3.5°; western New Mexico, 49.2°, +4.8°; Arizona, 57.3°, +2.9°; and southeastern Nevada, 54.2°. The highest monthly mean was 69.4°, at Mohawk Summit, Ariz., and the lowest, 16.4°, at Corona, Colo. In the extreme southwestern part of the district, in the vicinity of the Gulf of California and in southeastern Nevada, 9 or 10 days were cooler than the normal, while in the rest of the district only 3 or 4 days were relatively cool. With one exception the deficiencies were small. This is rather remarkable, as uniformity in the mean temperature, especially in the central and northern parts of the district, is not common to March. By subdivisions, the extremes were: Western Wyoming, 62° and −16°; western Colorado, 73° and −12°; eastern Utah, 86° and −6°; western New Mexico, 83° and 2°; Arizona, 99° and 15°; and southeastern Nevada, 93° and 22°.

PRECIPITATION.

The average for the 187 stations reporting was 1.22 inches, or 0.04 inch below the normal. The average for March, 1910, was 0.56 inch. By watersheds, the means and departures were: Green, 0.73, −0.69; Grand, 2.00, +0.11; San Juan, 2.53, +0.51; Little Colorado, 1.33, +0.50; Gila, 0.81, −0.11; Mimbres, 0.91, +0.30; and lower Colorado, 0.96, −0.07 inch. The greatest monthly precipitation was 6.36 inches, at Corona, Colo., while there was none at Hermanes and Pratt, N. Mex., and Naco, Ariz. The rains of March 3–5, in Arizona, caused moderate floods in the Verde and Salt Rivers on the 6th, 7th, and 8th. High water also occurred in the Muddy River, in southeastern Nevada, on the 10th. The damage by these freshets consisted principally in making the streams unfordable and thus interrupting traffic. The average number of days with 0.01 inch or more of pre-

Below is extract from March section snowfall bulletins that pertains to AZ. US Weather Bureau (March 1911), page 3.

Arizona.—The snowfall of the month was greatly deficient, and decidedly less than that of March last year, except over the upper Gila watershed. The snow at 7,000 feet elevation disappeared on the 13th; at 8,000 feet on the 21st; at 8,500 feet on the 25th, and at 9,000 feet about the 30th. At higher altitudes the snow is well packed and is melting slowly.

TABLE 2.—*Daily precipitation for March, 1911. District No. 9*—Continued.

Stations.	Watershed.	Day of month. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
Arizona.																																	
Allaires Ranch	Sonora			0.01	.02	.01												T.				.02	.02		.48	.10							.66
Aztec	Gila			T.		.10																			.08								.18
Benson	San Pedro					.02	.15											T.								.04							.21
Bisbee	do	.09			T.	.20																	.01			.30							.60
Bonita	Desert																																
Bowie	Gila				.02	.08																	.03			.18							.31
Buckeye	do			T.	T.	.39																T.	.03										.42
Camp Verde	Verde																																
Canille	San Pedro	.09			.02	.12	.09				T.										T.		.01		T.	.08							.41
Casa Grande	Gila				.02	.50																	.01	.14									.67
Casa Grande Ruins	do				.07	.06	.43				.03												T.			T.							.59
Cavecreek	Verde				T.	.24	.60				.05												.30										1.19
Chin Lee	San Juan			.04	.06	.20	.35				.03	.20											.20	.01	.35								1.44
Chlarson's Mill	Gila				.49	1.07																	.12	.27		.31	.05						2.31
Clifton	do						.09																	.64	.02	.20							.95
Cline	Salt																																
Cochise	Desert																						.02			.36							.38
Columbia	Agua Fria					.04	.60				.15							0.16							.15								1.10
Congress	Hassayampa																																
Courtland	White																							.08		.10							.18
Dos Cabezos	Desert					.14						.06						T.								.15							.35
Douglas	Sonora	.16				.06															T.		T.			.03							.25
Dudleyville	Gila	T.	T.	T.	.02	.06	.42				.02												.05	.05		.20							.82
Fairbank	San Pedro																									.35							.35
Flagstaff	Little Colo.			.09	1.10	.11	.19			T.	.69	.03								T.			.16	T.	.06		.28						2.71
Flagstaff (1)	do																																
Flagstaff (2)	do			.15	.20	.46					.60												.19	T.			T.	0.06					1.66
Florence	Gila				.20	.20	.50																										.90
Fort Apache	Salt				.40	1.20	T.				.20												.01	T.									1.81
Fort Huachuca	San Pedro				.10						.50															.11							.71
Fort Mohave	Colorado																																
Gila Bend	Gila						.30																T.										.30
Globe	Salt				.06	.17	.80				.06												.06		.02	.02							1.19
Grand Canyon	Colorado			.02	.64		.15			0.08	.72												.18	.12	.26		T.						2.17
Grand Canyon (1)	do		T.	.01	.13		.13			.14	.96												.03	.08	.11								1.59
Granite Reef Dam	Salt				.05	.04					.48												.05										.62
Greer	Little Colo.																																
Heber	do																																
Hereford	Gila																									.22	.05						.27
Holbrook	Little Colo.	.05		.04																			.09										.18
Indian Oasis	Desert																																
Intake	Salt			.15	.30	1.05					.20																						1.70
Jerome	Verde				.63	.43	.55				.66												.45	.24	.07		.08						3.11
Keams Canyon	Little Colo.			.05	.15	.25	.38				.14	.11									T.		.25	.02	.22	T.							1.57
Kingman	Colorado																																
Lewis Springs	San Pedro					.03																				.16							.19
Maricopa	Gila				.35																		.04										.39
McNeal	Desert					.15																.02		.04	.10								.31
Mesa	Salt			T.		.25					.06											.05											.36
Mohawk Summit	Gila										T.																						T.
Naco	San Pedro																																.00
Natural Bridge	Verde					.81	1.25				.25	.05											.35			.10							2.81
Oracle	San Pedro				T.	.25	.75				T.												T.	.10	.03	.12							1.25
Osborn	do																									.10							.10
Paradise	Desert					.20						.20						T.				T.				.22							.62
Parker	Colorado		T.																														T.
Payson	Verde			T.	T.	.42	.79				.18	.05											.26		T.								1.70
Phoenix	Salt			.01	T.	.25	.24				.01											.02	.11										.64
Phoenix (1)	do				T.	.05	.47				T.												.08										.60
Phoenix (2)	do					.60																											.60
Pinal Ranch	Gila				.01	.77	1.41	.04			.04											.02	T.	.03	.06								2.38
Pinto	Little Colo.				.58	.05	.02				T.												.23	.19									1.07
Prescott	Hassayampa				.27	.64	.38				.70												.28		.06								2.33
Quartzsite	Colorado									.07																							.07
Redrock	Santa Cruz				.04	.40					.02											T.	T.		.11								.57
Roosevelt	Salt				.15	.35	1.05				.10												.19		.01								1.85
Sacaton	Gila					.08	.39																										.47
St. Johns	Little Colo.																																
St. Michaels	do			T.	T.	.10	.70					.05										T.	.56		.50								1.91
Salome	Colorado				.10													.12					.02	.16	.18								.58
San Carlos	Gila				T.	.61	.41				T.												T.	.04	.20	.21							1.47
San Simon	do				.06																		.05										.11
Seligman	Verde																																
Sentinel	Gila					.01	.21															.04											.26

TABLE 2.—*Daily precipitation for March, 1911. District No. 9*—Continued.

Stations.	Watershed.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
Arizona—Cont'd.																																	
Showlow	Little Colo.																																
Silverbell	Santa Cruz.						0.52																		0.01	0.18							0.71
Snowflake	Little Colo.	T.		T.	0.03	T.	.25					0.25							T.	0.02		0.08	0.15		.15			T.					.93
Supai	Colorado																																
Tempe	Salt				.05	.03	.37				0.08												.06										.59
Thatcher	Gila						T.																	0.27		.15							.42
Tombstone	San Pedro				.13	.05																	.02			.46							.66
Truxton	Colorado			.12	T.				T.	.30	.08									T.			.08	T.	T.		0.06	T.					.64
Tuba	Little Colo.				T.	.10	.20	0.05			T.	.32									T.		.07	.18									.92
Tucson	Santa Cruz.				T.	.06	.14																T.			.05							.25
Tucson (1)	do.				.06	.10																		.13									.29
Tucson (2)	do.				T.	.04	.13				T.												.09			.08							.34
Vail	do.					.06																		.12									.18
Walnut Grove	Hassayampa						1.02				.85													.30									2.17
Wickenburg	do.										.10																						.10
Willcox	Desert																	T.								.43							.43
Williams	Colorado			.05	.55	1.40					1.26	.40												.10			.10						3.86
Winslow	Little Colo.				.60	.05	.02				.23	.04										T.	.27	.10	.02			T.					1.33
Yarnell	Hassayampa																																
Yuma	Colorado			T.	T.	T.			T.		.02											.03	.02		.05								.12
Yuma (1)	do.			T.	T.		T.		T.		.03											.04	.02		.15								.24

TABLE 3.—*Maximum and minimum temperatures for March, 1911. District No. 9, Colorado Valley.*

Date.	Arizona.																						Logan, Nev.	
	Bisbee.		Flagstaff.		Fort Apache.		Grand Canyon.		Parker.		Phoenix.		Prescott.		St. Michaels.		San Carlos.		Tucson.		Yuma.			
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1	58	41	45	23	53	30	51	26	73	40	68	45	55	25	48	22	67	41	69	45	71	42	63	39
2	62	40	45	23	62	30	49	24	75	40	74	46	58	28	50	27	72	36	76	43	76	44	63	44
3	63	44	47	29	62	33	48	30	68	41	70	50	53	30	52	29	66	40	75	48	71	48	64	44
4	65	47	42	31	62	35	47	32	76	36	69	50	48	35	54	32	69	44	72	54	71	49	68	47
5	58	46	43	32	65	44	47	30	68	36	66	54	50	41	52	40	66	50	70	57	65	49	67	30
6	60	47	42	31	53	40	44	31	75	40	68	53	50	30	50	36	66	49	70	52	74	45	66	35
7	66	41	48	28	63	31	52	29	76	45	74	46	58	28	56	28	74	37	78	42	80	46	68	35
8	72	43	54	32	67	32	58	31	80	52	79	45	62	32	60	29	78	40	79	43	85	50	73	51
9	72	47	53	33	68	34	53	30	74	52	78	52	61	39	48	32	80	50	88	45	82	54	68	53
10	73	47	43	32	64	37	48	31	77	38	66	55	52	41	46	28	69	42	74	51	73	52	67	52
11	62	44	42	26	55	33	50	24	75	37	64	42	52	30	59	29	65	42	72	43	74	46	70	38
12	65	37	49	22	62	27	50	18	76	40	73	42	54	25	58	28	74	32	76	35	80	47	68	38
13	68	43	49	25	69	27	54	22	82	41	77	43	60	26	58	28	75	34	79	37	81	57	72	38
14	70	45	52	30	66	35	60	28	85	41	81	49	63	28	65	21	78	46	79	43	85	56	75	47
15	71	46	60	31	68	32	58	30	85	42	86	49	68	35	56	25	80	38	70	44	87	50	79	43
16	74	46	59	29	69	46	57	28	78	45	83	52	66	33	58	28	77	41	86	46	90	53	81	39
17	67	52	57	24	67	37	62	23	85	45	83	51	64	33	61	32	79	42	84	51	88	51	82	39
18	66	47	59	28	67	36	64	23	84	46	82	54	68	31	62	31	79	37	85	46	87	50	80	45
19	67	44	57	32	67	32	63	26	82	46	83	50	66	33	63	27	82	37	81	44	87	49	81	50
20	68	48	57	26	68	40	62	30	90	47	82	49	64	30	63	28	81	39	84	51	86	49	82	46
21	62	43	57	31	65	36	64	27	78	47	77	52	64	31	64	28	78	41	80	48	68	49	80	42
22	63	42	44	32	62	43	52	30	79	55	72	53	54	39	52	34	73	48	76	52	78	54	82	52
23	60	42	51	31	56	35	62	31	86	45	76	49	54	29	51	34	69	41	75	46	81	47	75	51
24	62	40	52	30	62	37	58	29	80	42	78	51	53	32	55	34	70	45	76	53	80	53	76	51
25	56	40	56	26	61	38	64	24	86	45	78	54	54	33	54	32	70	49	73	49	85	48	79	43
26	61	45	54	28	63	35	58	26	86	48	79	55	60	39	51	31	75	40	77	52	83	53	73	46
27	67	47	57	30	67	37	64	28	79	43	82	51	64	34	59	27	76	40	82	45	85	54	83	45
28	70	50	62	31	71	33	66	32	88	44	85	50	68	31	57	31	83	40	83	51	92	53	82	43
29	73	55	68	26	72	34	60	26	85	46	86	48	71	30	65	28	85	38	84	51	94	52	88	44
30	72	54	68	26	75	32	68	28	85	45	86	53	72	32	62	30	86	38	87	43	94	54	82	47
31	73	45	66	29	74	35	64	28	90	50	88	55	74	35	68	28	86	40	86	51	96	52	93	47
Means	66.0	45.1	52.8	28.6	64.7	35.0	56.7	27.6	80.2	43.9	77.2	49.9	60.0	32.2	56.7	29.6	75.1	41.2	78.3	47.1	81.6	50.2	75.2	44.0

There was heavy rain in central and northern AZ on Feb. 4 and 5, 1911 and the first 11 days were warmer than normal. The heavy rain and warmer temperatures produced high runoff in early February. In the middle and last part of Feb. 1911 it was colder than normal with a few days below 0^0 F at Flagstaff and there was a snowpack at the higher elevations. There was moderate flooding on the Verde River on the 6^{th}-8^{th} of March. The snow disappeared at the 7000 ft elevations on the 13^{th} and at the 8000 ft elevation on the 21^{st} of March, 1911.

Follansbee, Robert and others, 1914, SURFACE WATER SUPPLY OF THE UNITED STATES 1911 PART IX. COLORADO RIVER BASIN; USGS Water Supply Paper 309, 266p. (p. 243.)

VERDE RIVER NEAR CAMP VERDE, ARIZ.

Location.—Just below power plant of Arizona Power Co. at Camp Childs, Ariz., about 19 miles southeast of Camp Verde, Ariz., and about 3 miles above mouth of Fossil Creek.

Records available.—February 26 to December 31, 1911.

Drainage area.—Not measured.

Gage.—Inclined staff in three sections on left bank about 300 feet below power plant of Arizona Power Co.

Channel.—Bowlders and bedrock; apparently permanent.

Discharge measurements.—Made from car and cable 1 mile above gage.

Diversions.—About 60 second-feet of water diverted from Fossil Creek used for power development and returned to the river above the gage.

Accuracy.—No estimates can be prepared until additional discharge measurements are made.

Cooperation.—Gage height record furnished by the United States Reclamation Service.

The following discharge measurement was made by C. C. Jacob:

August 5, 1911: Gage height, 5.02 feet; discharge, 208 second-feet.

Daily gage height, in feet, of Verde River near Camp Verde, Ariz., for 1911.

[O. O. Stevens, R. C. Ricketts, observers.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.45	4.5	3.35	3.5	3.75		5.1	5.5	5.5	5.2
2		5.45	4.5	3.3	3.6	3.9		5.0	5.7	5.4	5.2
3		5.9	4.4	3.3	3.55	4.0		5.0	5.6	5.4	5.2
4		6.05	4.3	3.3	3.6	4.5		5.0	5.5	5.4	5.2
5		10.95	4.15	3.3	3.6	4.0		5.0	6.4	5.25	5.2
6		12.75	4.1	3.3	3.55	3.9	5.0	4.9	7.9	5.4	5.2
7		11.2	4.1	3.3	3.55	4.9	5.0	4.9	6.45	5.3	5.2
8		8.0	4.05	3.3	3.5	5.3	5.0	4.85	5.9	5.25	5.2
9		7.5	3.85	3.4	3.55	4.2	4.9	4.9	5.55	5.2	5.2
10		7.3	3.8	3.4	3.5	3.9	5.2	4.9	5.45	5.2	5.2
11		13.75	3.7	3.35	3.45	3.75	5.0	4.9	5.4	5.2	5.2
12		8.7	3.65	3.35	3.4	3.65	4.75	5.5	5.3	5.2	5.2
13		7.2	3.5	3.3	3.6	3.75	4.9	5.4	5.3	5.2	5.2
14		6.55	3.5	3.35	3.55	3.55	4.9	5.7	5.3	5.2	5.2
15		6.15	3.5	3.4	3.5	3.5	4.9	5.5	5.2	5.2	5.2
16		5.95	3.5	3.4	3.5	3.6	4.9	5.3	5.2	5.2	5.2
17		5.7	3.5	3.4	3.5	4.3	4.8	5.2	5.2	5.2	5.2
18		5.45	3.5	3.4	3.4	5.5	5.0	5.1	5.2	5.2	5.3
19		5.25	3.5	3.4	3.4	4.4	4.9	5.1	5.2	5.2	5.3
20		5.15	3.5	3.4	3.6	5.6	4.9	5.5	5.2	5.2	5.3
21		5.1	3.4	3.4	4.0	6.5	5.25	5.55	5.2	5.2	5.3
22		5.0	3.4	3.4	3.65	6.9	5.9	5.3	5.2	5.25	5.3
23		5.0	3.4	3.4	3.55	6.0	5.7	5.45	5.2	5.25	5.3
24		4.95	3.3	3.4	3.6	5.5	5.85	5.1	5.1	5.2	5.3
25	5.5	4.9	3.3	3.4	3.5	6.6	5.8	5.2	5.1	5.2	5.3
26	5.45	4.9	3.3	3.4	3.5	5.55	5.5	5.2	5.15	5.2	5.3
27	5.45	4.8	3.2	3.5	3.5	5.1	5.4	5.2	5.4	5.2	5.3
28	5.45	4.75	3.2	3.5	3.35	5.65	5.6	5.1	5.6	5.2	5.3
29		4.7	3.3	3.55	3.4	5.3	5.4	5.15	5.85	5.2	5.3
30		4.7	3.3	3.5	3.45	5.1	5.3	5.2	5.75	5.2	5.3
31		4.65		3.5		5.0	5.2		5.5		5.3

The discharges corresponding to the above daily gage heights are unknown. Gage heights in Apr.-July are roughly 2 ft. less than those for adjacent days. The cause of this difference is likely scour and fill of the unstable low flow channel.

SALT RIVER BASIN.

SALT AND VERDE RIVERS AT McDOWELL, ARIZ.

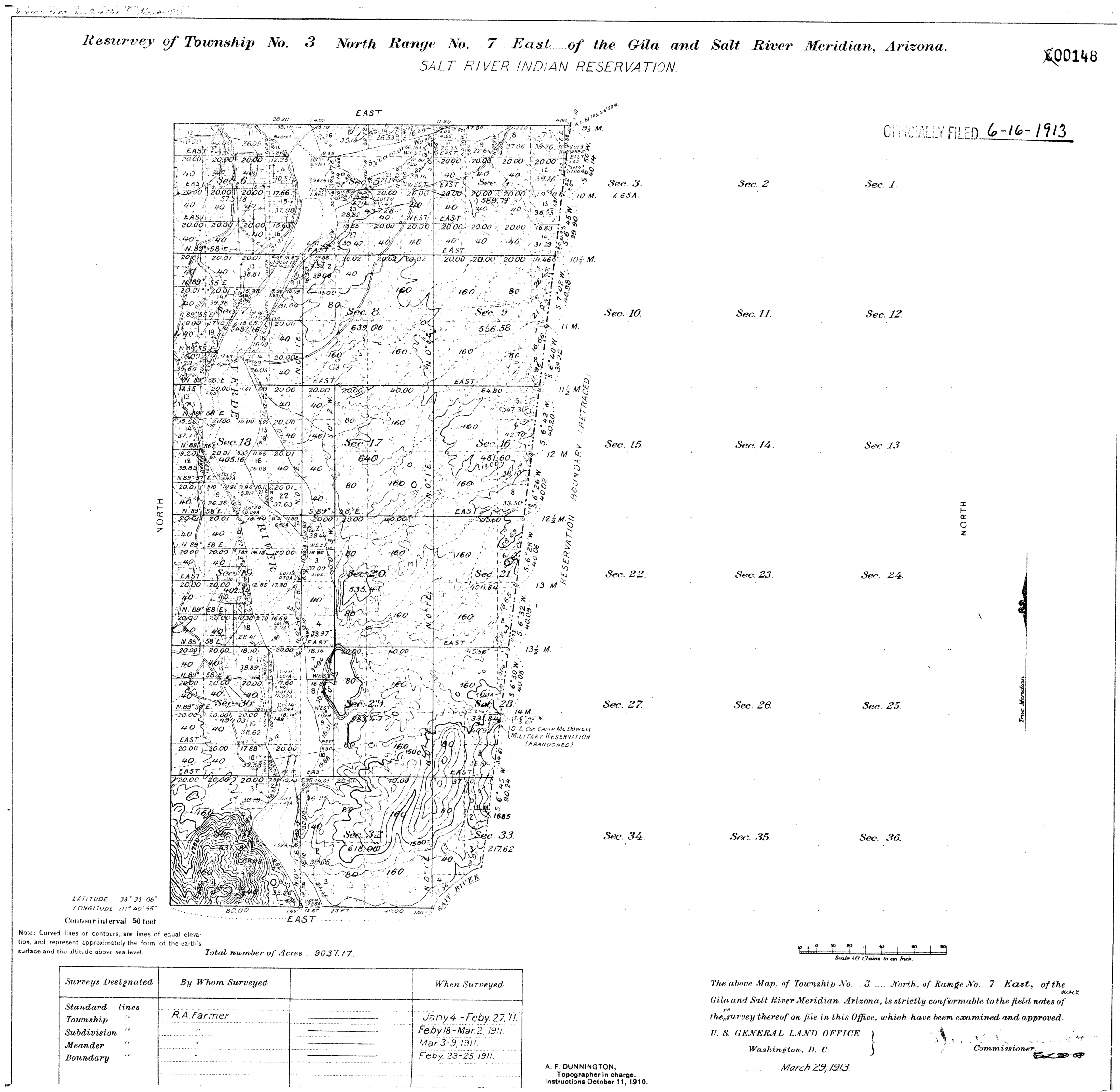
The following estimates of monthly discharge are published as furnished by the United States Reclamation Service. For description of irrigation plan of the Salt River project in Arizona, see Tenth Annual Report of the Reclamation Service.

Estimated monthly discharge of Salt and Verde rivers for 1911.

Month.	Salt River near Roosevelt, Ariz. (drainage area 5,756 square miles).		Verde River at McDowell, Ariz. (drainage area 6,000 square miles).	
	Mean discharge in second-feet.	Run-off, total in acre-feet.	Mean discharge in second-feet.	Run-off, total in acre-feet.
January	66,898	132,691	90,009	178,534
February	81,080	160,820	72,086	142,976
March	135,076	267,919	73,518	145,820
April	33,429	66,306	12,900	25,587
May	17,481	34,673	14,874	29,501
June	9,663	19,166	8,509	16,878
July	19,102	37,888	13,756	27,284
August	10,790	21,402	7,580	15,034
September	7,352	14,582	16,551	32,829
October	28,074	55,684	21,108	41,868
November	11,863	23,530	15,304	30,356
December	7,246	14,372	18,291	37,529
The year	35,671	849,033	30,374	724,196

Follansbee, Robert and others, 1914, SURFACE WATER SUPPLY OF THE UNITED STATES 1911 PART IX. COLORADO RIVER BASIN; USGS Water Supply Paper 309, 266p. (p. 242.)

T3N R7E: The US Weather Bureau description of precipitation, temperature and storms for February and March 1911 clearly shows base runoff of the Verde River was present during the GLO measurements of water depth along T3N R7E for the survey of Feb. 18 to March 9, 1911. During the last couple of days of the GLO survey (about March 6-9, 1911) there probably was direct runoff but most of the surveying was along Sycamore Wash and the Salt River. No measurements of flow depth on the Verde River were made during any direct runoff as shown by the following survey notes for this township. Thus, as stated by surveyor Mr. Farmer, the river was very low at the time when measurements of depth were made (See page 11 of the Nov. 14, 2014 Addendum for the measurements of depth made for base flow conditions when there were diversions by settlers upstream).



Pages 1, 94-102 for Book 2986 of the GLO survey by Mr. Farmer for at T3N R7E follow:

Book "I"

4—679

74
(1)

BOOK 2396

MAY 18 1911

FIELD NOTES

OF THE SURVEY OF THE

Subdivision and Meanders of

T. 3 N., R. 7 E.,

SALT RIVER INDIAN RESERVATION,

Of the Gila and Salt River Principal *Meridian,*

In the State of Arizona,

EXECUTED BY

Robert A. Farmer,

Topographer,

In the capacity of U. S. Surveyor....., under instructions dated October 11-, *1910*,

issued by the ~~*United States Surveyor General to govern surveys included in Group No.*~~ .... ~~*, which were approved by the*~~ *Commissioner of the General Land Office,* to A. F. Dunnington, Topographer in Charge. ~~*191 , pursuant to authority contained in the Act of Congress dated*~~ ~~*, 191*~~

Survey commenced February 18-, *191*1.

Survey completed March 9-, *191*1.

6—151

Meanders T. 3 N., R. 7 E.

N. 4° 0' E.	5.32 chs.	Set iron post for angle point with brass cap stamped A P
N. 7° 45' W.	9.00 "	Set iron post for angle point with brass cap stamped A P
N. 19° E.	6.10 "	to M. C. of sec. 19, which is 2.10 chs. West of ¼ sec. cor. bet. secs. 19 and 20.
N. 17° 15' E.	7.02 "	to M. C. of secs. 19 and 20, which is 6.70 chs. N. 0° 1' E. of ¼ sec. cor. bet. secs. 19 and 20.

Land, level.
Soil, 2nd rate.
Timber, mesquite and cottonwood.

Thence in sec. 20,

Over level land,

Through dense mesquite brush.

N. 22° 45' E.	8.00 chs.	Set iron post for angle point with brass cap stamped A P
North	5.90 "	to M. C. of sec. 20, which is 16.90 chs. West of 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 20.
N. 9° 30' W.	3.56 "	Set iron post for angle point with brass cap stamped A P
N. 28° 15' W.	5.30 "	to M. C. of secs. 19 and 20, which is 11.83 chs. S. 0° 1' W. of the cor. of secs. 17, 18, 19 and 20.

Land, level.
Soil, 2nd rate.
Brush, mesquite and scattered cottonwood trees.

Thence in sec. 19,

Over level land,

Through mesquite brush and trees.

N. 45° 0' W.	16.70 chs.	to M. C. of secs. 18 and 19, which is 11.80 chs. S. 89° 58' W. of the cor. of secs. 17, 18, 19 and 20.

Land, level.
Soil, 2nd rate.
Mesquite brush and trees.

March 6, 1911

- March 6, 1911.

March

Meanders T. 3 N., R. 7 E.

March 7, 1911, at 8h., a.m., l.m.t., I set off 33° 36' N. on the latitude arc, 5° 31' S. on the declination arc, and determine a meridian with the solar at the M. C. of secs. 18 and 19, which is 11.80 chs. S. 89° 58' W. of the cor. of secs. 17, 18, 19 and 20.

Thence I run with meanders in sec. 18,

Over level land,

Through mesquite brush and trees.

N. 54° 45' W.	10.04 chs.	to M. C. of sec. 18, which is 14.20 chs. South of 1/16 sec.cor. No. 11 in the center of the SE. ¼ of sec. 18.
N. 49° 45' W.	8.00 "	Set iron post for angle point with brass cap stamped A P
N. 24° W.	9.90 "	to M. C. of sec. 18, which is 10.12 chs. S. 89° 57' W. of 1/16 sec. cor. No. 11 in the center of the SE. ¼ of sec. 18.
N. 20' W.	7.60 "	Set iron post for angle point with brass cap stamped A P
N. 26° 45' W.	6.80 "	Set iron post for angle point with brass cap stamped A P
N. 30° 45' E.	7.90 "	to M. C. of sec. 18 which is 11.68 chs. S. 89° 56' W. of 1/16 sec. cor. No. 7 bet. the NE. and SE. ¼s of sec. 18.
N. 30° 30' E.	7.80 "	Set iron post for angle point with brass cap stamped A P
N. 12° 30' E.	6.90 "	Set iron post for angle point with brass cap stamped A P
N. 10° 15' E.	4.70 "	to M. C. of sec. 18 which is 5.00 chs. S. 89° 58' W. of 1/16 sec. cor. No. 5 in the center of the NE. ¼ of sec. 18.
North	11.95 "	Set iron post for angle point with brass cap stamped A P
N. 22° 45' W.	8.70 "	to M. C. of secs. 7 and 18, which is 8.39 chs. S. 89° 56' W. of 1/16 sec. cor. No. 1 bet. secs. 7 and 18, E½.

On Verde R. but no depths of flow measured.

Land, level.
Soil, 2nd rate.
Brush, sage and mesquite.
Scattered mesquite and cottonwood trees.

Thence in sec. 7,

Over level, sandy land,

Through dense mesquite brush, with scattered mesquite and cottonwood trees.

N. 26° 35' W. 17.35 chs.		Set iron post for angle point with brass cap stamped A P
N. 12° 15' E. 4.60	"	to M. C. of sec. 7, which is 15.14 chs. S. 89° 55' W. of the 1/16 sec. cor. No. 11 in the center of the SE. ¼ of sec. 7. At 60 lks., road, brs. E. and W.
N. 34° 35' E. 24.30	"	to M. C. of sec. 7, which is 1.35 chs. S. 89° 55' W. of 1/16 sec. cor. No. 7 bet. the NE. and SE. ¼s of sec. 7.
N. 35° 24' E. 2.33	"	to M. C. of sec. 7 which is 1.90 chs. North of 1/16 sec. cor. No. 7 bet. the NE. and SE. ¼s of sec. 7.
N. 28° 45' E. 20.66	"	to M. C. of sec. 7 which is 10.09 chs. S. 89° 55' W. of 1/16 sec. cor. No. 6 bet. secs. 7 and 8, N½¼
N. 28° E. 3.30	"	Set iron post for angle point with brass cap stamped A P
N. 26° 5' E. 10.00	"	Set an iron post for angle point with brass cap stamped A P
N. 41° 45' E. 6.17	"	to M. C. of secs. 7 and 8, which is 16.50 chs. N. 0° 1' E. of 1/16 sec. cor. No. 6 bet. secs. 7 and 8, N½. Last course along base of 40-ft. bluff, brs. NE. and SW.

Land, level and rolling.
Soil, 2nd and 4th rate.
Brush, sage and mesquite.
Scattered willow, cottonwood and mesquite trees.

Moving east away from Verde River toward Sycamore Ck.. No depth of water measured.

Thence in sec. 8,

Along base of 40-ft. bluff, brs. NE. and SW.,

Through mesquite, greasewood and scattered pale verde trees.

N. 65° 20' E. 6.15 chs. to M. C. of secs. 5 and 8, which is 14.88 chs. West of 1/16 sec. cor. No. 2 bet. secs. 5 and 8, W¼.

Land, rolling.
Soil, 4th rate.
Brush, greasewood.
Scattered pale verde trees.

March 7, 1911, at this M. C., I set off 5° 28' S. on the declination arc, and at 12h. 11m. 30s., p.m., observe the sun on the meridian; the resulting latitude is 33° 38' N., which is within 1' of the correct latitude.

Thence in sec. 5,

Over rolling land,

Meanders T. 3 N., R. 7 E.

Through greasewood brush and scattered palo verde trees.

N. 52° 40' E.	18.80 chs.	to M. C. of sec. 5, which is 11.40 chs. N. 0° 7' W. of 1/16 sec. cor. No. 2 bet. secs. 5 and 8, W½. At 10.00 chs., leave bluff, brs. NE. and SW. Enter level land, with dense growth of mesquite and cottonwood trees.
N. 8° 55' E.	8.71 "	to M. C. of sec. 5, which is 18.65 chs. West of 1/16 sec. cor. No. 10 bet. the SE. and SW. ¼s of sec. 5.
N. 8° 45' W.	8.85 "	Set an iron point for angle point with brass cap stamped A P. This point is junction of left bank of Sycamore Wash with left bank of Verde River.

Surveying along Sycmore Wash. No depths of water measured.

Thence with meanders of left bank of Sycamore Wash, up stream.

In sec. 5.

N. 64° 30' E.	12.00 chs.	Set an iron post for angle point with brass cap stamped A P
N. 33° 30' E.	7.30 "	to M. C. of sec. 5 which is 5.15 chs. West of C. ¼ sec. cor. of sec. 5. At 1.00 ch., mouth of drain, course W.
N. 37° 20' E.	8.49 "	to M. C. of sec. 5 which is 6.75 chs. N. 0° 7' W. of C. ¼ sec. cor. of sec. 5.
N. 67° 35' E.	21.63 "	to M. C. of sec. 5, which is 15.00 chs. N. 0° 7' W. of 1/16 sec. cor. No. 7 bet. the NE. and SE. ¼s of sec. 5.
N. 55° 5' E.	8.73 "	to M. C. of sec. 5, which is 12.80 chs. West of 1/16 sec. cor. No. 6 bet. secs. 4 and 5, N½.
N. 50° 30' E.	15.58 "	to M. C. of secs. 4 and 5, which is 10.55 chs. N. 0° 7' W. of 1/16 sec. cor. No. 6 bet. secs. 4 and 5, N½.

Land, level.
Soil, 2nd rate.
Brush, mesquite and sage.
Willow, cottonwood, and mesquite trees.

Thence in sec. 4,

Over level land,

Through sage and mesquite brush, with a few scattered trees.

Meanders T. 3 N., R. 7 E.

S. 87° 51' E. 20.02 chs. to M. C of sec. 4, which is 9.80 chs. N. 0° 8' W. of 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 4.

East 8.40 " Set an iron post for angle point with brass cap stamped A P

N. 61° 15' E. 6.10 " Set an iron post for angle point with brass cap stamped A P

N. 78° 45' E. 6.41 " to M. C. of sec. 4, which is 14.00 chs. N. 0° 3' W. of 1/16 sec. cor. No. 4 bet. the NE. and NW. ¼s of sec. 4.

N. 57° 15' E. 10.90 " to M. C. of secs. 4 and 33, [redacted] which is 10.80 chs. West of the 1/16 sec. cor. No. 1 bet. secs. 4 and 33, E½, on the N. bdy. of the tp., both cors. previously described.
At 8.00 chs., road brs. N. and S.
At 9.50 chs., road brs. N. and S.

Land, level.
Soil, 2nd rate.
Brush, mesquite and sage.
Scattered mesquitetrees.

- March 7, 1911.

March 7, 1911.
Survey along
Sycamore Wash.

March 8, 1911, at 8h., a.m., l.m.t., I set off 33° 39' N. on the latitude arc, 5° 8' S. on the declination arc, and determine a meridian with the solar at the M. C. of secs. 4 and 33, which is 11.40 chs. East of the cor. of secs. 4, 5, 32 and 33, on the N. bdy. of the tp., both cors. previously described.

Thence I run with meanders of the right bank of Sycamore Wash, down stream,

In sec. 4,

Over rolling land,

Through greasewood brush and scattered palo verde trees,

Along 30- ft. bank.

S. 66° W. 12.48 chs. to M. C. of secs. 4 and 5, which is 5.08 chs. S. 0° 7' E. of cor. of secs. 4, 5, 32 and 33.

Land, rolling.
Soil, 3rd rate.
Brush, greasewood.
Scattered palo verde trees.

Thence in sec. 5,

Over rolling land,

Through greasewood and scattered mesquite brush.

S. 72° 26' W. 20.98 chs. to M. C. of sec. 5, which is 11.41 chs. S. 0° 7' E. of the 1/16 sec. cor. No. 1 bet. secs. 5 and 32, on the N. bdy. of the tp., previously described.

S. 79° 30' W. 20.34 " to M. C. of sec. 5, which is 15.12 chs. S. 0° 7' E. of the ¼ sec. cor. bet. secs. 5 and 32, on the N. bdy. of the tp., previously described.
At 8.00 chs., leave rolling land, b rs. NW. and SE. Thence over level land, through dense mesquite.

S. 76° 17' W. 20.5[illegible] " to M. C. of sec. 5, which is also 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 5.

S. 82° 30' W. 1.50 " Set an iron post for angle point with brass cap stamped A P

N. 88° 45' W. 6.86 " to M. C. of sec. 5, which is 8.35 chs. West of 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 5.
This M. C. is at the junction of the right bank of Sycamore Wash with the left bank of Verde River.

Junction of Verde R. and Sycamore Wash. No depths of flow measured.

March 8, 1911

Thence with <u>meanders of the left bank of verde River,</u>

<u>up stream.</u>

In sec. 5.

N. 18° 40' W. 21.11 chs. to M. C. of secs. 5 and 32, which is 15.10 chs. West of 1/16 sec. cor. No. 2 bet. secs. 5 and 32, W½, on the N. bdy. of the tp., both cors. previously described.
At 18.00 chs., road brs. NE. and SW.

Land, level.
Soil, 2nd rate.
Brush, mesquite.

- March 8, 1911.

<u>Meanders of Island in Sycamore Wash, in sec. 5:</u>

March 9, 1911, at 8h., a.m., l.m.t., I set off 33° 38' N. on the latitude arc, 4° 44' S. on the declination arc, and determine a meridian with the solar at the M. C. of sec. 5, which is 11.50 chs. East of 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 5. This M. C. is on the East shore of low island in Sycamore wash, in sec. 5, T. 3 N., R. 7 E.

Thence I run with meanders in sec. 5,

Along low bank,

Through sage brush.

S. 28° 0' W.	5.70 chs.	Set an iron post for angle point with brass cap stamped A P
S. 59° 15' W.	3.50 "	set an iron post for angle point with brass cap stamped A P
N. 83° W.	5.86 "	to M. C. of sec. 5, which is 6.10 chs. S. 0° 7' E. of 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 5.
N. 69° 30' W.	2.00 "	set an iron post for angle point with brass cap stamped A P
N. 28° 15' W.	6.12 "	to M. C. of sec. 5, which is 4.77 chs. West of 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 5.
N. 25° 45' W.	5.20 "	Set an iron post for angle point with brass cap stamped A P
N. 8° 30' E.	4.40 "	Set an iron post for angle point with brass cap stamped A P
N. 31° 15' E.	5.20 "	Set an iron post for angle point with brass cap stamped A P
N. 85° 45' E.	3.70 "	to M. C. of sec. 5, which is 13.74 chs. N. 0° 7' W. of 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 5.
S 76° 30' E.	4.00 "	Set an iron post for angle point with brass cap stamped A P
S. 62° 30' E.	4.00 "	set an iron post for angle point with brass cap stamped A P
S. 52° E.	9.00 "	Set an iron post for angle point with brass cap stamped A P
S. 29° 15' W.	6.22 "	to M. C. of sec. 5, which is 11.50 chs. East of the 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 5, the place of beginning.

Land, level.
Soil, 2nd rate.
Brush, sage.

March 9, 1911: Cloudy at noon; no observation for latitude.

March 9, 1911.
Cloudy at noon.
No depths of flow measured.

On Salt River March 9, 1911.

No depths of flow measured.

Meanders of the right bank of Salt River, up stream.

March 9, 1911, I commence at the meander cor. of secs. 4 and 33, which M. C. is 1 ch. East of cor. of secs. 4, 5, 32 and 33, on the S. bdy. of the tp., both corners previously described.

Thence I run with meanders in sec. 33,

Along the right bank of Salt River (which river is part of the South and East bdy. of Salt River Indian Reservation), up stream,

Over level land, through brush, along bank 5 ft. high.

N. 28° 0' E.	9.00 chs.	Set an iron post for angle point with brass cap stamped A P
N. 49° 30' E.	11.50 "	Set an iron post for angle point with brass cap stamped A P
N. 53° 30' E.	13.00 "	Set an iron post for angle point with brass cap stamped A P
N. 75° 30' E.	6.62 "	to M. C. on East bdy. of old Camp McDowell Reservation, which is 55.63 chs. S. 6° 45' W. from C. C. of secs. 28 and 33, both corners previously described.

Land, level.
Soil, 2nd and 3rd rate.
Mesquite brush.

\- March 9, 1911.

River very low at time of survey with depths from 21/2 to 4 ft deep

GENERAL DESCRIPTION.

The portion of T. 3 N., R. 7 E., which is within the Salt River Indian Reservation, contains two kinds of land, rolling and rocky, 4th rate, and flat and sandy along river, 2nd rate.

Verde River runs Southerly through secs. 5,6,7,8,18,19, 20,29,30,31,32. At the time of survey it was very low, being from 2½ to 4 ft. deep.

Very Low!

Sycamore Wash runs Westerly through secs. 4 and 5, into Verde River. At time of survey, it was dry.

There is very little land East of the Verde River fit for cultivation, but almost all of the land West of the river, except sec. 31 and the S. ½ of sec. 30, can be cultivated when cleared.

There are groups of Indian huts all along the West side of the river, but none on the East side.

The quarters of the Indian Superintendent are in the North ½ of sec. 6. An artesian well and windmill are in the NE. ¼ of sec. 6.

There is a fringe of cottonwood trees along the West bank of the river, but on the East side the mesquite extends to edge of the bank.

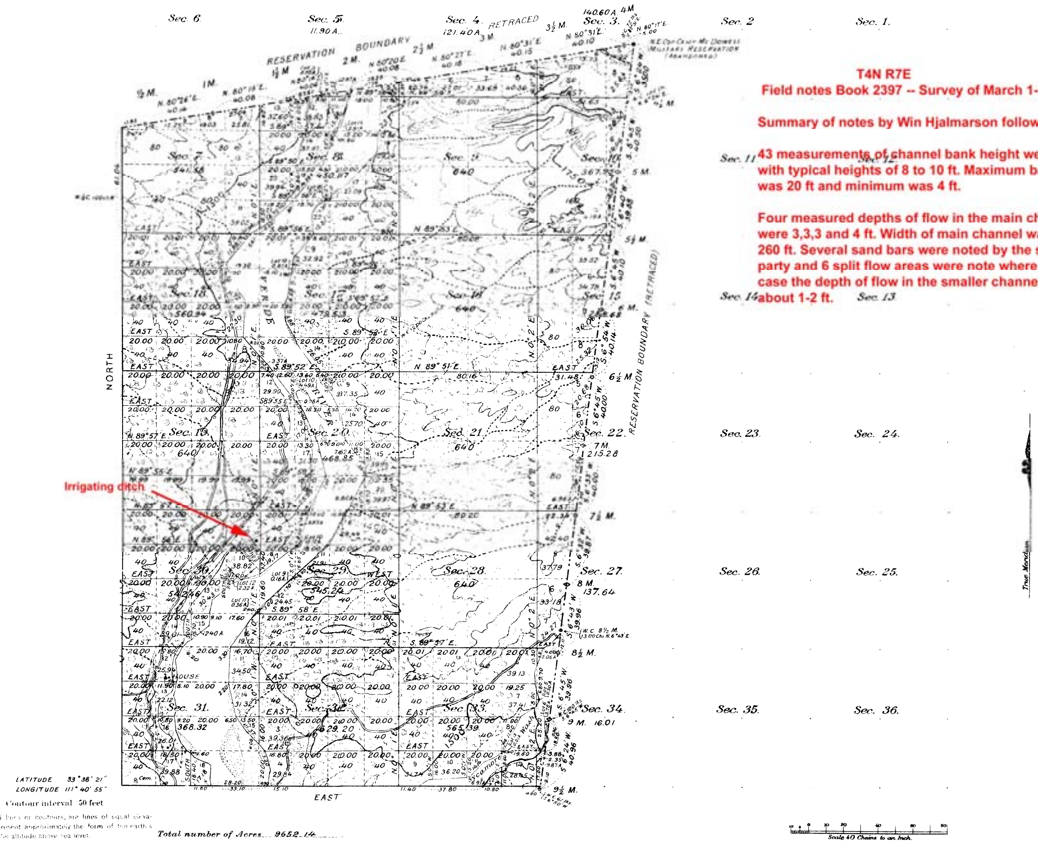
Robert A. Farmer,

Topographer and U. S. Surveyor.

Resurvey of Township No. 4 North Range No. 7 East of the Gila and Salt River Meridian, Arizona. 800181

SALT RIVER INDIAN RESERVATION

OFFICIALLY FILED 6-16-1913



Contour interval 50 feet

Note: Curved lines or contours, are lines of equal elevation, and represent approximately the form of the earth's surface and the altitude above sea level.

Total number of Acres 9652.14

Surveys Designated	*By Whom Surveyed*		*When Surveyed*
Standard lines			
Township "	R. A. Farmer	———	Feb 27-28, 1911
Subdivision "	"	———	Mar. 1-16, 1911
Meander "	"	———	Mar. 17-20, 1911
Boundary "	"	———	Feb. 18-23, 1911

A. F. DUNNINGTON,
Topographer in charge.
Instructions October 11, 1910.

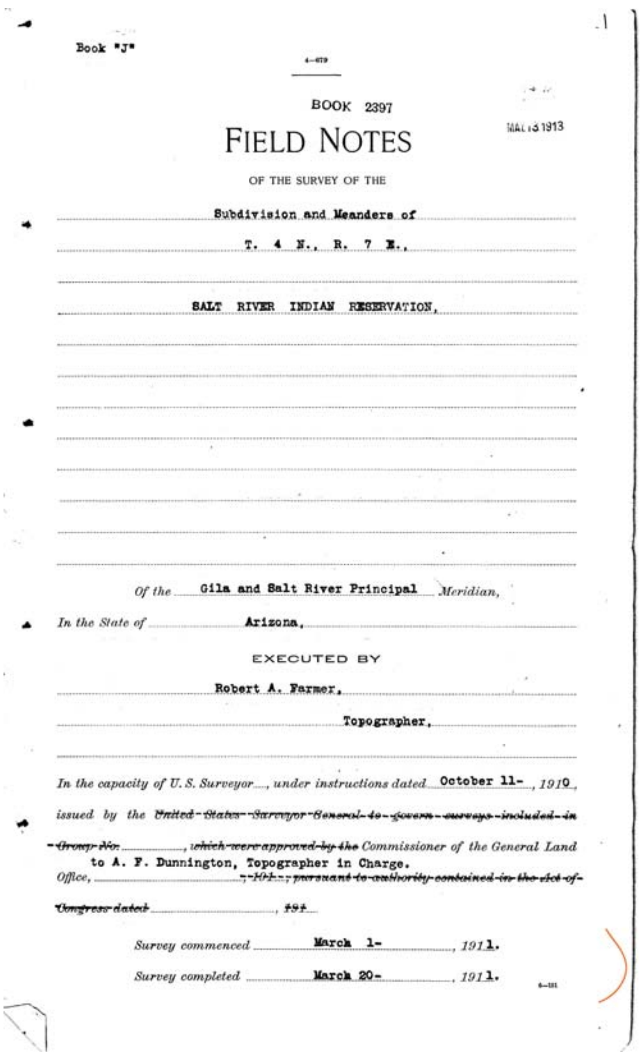
The above Map, of Township No. 4 North, of Range No. 7 East, of the Gila and Salt River Meridian, Arizona, is strictly conformable to the field notes of the resurvey thereof on file in this Office, which have been examined and approved. W.H.L.

U. S. GENERAL LAND OFFICE
Washington, D. C.
March 29, 1913.

Commissioner.

T4N R7E: The US Weather Bureau description of precipitation, temperature and a storm for March 1911 form the basis of this assessment. The rains on March 3-5 produced "moderate floods" on the Verde River on the 6th-8th of March. The snow disappeared at the 7000 ft elevations on the 13th and at the 8000 ft elevation on the 21st of March, 1911.

Measurements of depth were for base flow conditions except possibly for the 3 ft. depths on Mar. 8 and 13, 1911 (pages 45 & 69 of the survey notes). There is no mention of high flow in the survey notes. Thus, measurements of depth of 4 ft and 3 ft. were for base flow and the two later measured depths 3 ft. may have some direct runoff based on records of stage at the USGS gage nr Camp Verde and Weather Bureau records.



Book "J"

4—679

BOOK 2397

MAR 13 1913

FIELD NOTES

OF THE SURVEY OF THE

Subdivision and Meanders of

T. 4 N., R. 7 E.,

SALT RIVER INDIAN RESERVATION,

Of the Gila and Salt River Principal *Meridian,*

In the State of Arizona,

EXECUTED BY

Robert A. Farmer,

Topographer,

In the capacity of U. S. Surveyor, under instructions dated October 11-, *1910,*

issued by the ~~*United States Surveyor General to govern surveys included in Group No.*~~ *,* ~~*which were approved by the*~~ *Commissioner of the General Land Office,* to A. F. Dunnington, Topographer in Charge. ~~*, 191 ; pursuant to authority contained in the act of Congress dated , 191*~~

Survey commenced March 1-, *1911.*

Survey completed March 20-, *1911.*

Pages 1, 6-8, 42,45,46, 68,69 Book 2397 of the GLO survey by Mr. Farmer for at T4N R7E follow. Both this survey (Mar. 1-20) and the previous survey (Feb. 18-Mar. 9) were made by Mr. Farmer in 1911).

Date is March 2, 1911 on p. 6 of survey notes. A measurement of depth on following page of notes.

Subdivision T. 4 N., R. 7 E.

Chains	
	Soil, 1st rate. Greasewood brush, and mesquite. - March 2, 1911.
	March 2, 1911, at 7h., a.m., l.m.t., I set off 33° 38' N. on the latitude arc, 7° 25' S. on the declination arc, and determine a meridian with the solar at the ¼ sec. cor. bet. secs. 31 and 32.
	Thence I run
	West on a random line through middle of sec. 31.
20.00	Set temp. 1/16 sec. cor. No. 7.
40.00	Set temp. C. ¼ sec. cor.
60.00	Set temp. 1/16 sec. cor. No. 8.
80.00	Intersect ¼ sec. cor. bet. secs. 31 and 36, on the W. bdy. of the tp., previously described.
	Thence I run
	East on a true line through middle of sec. 31,
	Descending to river bottom.
6.50	Abandoned ditch, 15 lks. wide, course SW.
16.50	Road brs. NE. and SW.
18.30	Wire fence brs. N. 15° W. and S. 15° E.
20.00	Set an iron post for 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 31, with brass cap stamped No 8 in N. 1/16 S 31 in Center 1911 in S.
	Dig pits 18x18x12 ins. E. and W. of post 3 ft. dist.;and raise mound of earth 3½ ft. base, 1½ ft. high, N. of cor.
21.50	Irrigation ditch, 16 lks. wide, course S.
	Foot of descent; enter river bottom land, brs. N. and S., and dense mesquite thicket, same bearing.
25.00	Leave thicket, brs. N. and S. Enter old field.
30.80	Right bank of Verde River, 4 ft. high.
	Set an iron post for M. C. of sec. 31, with brass cap stamped M C in E. 1911 in S. 1/16 S 31 in W.
	Dig a pit 36x36x12 ins. 8 ft. W. of post and raise mound of earth 4 ft. base, 2 ft. high, W. of cor.

Depth measurement of 3 ft on March 2, 1911.

BOOK—2397 7

Subdivision T. 4 N., R. 7 E.

Chains	
31.00	Foot of river bank; enter channel of Verde River, 3 ft. deep, course S.
40.00	Point for C. ¼ sec. cor. falls in river.
60.00	Point for 1/16 sec. cor. No. 7 falls in river.
65.00	Leave channel, course S. 20° E. Thence over sand bar.
66.50	Left bank of Verde River, 4 ft. high, course S. 20° E.
	Set an iron post for M. C. of sec. 31, with brass cap stamped
	1/16 M C in W. 1911 in S. S 31 in E.
	Dig a pit 36x36x12 ins. 8 ft. E. of post and raise mound of earth 4 ft. base, 2 ft. high, E. of cor.
	Thence over flat, open land.
68.00	Leave open land; enter dense mesquite thicket with scattered cottonwood timber, brs. N. and S.
72.00	Dry wash, 28 lks. wide, course SW.
80.00	The ¼ sec. cor. bet. secs. 31 and 32.
	Land, mostly river bottom. Soil, 1st and 2nd rate. Timber, cottonwood. Dense mesquite underbrush.
	From the 1/16 sec. cor. No. 6 bet. secs. 31 and 32, N½,
	I run
	West on a random line through N. ½ of sec. 31.
20.00	Set temp. 1/16 sec. cor. No. 5.
40.00	Set temp. 1/16 sec. cor. No. 4.
60.00	Set temp. 1/16 sec.cor. No. 3.
80.00	Intersect 1/16 sec. cor. No. 6 bet. secs. 31 and 36, N½, on the W. bdy. of the tp., previously described.
	Thence I run
	East on a true line through N. ½ of sec. 31,
	Descending over smooth land, through brush.
15.00	Abandoned irrigation lateral, 20 lks. wide, course SW.
17.20	Road brs. NE. and SW.
17.40	Wire fence brs. NE. and SW. Foot of descent.

Measurement of depth = 4 ft on p. 8 of survey notes. Date is March 2, 1911.

Subdivision T. 4 N., R. 7 E. BOOK 2397

Chains	
	Enter level river bottom, brs. NE. and SW.
18.00	Dry wash, 30 lks. wide, course NE.
20.00	Set an iron post for 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 31, with brass cap stamped
	No 3 in N. 1/16 S 31 in center 1911 in S.
	Dig pits 18x18x12 ins. E. and W. of post 3 ft. dist.; and raise mound of earth 3½ ft. base, 1½ ft. high, N. of cor.
24.90	Wire fence brs. N. and S.
26.00	Frame house 25x40 ft. brs. N. 2.25 chs. dist.
27.40	Irrigation ditch, 20 lks. wide, course S. 10° E.
	Leave brush; enter field, brs. N. and S.
31.90	Right bank of Verde River, 8 ft. high, course S.
	Set an iron post for M. C. of sec. 31, with brass cap stamped
	M C in E. 1911 in S. 1/16 S 31 in W.
	Dig pit 36x36x12 ins. 8 ft. W. of post and raise mound of earth 4 ft. base, 2 ft. high, W. of cor.
	Enter channel of river, 4 ft. deep, course S.
37.90	Leave channel of river; thence over sand bar.
40.00	Point for 1/16 sec. cor. No. 4 falls in river.
60.00	Point for 1/16 sec. cor. No. 5 falls in river.
62.20	Left bank of Verde River, 4 ft. high.
	Set an iron post for M. C. of sec. 31, with brass cap stamped
	1/16 M C in W. 1911 in S. S 31 in E.
	Dig a pit 36x36x12 ins. 8 ft. E. of post and raise mound of earth 4 ft. base, 2 ft. high, E. of cor.
	Thence over river bottom.
66.00	Enter dense mesquite thicket, along river bank.
80.00	The 1/16 sec. cor. No. 6 bet. secs. 31 and 32, N½.
	Land, mostly river bottom. Soil, 1st rate. Greasewood brush. Dense mesquite thicket.

Date on p. 11 of survey notes established as March 3, 1911.

Subdivision T. 4 N., R. 7 E. BOOK 2397

Chains

2 notches on the S. and 5 on the E. edge.

From which -

Mesquite, 8 ins. in diam., brs. N. 79° 20' E., 352 lks. dist., mkd. T 4 N R 7 E S 20 B T
Mesquite, 6 ins. in diam., brs. S. 61° 55' E., 62 lks. dist., mkd. T 4 N R 7 E S 29 B T
Mesquite, 10 ins. in diam., brs. S. 67° 15' W., 178 lks. dist., mkd. T 4 N R 7 E S 30 B T
Mesquite, 7 ins. in diam., brs. N. 84° 50' W., 179 lks. dist., mkd. T 4 N R 7 E S 19 B T

After diligent search, find no trace of old cor.

Land, river bottom, 60.40 chs. River bed and channel, 19.60 chs.
Soil, 1st rate.
Timber, mesquite, with thick mesquite underbrush.

March 3, 1911, at the cor. of secs. 19, 20, 29 and 30, I set off 7° 0' S. on the declination arc, and at 12h. 12m. 15s., p.m., l.m.t., observe the sun on the meridian; the resulting latitude is 33° 40' N., which is within 1' of the correct latitude. 3/3/11

Thence I run

West on a random line bet. secs. 19 and 30.

Chains	
20.00	Set temp. 1/16 sec. cor. No. 1.
40.00	Set temp. ¼ sec. cor.
60.00	Set temp. 1/16 sec. cor. No. 2.
80.00	Fall 6 lks. N. of cor. of secs. 19, 24, 25 and 30, on the W. bdy. of the tp., previously described.

Thence I run

N. 89° 57' E. on a true line bet. secs. 19 and 30,

Descending over smooth land, through brush.

Chains	
0.10	Draw, 15 lks. wide, drains SE.
12.00	Dry wash, 20 lks. wide, course SE.
20.00	Set an iron post for 1/16 sec. cor. No. 2 bet. secs. 19 and 30, W½, with brass cap stamped

No 2 1/16 S 19 in N.
S 30 1911 in S.

Dig pits 18x18x12 ins. E. and W. of post 3 ft. dist.; and raise mound of earth 3½ ft. base, 1½ ft. high, N. of cor.

No B.T.'s available.

Date on p. 42 of survey notes is March 8, 1911.

Subdivision T. 4 N., R. 7 E. BOOK 2397

Chains	
	Begin descent along N. slope of ridge.
80.04	The cor. of secs. 20, 21, 28 and 29.
	Land, river bottom, 1st rate, 28.00 chs. Rough and broken, 29.40 chs. River channel and s and bar, 10.60 chs. Timber, mesquite and cottonwood, 28.00 chs. Brush, greasewood and catclaw.
	March 8, 1911, at this cor., I set off 5° 4' S. on the declination arc, and at 12h. 11m., p.m., l.m.t., observe the sun on the meridian; the resulting latitude is 33° 40' N., which is within 1' of the correct latitude.
	From the 1/16 sec. cor. No. 12 bet. secs. 28 and 29, S½,
	I run
	West on a random line through the S. ½ of sec. 29.
20.00	Set temp. 1/16 sec. cor. No. 11.
40.00	Set temp. 1/16 sec. cor. No. 10.
60.00	Set temp. 1/16 sec. cor. No. 9.
80.04	Fall 4 lks. S. of the 1/16 sec. cor. No. 12, bet. secs. 29 and 30, S½.
	Thence I run
	S. 89° 58' E. on a true line through the S. ½ of sec. 29
	Over river bottom, through brush.
20.01	Set an iron post for 1/16 sec. cor. No. 9 in the center of the SW. ¼ of sec. 29, with brass cap stamped No 9 in N. 1/16 S 29 in center 1911 in S.
	Raise mound of stone 2 ft. base, 1½ ft. high, N. of cor.
28.00	Leave river bottom, brs. NW. and SE.
	Begin ascent over rough land.
40.02	Set an iron post for 1/16 sec. cor. No. 10 bet. the SE. ¼ and SW. ¼s of sec. 29, with brass cap stamped No 10 in N. 1/16 S 29 in center 1911 in S.
	Raise mound of stone 2 ft. base, 1½ ft. high, N. of cor
42.00	Top of ascent, brs. NW. and SE.
	Thence over rough land.
46.00	Dry wash, 20 lks. wide, course SW.

Measurement of flow depth = 3 ft. deep on p. 45 of survey notes.

Subdivision T. 4 N., R. 7 E. BOOK 2397

Chains	
23.00	Enter shallow channel of Verde River, 1 to 3 ft. deep, course SW.
32.00	Enter main channel, 3 ft. deep, course SW. 3
39.10	Leave main channel, and ascend steep bank, 20 ft. high,
40.00	Top of left bank of Verde River.
	Set an iron post for 1/16 sec. cor. No. 4 and also M. C., bet. the NE. and NW. ¼s of sec. 29, with brass cap stamped 1/16 M C in W. 1911 in S. S 29 in E.
	Dig a pit 36x36x12 ins. 8 ft. E. of post and raise mound of earth 4 ft. base, 2 ft. high, E. of cor.
	Thence over rough and broken land, through greasewood brush.
41.00	Begin ascent, brs. NE. and SW.
46.00	Top of ascent, brs. NE. and SW.
	Thence over rough and broken land.
60.00	Set an iron post for 1/16 sec. cor. No. 5 in the center of the NE. ¼ of sec. 29, with brass cap stamped No 5 in N. 1/16 S 29 in center 1911 in S.
22	Raise mound of stone 2 ft. base, 1½ ft. high, N. of cor.
62.00	Begin descent brs. NE. and SW.
67.00	Dry wash, 8 lks. wide, course SW.
	Foot of descent; begin ascent, brs. NE. and SW.
77.00	Top of ascent, brs. NE. and SW.
80.00	The 1/16 sec. cor. No. 6 bet. secs. 28 and 29, N½.
	Land, river bottom, soil 1st rate, 22.00 chs. Rough and broken, rocky and 3rd rate, 40.00 chs. River and sand bar, 18.00 chs. Timber, cottonwood for 7.00 chs. Brush, catclaw, mesquite, greasewood.

	From the 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 29, I run
	N. 0° 1' E. on a random line through middle of E sec. 29.

Date is March 8, 1911 on p. 46 of survey notes.

Subdivision T. 4 N., R. 7 E.

Chains	
20.00	Intersect the 1/16 sec. cor. No. 3 in the center of the NW. ¼ of sec. 29.
	Thence I run
	S. 0° 1' W. on a true line through middle of the NW. ¼ of sec. 29,
	Over level river bottom, through heavy cottonwood timber and dense arrow weed underbrush.
1.25	Right bank of Verde River, 4 ft. high, course SW.
	Set an iron post for M. C. of sec. 29, with brass cap stamped
	M C 1911 in S. 1/16 S 29 in N.
	From which -
	Cottonwood, 8 ins. in diam., brs. N. 71° 45' W., 54 lks. dist., mkd. 1/16 S 29 B T Cottonwood, 10 ins. in diam., brs. N. 3° 30' W., 26 lks. dist., mkd. 1/16 S 29 B T
1.38	Enter shallow channel of Verde River, 1 to 2 ft. deep, course SW.
8.00	Enter main channel of Verde River, course SW.
17.80	Leave channel of Verde River; begin ascent of steep bank.
18.10	Top of left bank of Verde River, 20 ft. high.
	Set an iron post for M. C. of sec. 29, with brass cap stamped
	1/16 M C in N. S 29 1911 in S.
	Dig a pit 36x36x12 ins. 8 ft. S. of post and raise mound of earth 4 ft. base, 2 ft. high, S. of cor.
20.00	The 1/16 sec. cor. No. 8 bet. the NW. and SW. ¼s of sec. 29.
	Land, river bottom, soil 1st rate, 1.25 chs. Rough and rocky, 1.90 chs. River channel, 17.85 chs. Cottonwood timber, 1.25 chs., N½. Greasewood brush, 1.90 chs., S½.
	- March 8, 1911.

March 9, 1911, at 7h., a.m., l.m.t., I set off 33° 40' N. on the latitude arc, 4° 43' S. on the declination arc, and determine a meridian with the solar at the cor. of secs. 20, 21, 28 and 29.

March 8, 1911

Date is March 11, in middle of p. 68 of survey notes.
Date is March 13, 1911 on bottom of p. 68 of survey notes.

BOOK 2397

Subdivision T. 4 N., R. 7 E.

Chains	
	Thence over river bottom, through timber.
34.00	Leave river bottom and mesquite timber, brs. NE. and SW.
	Begin gradual ascent through scattered palo verde and ironwood timber, and greasewood brush.
40.00	Set an iron post for ¼ sec. cor. bet. secs. 5 and 8, with brass cap stamped ¼ S 5 in N. S 8 1911 in S. Dig pits 18x18x12 ins. E. and W. 3 ft. dist.; and raise mound of earth 3½ ft. base, 1½ ft. high, N. of cor. No B.T.'s available.
47.00	Dry wash, 8 lks. wide, course SE.
49.10	Intersect North bdy. of old Camp McDowell Reservation, at a point from which the 1½ M. P. brs. S. 80° 19' W., 18.37 chs. dist. Set an iron post for C. C. of secs. 5 and 8, with brass cap stamped C C in E. 1911 in S. T 4 N S 5 in NE. quadrant R 7 E S 8 " SE. " 5 notches on the S. and 1 on the N. edge. From which - Palo verde, 6 ins. in diam., brs. N. 89½° E., 114 lks. dist., mkd. T 4 N R 7 E S 5 C C B T Palo verde, 8 ins. in diam., brs. S. 8½° E., 185 lks. dist., mkd. T 4 N R 7 E S 8 C C B T Land, rough and broken, 6.90 chs. River bottom, 9.10 chs. Smooth slope, 15.10 chs. Soil, 1st to 3rd rate. Timber, mesquite, palo verde and ironwood. Brush, greasewood and catclaw. - March 11, 1911.

Chains	
	March 13, 1911, at 8h., a.m., l.m.t., I set off 33° 42' N. on the latitude arc, 3° 9' S. on the declination arc, and determine a meridian with the solar at the 1/16 sec. cor. No. 12 bet. secs. 8 and 9, 8½. Thence I run N. 89° 56' W. on a random line through S. ½ of sec. 8.
20.00	Set temp. 1/16 sec. cor. No. 11.
40.00	Set temp. 1/16 sec. cor. No. 10.

Measurement of flow depth = 3 ft. deep on p. 69 of survey notes.
Data = March 13, 1911 on bottom of prior page.

69

…K 2397

Subdivision T. 4 N., R. 7 E.

Chains	
60.00	Set temp. 1/16 sec. cor. No. 9.
80.00	Intersect the 1/16 sec. cor. No. 12 bet. secs. 7 and 8, 8½.
	Thence I run
	S. 89° 56' E. on a true line through S. ½ of sec. 8,
	Over level river bottom,
	Through dense mesquite thicket.
14.60	Road brs. N. and S.
18.00	Leave mesquite thicket.
19.20	Right bank of Verde River, 10 ft. high, course S. 50° W.
	Set an iron post for M. C. of sec. 8, with brass cap stamped
	M C in E. 1/16 in NW. 1911 in S. S 8 in W.
	Dig a pit 36x36x12 ins. 8 ft. W. of post and raise mound of earth 4 ft. base, 2 ft. high, W. of cor.
	No B.T.'s available.
19.35	Enter channel Verde River, 3 ft. deep, course SW.
20.00	Point for 1/16 sec. cor. No. 9 falls in river.
35.00	Leave main channel of Verde River; thence over sand bar.
38.70	Left bank of Verde River, 6 ft. high.
	Set an iron post for M. C. of sec. 8, with brass cap stamped
	M C in W. 1/16 in NW. 1911 in S. S 8 in E.
	From which -
	Mesquite, 10 ins. in diam., brs. S. 71° E., 45 lks. dist., mkd. 1/16 S 8 M C B T Mesquite, 6 ins. in diam., brs. S. 40° E., 36 lks. dist., mkd. 1/16 S 8 M C B T
	Thence over level river bottom,
	Through mesquite timber and brush.
40.00	Set an iron post for 1/16 sec. cor. No. 10 bet. the SE. and SW. ¼s of sec. 8, with brass cap stamped
	No 10 in N. 1/16 S 8 in center 1911 in S.
	From which -
	Mesquite, 10 ins. in diam., brs. N. 38½° E., 63 lks.

This description of entering the 3 ft. deep channel and leaving the main channel then crossing a sand bar does not give me the impression the flow was very high. I've waded (measured) the Verde many times as a young USGS engineer and it would be very risky to do so when there was direct runoff of any consequence.

Based on the GLO survey there was a sandy main channel with defined banks a few feet high. There were also overflow channels in places that may of may not have contained base flow (when there were few diversions upstream).

SUPPLEMENT 5. Six notes on dry land farming

<u>Dry Note 1:</u> A little dry farming in the Prescott area but where ever practicable "... irrigation has been employed...". Text and reference shown below:

YAVAPAI COUNTY, the largest in the United States (*a*), comprises about one-fourth the area of Arizona. The county contains an exceedingly small proportion of irrigable land, since it includes that part of Arizona adjoining Utah which contains the greater portion of the grand canyons of the Colorado. These stupendous gorges cut the great plateau to the depth of from 3,000 to 6,000 feet. The minor lateral canyons, in which flow the tributaries of the Colorado, are also cut to a great depth, which decreases toward their head waters. Thus the water of the northern part of the territory, though large in amount, is wholly useless, lying as it does hundreds and thousands of feet below the level of the arable lands. It is only toward the southern portion of the county, where the great plateau begins to break off and the valleys are less deep and narrow, that agriculture has been seriously attempted. Along the line of the Atlantic and Pacific railroad, which crosses the county from east to west, at an elevation of from 5,000 to 7,000 feet, some crops, especially for forage, are raised without irrigation. For example, at Flagstaff, at an elevation of about 7,000 feet, corn, potatoes, and vegetables, as well as a little wheat, oats, and barley are thus cultivated, the cereals being generally cut for forage purposes. The same is true of Prescott, although near that place irrigation has been employed wherever practicable. On the head waters of the Agua Fria, at an elevation of about 4,500 feet, there is also a little dry farming.

Newell, F. H., 1894, Report on agriculture by irrigation in the western <u>United States. Census Office</u>, 11th census, 1890, U.S. Government Printing Office, 336 pages, page 31

<u>Dry Note 2:</u>

Area VII

Intermediate Altitude Livestock Grazing Area

Area VII has a somewhat higher altitude than Areas II and V, the range in altitude varying from 3,000 to 5,000 feet. It is primarily a livestock grazing area, although a small number of irrigated valleys are scattered throughout the area. Water supply for these small irrigated areas is obtained from streams, small reservoirs, and in a few cases from wells. There is one small artesian well district (flowing) in this area. Acreage served, however, is not great. Some dry farming is practiced in certain higher altitude sections, but production is uncertain.

Baker. H. R., 1936, Type of farming areas in Arizona; SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1936, 97p. (p. 88).

<u>Dry Note 3:</u>

DEFICIENCY OF WATER.

As to the practical bearings of these investigations it is sufficient to state that the area cultivated by irrigation in most drainage basins of the arid region is far larger than can be covered by the present water

222 HYDROGRAPHY OF THE ARID REGIONS.

supply, and each year the crops upon thousands of acres in various localities are injured or lost for lack of water at critical times. Besides this, there is a still greater acreage which can be reached by canal systems constructed or projected, including bodies of land as good as that now under cultivation and sometimes better, and in addition to these irrigated and irrigable lands there are in many parts of the arid region plains of arable land so vast that by no possibility can they ever be brought under irrigation. Thus as a whole the water supply can never be conserved too carefully, for there will always be fertile lands in excess of that supply.

With greater economy in the use of the present available water, a greater acreage each year can be successfully cultivated, but there will soon be a limit to the slow growth in this manner, for under ordinary circumstances it will happen that each year the amount of land successfully cultivated must fluctuate with the variations of water in the rivers; in years of large flow, the farmers will be prosperous, while, when droughts occur, a certain portion of the crops will be lost, if dependence is placed wholly upon the unregulated flow of the streams.

(Newell, 1891, pp. 221-222).

Newell, F. H., HYDROGRAPHY OF THE ARID REGIONS, in Powell, J. W., 1890-91, Twelfth Annual Report of the USGS, Part 2 Irrigation; WASHINGTON, GOVERNMENT PRINTING OFFICE 1891, 576p. (pp. 213-361).

General Comment: A limited amount of (experimental?) dry land farming in Big Chino Valley is noted in my report. See for example p. 43, pp 51-52 and p. 69, Appendix F.

Dry Note 4:

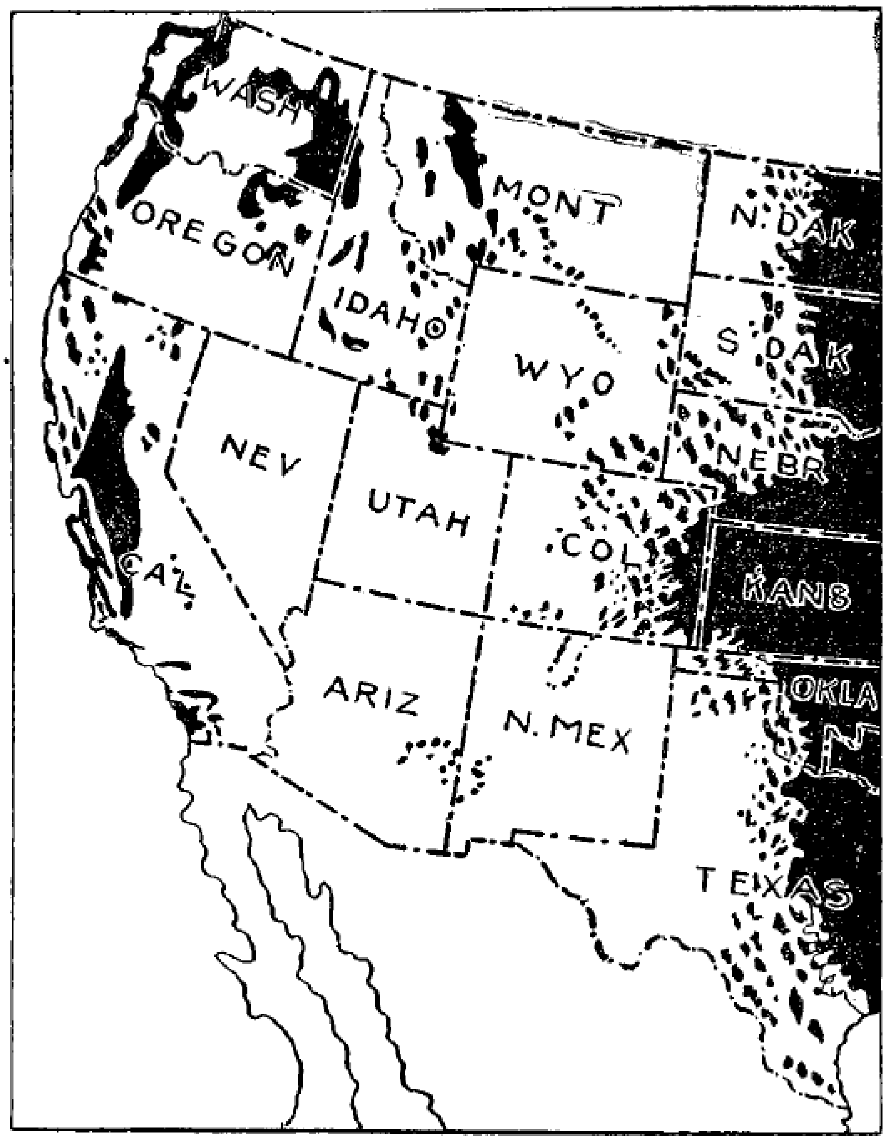


Fig. 20. The dry-farming areas (in black) in the western United States (After Newell.)

King, F. H. , 1907, Irrigation and drainage, *PRINCIPLES AND PRACTICE OF THEIR CULTURAL PHASE, 5th edition,* THE MACMILLAN COMPANY, London, 502p. (p. 102).

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Dry Note 5: Moisture in the spring months is most useful for the germinating seed and the early growth of plants. “Where irrigation is depended upon it is important to store a part of the flood waters and the run-off from early melting of mountain snows into reservoirs for the supply of late water when the streams are low. The dry farmer, where winter rains prevail, stores the moisture in his cultivated ground and the fallow lands of other regions act as storage until there is sufficient rainfall for the maturing of crops.” The following rainfall table is presented that shows sporadic and unreliable summer rainfall (footnote f) is a source of water for dry farming in AZ.

THE ARID REGION RAINFALL TABLE.

STATE.	PLACE.	Sec. of State.	Winter inches	Spring inches	Summer inches	Fall inches	Totals inches	
CALIFORNIA	Los Angeles	S. W.	8.9	4.3	0.1	2.3	15.6	a
	San Diego	S.	5.4	2.4	0.3	1.3	9.4	a
	Salton	S.	1.6	0.3	0.3	0.3	2.5	a
	San Jose	E. Cen.	7.5	4.6	0.1	2.6	14.8	a
OREGON	The Dalles	N. Cen.	7.8	2.6	0.9	4.1	15.4	a
	Pendleton	N. E.	4.7	4.2	1.8	3.8	14.5	a
WASHINGTON	North Yakima	E.	4.0	2.0	0.7	2.2	8.9	a
	Spokane	East	6.8	4.1	2.7	4.7	18.3	a
NEVADA	Carson City	West	5.3	2.7	0.7	2.1	10.8	a
	Potts	Central	2.0	3.1	1.4	0.8	7.3	a
	Pioche	S. E.	4.3	2.8	...	1.6	11.2	a
IDAHO	Boise	Central	5.2	3.7	1.3	2.7	12.9	a
	Pocatello	S. E.	3.0	4.1	0.9	1.8	9.8	a
UTAH	Provo City	Central	3.9	3.9	0.9	2.2	10.9	a
	Moab	Eastern	2.0	1.8	1.4	2.3	7.5	a
	Salt Lake City	N. Cen.	4.1	5.9	2.0	3.8	15.8	a
	Logan	N. W.	3.4	5.8	1.5	3.4	14.1	a
MONTANA	Kalispell	North	3.4	4.1	4.3	4.6	16.4	b
	Crow Agency	South	1.9	4.3	4.8	2.6	13.6	c
WYOMING	Laramie	South	0.9	3.5	3.5	2.0	9.9	c
	Evanston	S. W.	4.0	4.3	1.9	2.9	13.1	c
	Cheyenne	S. E.	1.3	4.7	5.0	2.1	13.1	c
	Ft. Laramie	E. Cen.	1.4	4.3	3.7	1.7	11.1	c
	Rawlins	S. Cen.	2.9	4.6	2.8	2.6	12.9	c
WYOMING	Lusk	E. Cen.	1.5	5.1	4.7	1.6	12.9	c
	Alcova	Central	1.5	3.6	2.5	1.8	9.4	c
	Lander	Central	1.9	6.3	2.6	2.6	13.4	c
	Thayne	W. Cen.	4.3	4.0	2.7	3.3	14.3	c
	Buffalo	N. Cen.	1.4	4.2	3.9	1.6	11.1	c
	Basin	N. W.	1.4	2.1	1.2	0.6	5.3	c
	Four Bear	N. W.	0.9	4.1	3.8	2.5	11.3	c
COLORADO	Ft. Collins	North	1.6	5.8	4.6	2.6	14.6	c
	Denver	Central	1.7	5.4	4.4	2.2	13.7	c
	Grand Junction	S. W.	1.4	2.2	1.9	2.2	7.7	c
	Las Animas	S. E.	1.0	3.6	5.1	1.7	11.4	c
	Hamps	On Divide	1.0	4.8	6.1	1.2	13.1	d
NEBRASKA	Kimball	W.	1.9	5.3	5.9	1.8	14.9	e
KANSAS	Garden City	S. W.	2.4	5.6	8.6	3.0	19.6	e
NEW MEXICO	Santa Fe	N. Cen.	2.0	2.7	6.2	3.3	14.2	f
	Mesilla Park	S. Cen.	1.2	1.0	4.8	2.4	9.4	f
ARIZONA	Prescott	Central	4.5	2.8	5.3	3.0	15.6	f
	Tucson	S. E.	2.3	0.9	4.5	2.1	9.8	f
	Yuma	S. W.	1.3	0.4	0.4	0.6	2.7	f

a—Largest rainfall in winter.
b—Evenly distributed.
c—Spring and summer receive most moisture.
d—Late summer.
e—Spring and summer.
f—Summer.

Buffum, B. C., 1909, ARID AGRICULTURE, A Hand-Book for the Western Farmer and Stockman, Published by the Author, 443p. (pp 23-27)

<u>Dry note 6.—</u>Bancroft, H. H.,1889, History of Arizona and New Mexico, Vol. XVII, 1530-1888, SAN FRANCISCO THE HISTORY COMPANY, PUBLISHERS, 829p.

Yavapai county, so named from the Indian tribe, was one of the four original counties created by the first legislature of 1864. At that time it included over half of the whole territory—all north of the Gila and east of the meridian of 113° 20′; and it still comprises more than one fourth, with an area of about 28,000 square miles.[2] North of latitude 35°, or of the rail-

Bancroft, 1899, pp 610-611.

road, is the Colorado plateau, cut to a depth of 1,000 to 6,000 feet by the grand cañon of the great river, and by the hardly less wonderful cañons of the Colorado Chiquito and other branches. This region has some fine forests and extensive grazing lands, but as a rule little water available for agriculture; and it is for the most part unoccupied, except by the Hualapai and Suppai Indians, and by a few Mormons on the Utah frontier. South of latitude 35°, the country is mountainous, but has many fertile valleys, of which that of the Verde is most extensive. It is well timbered, and has in most parts plenty of water, the climate being the most agreeable to be found in the territory. Here the lands are tilled to some extent without irrigation. All the mountains are rich in the precious metals; but most of the mines, as of the population, about 10,000 souls—perhaps considerably more[3]—are in the southwestern corner of the county. Prescott, founded in 1864 on Granite Creek, at an altitude of about 5,500 feet, is delightfully situated, and has many fine buildings of wood, brick, and stone. More than others in Arizona, it is described as resembling an eastern town. In 1864–7, Prescott was the temporary seat of government, and since 1877 has been the permanent capital; it has many large mercantile establishments; is well supplied with banks and with public buildings; and has three daily newspapers, including the *Arizona Miner*, the oldest journal of the territory. Its population is about 2,000. Flagstaff, with perhaps 500 inhabitants, is the leading railroad town, and the centre of an active lumbering and mercantile industry. The Arizona Central Railroad to connect Prescott with the Atlantic and Pacific in the north, and with Phœnix in the south, is expected to accomplish great things for the capital and for the country.[4]

Dry farming in Yavapai County (when the county was larger) is mentioned on the left but the location of this farming is not defined.

Footnote #3 below is interesting. I agree that some early statistics about the population, farming, mining, etc.. in Yavapai County are confusing.

[3] Hamilton gives the pop. in 1882 as 27,680, which is doubtless a great exaggeration, though I have no means of determining the correct figures. Acc. to the U. S. census of 1880, Yavapai had a pop. of 5,013, and Prescott 1,836. Hodge gives the county pop. as 13,738 in 1876. Hinton, 15,000 in 1878. All this is very confusing.

SUPPLEMENT 6. Comparing results of Hjalmarson's Methods 1 and 2 with USGS Bulletin 1177.

The following is an examination of the total and base flow leaving the Verde Valley past the USGS gage below Camp Verde (09506000) also known as the Chasm gage. This analysis uses the results of Methods 1 and 2, USGS Bulletin 1177 and ADWR Bulletin 2. The analysis of the hydrology, mostly the ground water, base flow in the Verde River below Camp Verde and the human impacts for early 1960s conditions as described in USGS Bulletin 1177 is very useful for checking the results of my methods 1 and 2.

> Twenter, F. R., and Metzger, D. G., 1963, Geology and ground water in Verde Valley-the Mogollon Rim region, Arizona: U.S. Geological Survey Bulletin 1177, 132 p.
>
> Owen-Joyce, S., and Bell, C.K., 1983, Appraisal of water resources in the upper Verde River area, Yavapai and Coconino counties, Arizona: Arizona Department of Water Resources Bulletin 2, 219 p

Again, the hydrologic conditions of the Verde Valley area in the early 1960s are important for this analysis because the deep well pumping had not significantly affected the amount of winter component of base flow entering the Verde River. It's fortunate for my analysis that these rather natural ground water-base flow conditions for the Verde Valley area were defined by Twenter and Metzger (1963).

Important items are:

1.—"The base flow in the Verde River and most tributaries varies seasonally in relation to the amount of water used by plants. Base flow is at a maximum in January and February and at a minimum in July and August. The year-to-year variation in base, flow that enters the Verde Valley by way of the Verde River and tributaries is small. A comparison of 1976-79 data with 1935-45 data showed variations in the quantity of summer base flow leaving the Verde Valley, which may indicate an increase in use of water along the streams in the valley rather than being a result of pumpage from the regional aquifer. Pumping from the regional aquifer probably would also decrease the winter base flow as well as the summer base flow." ADWR Bulletin 2 (1983), page 33.

2.—“Ground-water reservoirs that have not been materially affected by development are in hydrologic balance that is, the amount of recharge is about equal to the amount of discharge. The Verde Valley ground-water basin is in hydrologic balance; the amount of water recharged to rocks in the basin is about equal to the amount of water discharged as base flow at the Chasm gaging station...” “The average base flow at the gaging station during the winter 225 cfs or 150,000 acre-feet per year is an approximation of the minimum quantity of water recharged to all rocks in the ground-water basin.“ USGS Bulletin 1177 (1963), p 75.

“No water-level decline has been noted in the short-period records available. Recharge to the aquifers probably balances discharge.” USGS Bulletin 1177 (1963), p 95.

Examining gage records of base flow (and conducting measurements of base flow) in the winter months as discussed above (USGS Bulletin 1177 (1963), p 75.) minimizes the effects of vegetation transpiration and diversion of surface water through human infrastructure such as ditches and pumps. Records of stream flow and other data collected in winter, therefore, are expected to be more indicative of groundwater hydrologic processes.

3.—“All ground water discharged in the Verde Valley ground-water basin, except that lost through evapotranspiration, flows out of the basin at the Chasm gaging station as surface water in the Verde River. The base flow of the river, where it exits from the valley, is 225 cfs. This flow represents the minimum quantity of ground water discharged from rocks in Verde Valley.“ USGS Bulletin 1177(1963), p 75.

4.—Using Method 1 to compute the reduction in base runoff, about 7025 acres of cultivated land was estimated along Granite, Williamson Valley, Walnut and Big Chino Creeks. (Hjalmarson’s Report, p. 26). Typically low dams and shallow wells were used to divert flow to irrigate cultivated land adjacent to the stream channels. A weighted irrigation factor of 3.15 ac-ft/acre was used to determine the amount of water lost to ET (Hjalmarson’s Report ,Table 2 of 2, Item G, p. 20). “A reconnaissance land classification survey made by the Bureau of Reclamation in 1964 identified 13,420 acres as irrigated or as having a history of irrigation.” (USBR, 1974, p36 and p91). Thus, as of 1974, the estimated cultivated area totaling 7025 acres represents 52% of the land having a history of irrigation.

U.S. Bureau of Reclamation (USBR), 1974, Western United States Water Plan, State of Arizona, Chino Valley Unit, Appraisal Report: Bureau of Reclamation, 125 p.

5.—" Ground water in Verde Valley is used for irrigation and for industrial, domestic, and other purposes. Spring flow is the most intensively utilized source of ground water. Some springs discharge less than 10 gpm, whereas several springs, such as Page Springs, discharge more than 10,000 gpm. Development of ground water from wells is increasing, but this development is concentrated in small areas near Camp Verde, Cornville, Cottonwood, and Sedona." USGS Bulletin 1177 (1963), pp 94-95

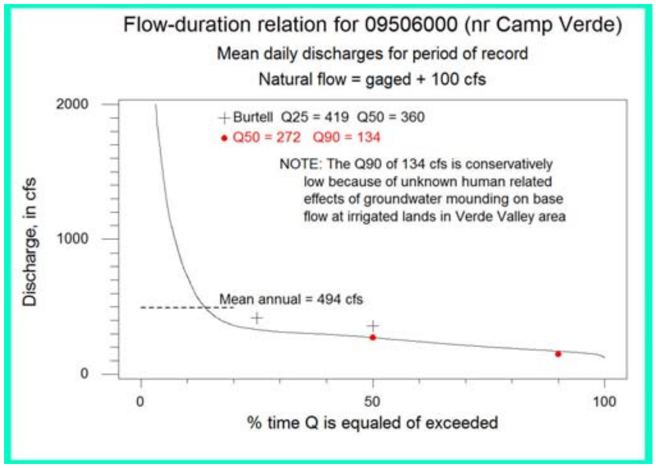
6. – "Ground water in Verde Valley has a twofold importance: (1) in its contribution to the water supply of the Salt River Valley and (2) in its utilization within Verde Valley itself. Large quantities of water derived from Verde Valley by way of the Verde River help to support the agricultural economy of the Salt River Valley in central Arizona. The perennial flow of the Verde River is sustained by ground water from springs that issue from rocks in the Verde Valley ground-water basin. About 225 cfs of the 465 cfs average flow of the river near its exit from Verde Valley is base flow." USGS Bulletin 1177 (1963), pp 94.

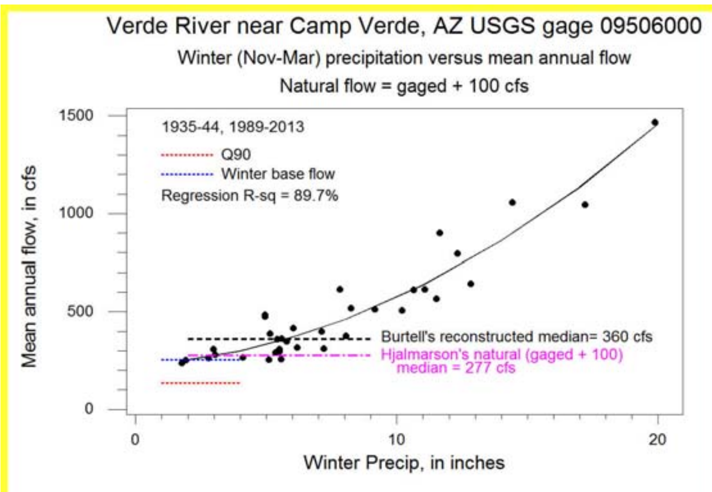
Discussion.--The 465 cfs average flow given above represents the average annual virgin flow at the USGS gage near Camp Verde except for the 28 cfs of virgin flow that was lost to ET from Quaternary aquifers and the land surface upstream of the Clarkdale gage (discussed for my method 2 on page 28 of my report). The sum of this loss of 28 cfs and the average annual flow of 465 cfs is equal to 493 cfs of virgin mean annual flow. This 493 cfs is an important check of method 2 (and also method 1) of my analysis. Consider my Virgin mean annual flow of 494 cfs (Figure G3 of Appendix G (p. 53) and Table 2 of 2 on page 20 of my report) that is only 1 cfs different than 493 cfs of this independent check based on USGS Bulletin 1177 (1963). **This is a marvelous independent check of my hydrologic methods for ANSAC.**

Also, the base flow of 225 cfs in item 6 above can be used to check my median flow of 277 cfs that is mostly base runoff (see figure G3 on p. 53 of Appendix G.). The sum of loss to ET of 28 cfs as discussed above and 225 cfs is equal to 253 cfs or roughly the same as the median at the USGS gage near Camp Verde. and the average annual flow of 465 cfs is equal to 493 cfs of virgin mean annual flow. **Again, this is a great independent check of my hydrologic methods for ANSAC.**

Three ways of looking at the hydrology of the Verde River near Camp Verde are shown in the following figures. The flow-duration relation at gage 09506000, the relation of mean annual flow for 09506000 versus winter precipitation and the median daily flow with the Q90 flow at the same gage may help ANSAC understand the above discussion and the natural hydrology. Hopefully these figures are informative.

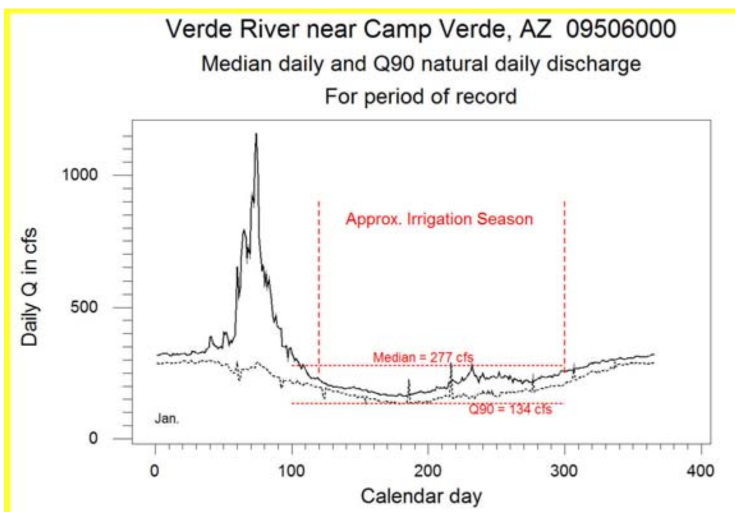
The flow-duration is for my estimate of the natural flow (gaged Q for period of record + 100 cfs). Mr. Burtell's estimates of Q25 and Q50 are greater than the corresponding Q25 and Q50 discharges on the relation that has been adjusted to natural flow (p. 52, section G2, Appendix G).





The winter precipitation versus mean annual runoff relation is surprisingly good. The mean annual precipitation for NOAA North Central Region of AZ is from: http://www.ncdc.noaa.gov/cag/time-series/us

The natural and ordinary flow can be viewed differently as shown on the right where the median discharge for each day of the entire USGS record of flow is presented. The natural median (277 cfs) and natural Q90 (134 cfs) of my analysis are also shown.



SUPPLEMENT 7. A critical look at Mr. Burtell's estimates of natural base flow along the Verde River and in the headwater area upstream of the USGS gage near Clarkdale (09504000).

First, I must apologize to ANSAC for what is by necessity a potentially lengthy discussion. I'll start by repeating why I used the annual water budget approach to describe the hydrology of the river and watershed (See Addition 7 of my Nov. 14, 2014 Addendum for additional information on my method). If the reader is unconvinced that Mr. Burtell's estimates of natural base flow are inappropriate, largely because potentially significant flow components are not defined or presently known, and wishes to read further, the reasons for using annual budgeting are followed by a discussion of what is known using a few facts.

The annual budgeting method I've used for this study for ANSAC obviously uses average annual amounts of water for transpiration, stream flow, precipitation, etc.. Annual budgeting is used even when we know, for example, that water consumption by crops is seasonal and where losses to ET are much greater in the summer than in the winter. We also know that recharge to groundwater from irrigation on lands adjacent to the Verde River and other streams is seasonal. These seasonal, and even daily, effects cause within-year changes in base flow. These changes of base flow affect navigability. Thus, an ideal assessment for ANSAC would include all the natural variability of the water budget components. However, because the water budget components we have are not precisely defined and because of the complex interrelations among the components, I settled on the common practice of annual water budgeting. Ross's study that was used by Mr. Burtell can be thought of as perhaps a starting point or proof of concept for understanding ditch impact on river flow. Perhaps somewhat basic, it demonstrated the concept of modeling the ditches. Thus, rather than fool ANSAC and myself, annual water budgeting, in the absence of complex computer based models that use more information than is available, reflects what we know about the natural base flow along the Verde River at this time.

> Ross, R.P., 2010, One-dimensional hydraulic model of Verde River near Camp Verde, Arizona, including irrigation ditch discharge: Northern Arizona University, Masters thesis, 149 p.

There are a few dozen diversions (ditches) in the Verde Valley and most serve fewer than ten homeowners. Over time the larger ditches have served more homeowners as farms became subdivided. Property owners have a water right served by a ditch and for a relatively small fee (dues) can use the water. Ditches withdraw as much as 50 cfs to 60 cfs (Verde and Cottonwood ditches) and are as much as 17 miles long (Verde Ditch). The pattern of water withdrawal and use has changed over time. Farms have been replaced by small acreages with a suburban agriculture appearance. Retirees water lawns, fruit trees and gardens and enjoy the river environment.

The Verde Ditch--one of oldest ditches in Verde Valley.
Acres served appear approximately the same since 1889. Differences in acres appear related to the source of the information and possibly to actual changes in acres served. Data are from the Verde Ditch wedsite.

http://www.verdeditch.com/page/about-us

Row	year	Acres served	Comment
1	1868	600	
2	1889	1170	
3	1898	1185	
4	1901	1200	Turney Report
5	1914	1170	Hancock Report
6	1914	1245	
7	1940	1250	
8	1979	1403	Verde ditch Co. 6 ac-ft/yr = 8419 ac-ft
9	1997	1337	VNRCD
10	2000	1110	ADWR

As part of a USGS study of base flow in the Verde Valley streamflow records at the Clarkdale gage and Camp Verde gage were used that showed base-flow conditions (See figure below from Garner, B.D., and Bills, D.J., 2012, (page 10).. Note the complex difference in relative amounts of base flow for the summer and winter periods for Clarkdale gage and Camp Verde gages.

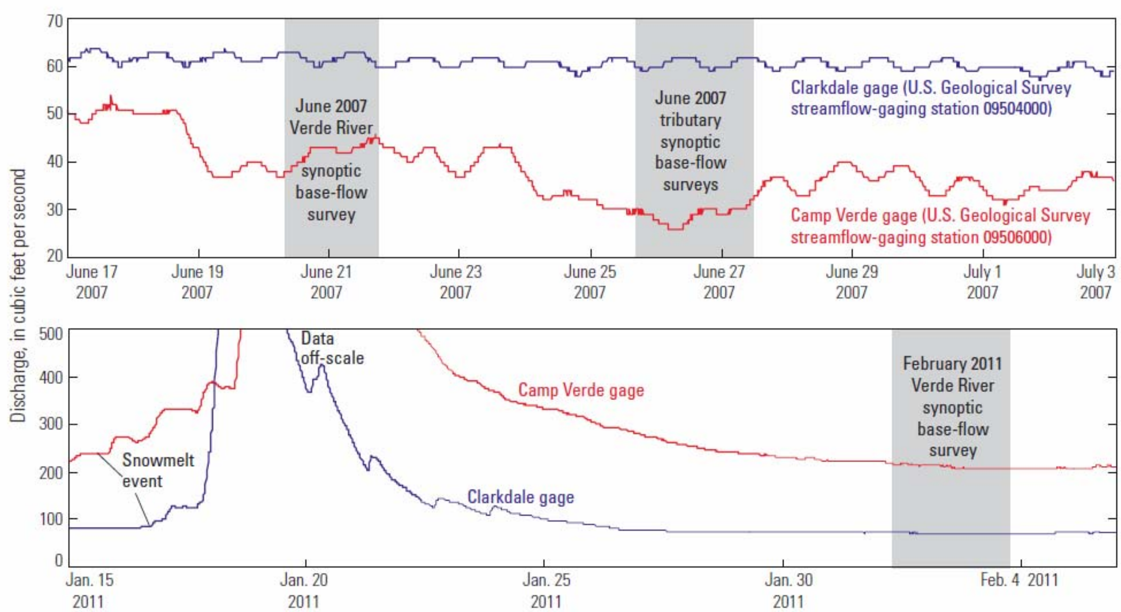


Figure 7. Instantaneous discharge at U.S. Geological Survey streamflow-gaging stations 09504000 and 09506000, June-July 2007 and January-February 2011, central Arizona.

In addition to changes over time there has been considerable variation in water use by individuals. Largely because of the sandy soil and poor irrigation practices a lot of the water diverted to the land seeps into the ground. Mounds of ground water are formed under cultivated land adjacent to the streams during the summer. Some mounding even *drowns* trees and stunts growth. The water is temporarily stored in the ground as it slowly returns to the Verde River during the winter. This mounding affect has been the result of general irrigation practices for many years as shown in the following table from page 276 of the Hayden Report (1940).

DIVERSION AND ACREAGE

None of the ditches seemed to be carrying a greater amount than ordinarily; several were carrying less than they had very recently contained. The following canals on the Verde and the Southern half of Oak Creek are the largest in the entire valley. This neighborhood is on the telephone line to Jerome from whence telephonic connection exists with Phoenix.

Canals and Location	Measured head in inches	Estimated full head in inches	Acreage	Meas. head in ac.-ft. for 7 mo. flow	Estimated full head in 7 mos. flow
Oak Creek					
James	20	50	15	13.88	34.70
Shuerman	44	88	28	16.36	32.72
Shuerman	40	40	17	24.50	24.50
Shuerman	20	50	8	26.03	65.07
Huckaby	87	174	8	113.20	226.40
Willard	10	10	5	20.83	20.83
Page	139	139	50	28.95	28.95
Dickinson & Horst	350	350	215	16.95	16.95
Fain	169	225	195	9.03	12.04
Hart	65	195	40	16.92	50.76
Verde River					
Duff	42	168	35	12.49	49.96
Dukxtra	36	72	50	7.50	15.00
E. Jordan	47	157	35	13.98	46.60
W. Jordan	62	89	20	32.28	46.11
Tunnel	190	380	250	7.92	15.84
Cottonwood	711	711	650	11.39	11.39
Hickey	243	405	158	16.02	26.70
O. K.	517	600	610	8.83	10.24
Eureka	448	747	420	11.11	18.52
Woods	1042	1042	1200	9.04	9.04
Enterprise	94	173	50	19.58	32.63
Eman	235	235	340	7.20	7.20
Total	4611	6100	4399		

The great variation in the use of water is largely due to faulty constructions, to individual ideas as to the need of water and to slope of lands, as the borders are always run with the greatest slope even where the water cuts gulleys in the land. The total of water measured amounted to 4611 inches for 4399 acres, which is equivalent to 1.042 inches per acre. This average flow will give the land as follows:

Ditches and other surface-water diversions in the Verde Valley complicate interpretation of the base-flow data. Water that is diverted from a stream is not necessarily all transpired through irrigated crops. Not all return flows have been measured for past studies and even had they been measured, their flow varies considerably, and several measurements might be needed for a representative or average value. Pathways also exist by which some diverted water infiltrates the subsurface and flows back to the river. Quantification of these and other aspects of the hydrology of ditch diversions are needed. An example of the complexity of the ditches follows:

Unaccounted-for water is calculated with respect to a ditch diversion and is the difference between the amount of water diverted into the ditch and the sum of all measured return flows from that ditch. “In June 2007, the total amount of unaccounted-for water among the seven major ditch systems in the Verde Valley was 105 cfs; in February 2011 unaccounted-for water was 37 cfs..”(Garner and Bills, 2012, p. 22). Unaccounted-for water is not equal to evapotranspiration from irrigated fields and ditch systems, as there are several other pathways that unaccounted-for water may follow. Obviously some of the unaccounted-for water is seasonally stored in the ground below the irrigated lands. (slightly modified from Garner and Bills, 2012, p. 22). Flow components of a single complex ditch system are shown in the figure to the right from Garner and Bills (2012, p. 7).

Figure 5. Conceptual diagram of an idealized perennial stream system with an active irrigation system (ditch diversions and irrigation).

Despite all that is not yet known about Verde Valley ditches and their hydrology, recent studies and reconnaissance have led to an improved understanding of the ditches as a collection of networked and interrelated canals. A steady-state computer model was constructed to simulate surface-water flow in the Verde River and the four major ditches in a reach—Ross's 4 canals (2010) (my note: Ross did not do this modeling). Recently, continuous stage-measuring equipment has been installed at key locations in some ditches. Future studies could improve understanding of ditches through hydrologic monitoring networks and analyses designed specifically to monitor the many hydrologic components outlined in the conceptual model presented in this report (fig. 5—the previous figure). Because ditch operations vary hour-to-hour and ditches likely are never under steady-state conditions in the summer, any such study would need to collect data (Modified from Garner and Bills, 2012, p. 23).

> "The ditches diverting water from the Verde River have not been studied comprehensively. Ross (2010) monitored flow rates into and out of four ditches at their headgates and final return flows back to the stream channels; no conclusions were reached about total water volumes delivered to customers, consumptive-use rates, or the spatial distribution or temporal variably of return flows other than the terminal return flow . Alam (1997) published anecdotal estimates of diverted amounts of water based on surveys of ditch operators. A comprehensive investigation of ditch-diversion hydrology would be possible, but would be a large undertaking well beyond the scope of the present study. Discussion about ditches in this report, therefore, is limited to information that was readily available and measurable." (Garner and Bills, 2012, p. 4)

Burtell Item A.—If at this point if ANSAC is not convinced that Mr. Burtell's method is inappropriate with undefined error then lets continue with the above discussion and the discussion of Supplement 6 by further examining his declaration on the non-navigability of the Verde River. DECLARATION OF RICH BURTELL ON THE NON-NAVIGABILITY OF THE VERDE RIVER AT AND PRIOR TO STATEHOOD, *In re Determination of Navigability of the Verde River (Case No. 04-009-NAV),* September 2014.

Mr. Burtell attempted to reconstruct ordinary and natural streamflow using "an accounting approach that adjusted (increased) gaged flows for upstream cultural depletions." (Burtell, 2014, p. 15). His approach was to use present (2009) irrigation diversions to estimate ordinary and natural streamflow (about 1860). This highly simplified approach has numerous pitfalls as previously discussed and including those associated with (1) temporal and spatial changes in the irrigation patterns along the numerous ditches in the Verde Valley, (2) the unique hydrologic and irrigation pattern for the 2009 "calibration" period that he used, (3) the changing interaction between regional and local groundwater and also the Verde River and the ditches, (4) changing base flow of the river from, for example, upstream water use by early settlers, (5) the individual ideas as to water needs for crops, and (6) site characteristics such as sandy soil, length of furrows and land slope.

The study period on 1914-1940 was selected partly because diversions appeared to be relatively stable (Burtell opinion item 70). The period was also selected because "...pumpage reduced baseflows in the river above Camp Verde by less than 1 cfs over the period.." (Burtell opinion item 69). However, the pumpage in question was deep well pumping of the basin fill aquifers in the upper Verde River Watershed. There was considerable depletion of quaternary aquifers and headwater springs above the USGS Paulden gage (Table 2of2 on p. 20 of my report and shown in flow diagram on p. 2 of Appendix A).

In his opinion item 68 (Declaration of 2014) Mr. Burtell seems to say that a sample of a population should be representative of the population. He incorrectly says "In characterizing ordinary streamflow conditions, a period of near normal flows is desirable." There is a difference between what he says and what he seems to mean but I'll not be picky and let that go for now. Let's focus on the fact that the sample should represent the population and not represent, for example, a wet period or a dry period imbedded in the study period of 1914-1940. Thus, I agree with what Mr. Burtell seems to say but did he practice what he preached?

ANSAC stay with me on this:
Let's consider the affect of dry years (2009 was a dry year) on Mr. Burtell's analysis starting with the following quotation from ADWR Bul. 2 (1983), p. 61.:
"Gaging-station records and seepage investigations along the Verde River indicate that the river is a gaining stream, although it does contain some short losing reaches. Net base flow leaving the valley is measured at Verde River near Camp Verde gaging station. The annual base flow for the 1977 water year was 80,000 acre-ft (table 9), which is 21,000 acre-ft/yr lower than the average value calculated for the 1934-45 water years of 101,000 acre-ft/yr. The data for water year 1977 were used because this water year is the only complete year of recent base flow data. The value for the base flow may be anomalous because 1977 was a dry year and more water probably was used for irrigation than was used in 1934-45. The seepage investigation of June 1979 indicates no appreciable gains or losses between the Verde River near Camp Verde gage to the outflow point except the gain from Fossil Springs. The outflow is adjusted for the base flow of Fossil Creek by adding the discharge of Fossil Springs, which averages 43 ft^3/s or 31,150 acre-ft/yr..." ADWR Bulletin 2 (1983), p. 61.

The significance of the above quotation from ADWR Bulletin 2 (1983), p. 61, is that 1977 was not a normal year because it was a dry year and thus more water was used for irrigation along ditches such as the Diamond S, Eureka, OK and Verde ditches in the Verde Valley (See following figure). In other words, more water was diverted from the Verde River for irrigation and was lost to ET because 1977 had below normal precipitation. The same is true of 2009 as discussed later.

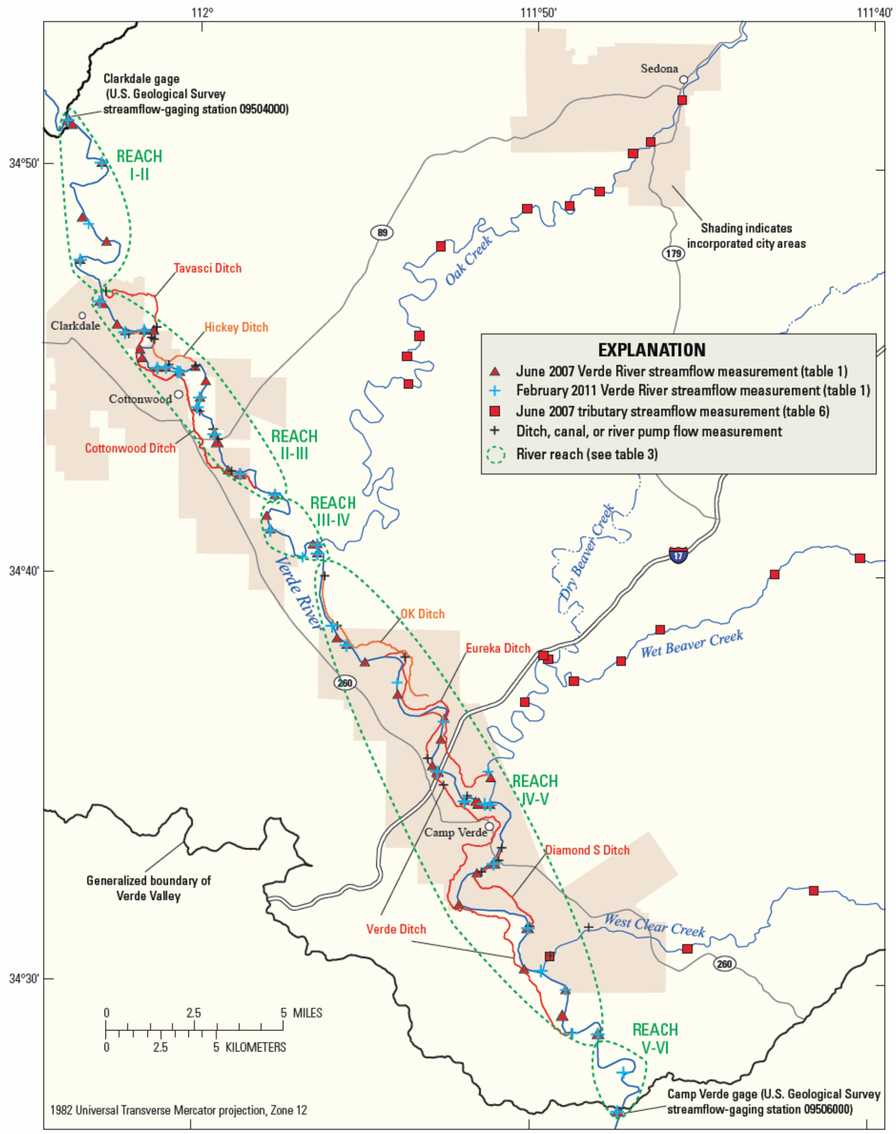


Figure 6. Synoptic base-flow survey measuring stations, 2007 and 2011, Verde Valley, central Arizona.

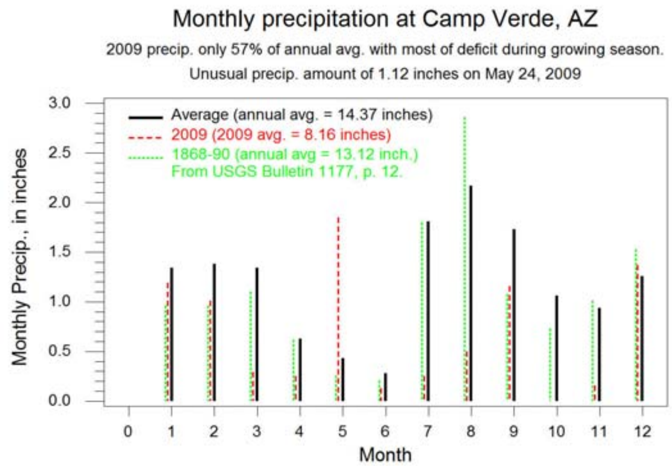
Garner, B.D., and Bills, D.J., 2012, Spatial and seasonal variability of base flow in the Verde Valley, central Arizona, 2007 and 2011: U.S. Geological Survey Scientific Investigations Report 2012–5192, 33 p.

While I have several concerns with Mr. Burtell's estimates of river depletions and reconstructed undepleted flows, one obvious concern that comes to mind is related to the prior quotation from ADWR Bulletin 2 (1983), p. 61. Mr. Burtell's opinion item 77 of his declaration follows:

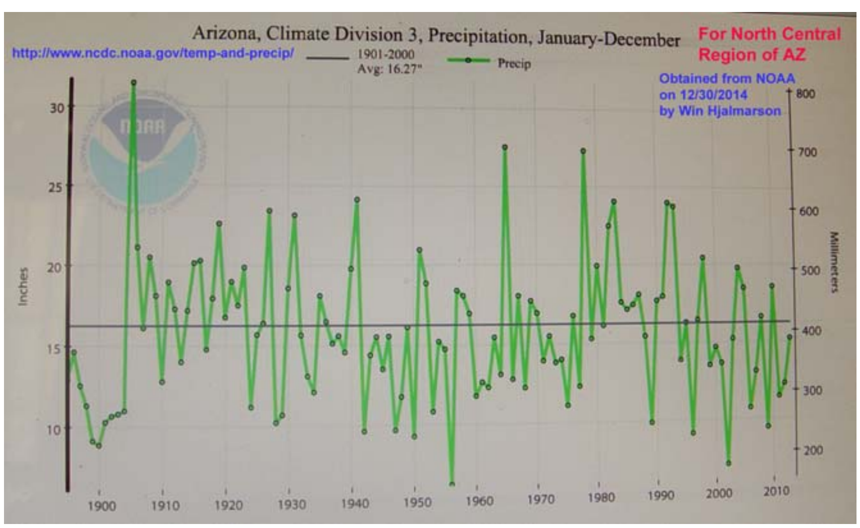
> Recent measurements by Ross (2010, pp.121-127) do, however, provide an estimate of the percentage of irrigation diversions in the Verde Valley that return to the river. Between October 2008 and May 2010, Ross measured the quantity of surface flow diverted into and directly returned to the Verde River along four ditches –Diamond S, Eureka, OK and Verde. He found that, on average, approximately 43% of the water diverted was directly returned to the river. The remaining 57% was either consumptively used or seeped back to the river via the subsurface. For purposes of flow reconstruction I assumed that, between 1910 and 1940, 57% of the water diverted from the Verde River and its tributaries for irrigation was depleted from the river and needs to be added back to the river above the gages. A summary of Ross' diversion and return flow data is provided in **Attachment F**.

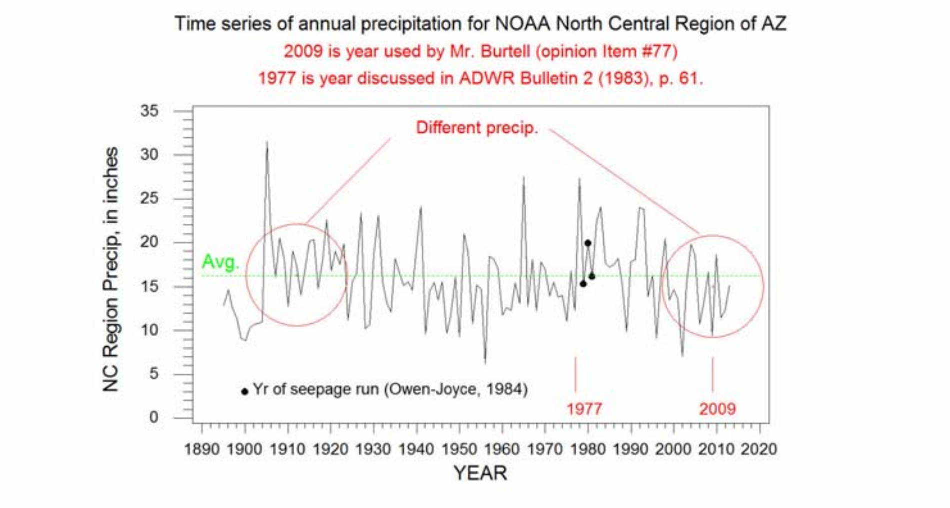
Some of the *rest of the story* as follows: *"The ditches diverting water from the Verde River have not been studied comprehensively. Ross (2010) monitored flow rates into and out of four ditches at their head gates and final return flows back to the stream channels; no conclusions were reached about total water volumes delivered to customers, consumptive-use rates, or the spatial distribution or temporal variably of return flows other than the terminal return flow. Alam (1997) published anecdotal estimates of diverted amounts of water based on surveys of ditch operators. A comprehensive investigation of ditch-diversion hydrology would be possible, but would be a large undertaking well beyond the scope of the present study. Discussion about ditches in this report, therefore, is limited to information that was readily available and measurable."* (Garner and others, 2012, p. 4). The Diamond S, Eureka, OK and Verde ditches are shown on the preceding figure from Garner and others, 2012, p. 9).

Mr. Burtell used Ross's data that spanned 2009 that, like 1977 discussed previously, was a dry year (See following figure). In other words, depletions of Verde River base flow by crop lands were for abnormally dry conditions and not representative of normal conditions. Burtell made no mention that 2009 was a dry year—even drier than 1977 as discussed in ADWR Bulletin 2 (1983), p. 61 and discussed previously. Also, I'm left to wonder if Ross ever intended his data to be used as Mr. Burtell used the data. I've recently discussed this with Mr. Robert Ross, presently a USGS employee, and he was unaware that Mr. Burtell was using his unsigned masters thesis for ANSAC.



Burtell Item B.--Let us continue to look at Mr. Burtell's estimates of river depletions and reconstructed undepleted flows based on Ross's data that spans 2009. Below are time series of precipitation for the north central region of AZ, that includes the Camp Verde area, as defined by the National Climatic Data Center (NCDC). This approach allows us to use a bigger picture of weather conditions for both 1977 and 2009 as related to precipitation records for 1895-2013. Precipitation for 2009 was deficient by 6.84 inches and ranks as the 7th lowest for the period. Likewise, precipitation for 1977 was deficient by 3.97 inches and ranks as the 28th lowest for the period. Thus, according page 61 of ADWR Bulletin 2 (1983), the base flow may have been anomalous for 1977 because it was a dry year; obviously the base flow for the drier 2009 was even considerably more anomalous. A generalization of natural flow in the Verde River based on a small and anomalous sample of hydrologic data (river depletions) for a dry year like 2009 is faulty. Errors are unknown and the evidence is insufficient to make such a generalization of conditions 100 years ago.





Burtell Item C.--Continuing with his declaration on the non-navigability of the Verde River and the transfer of information from Ross's study to other areas along the Verde River. (See, for example the 3rd column of Table 6, Burtell declaration).

The area along the Verde River where the two largest ditches (Verde and Diamond S ditches) used by Ross are located in the Camp Verde area studied by the USGS (Owen-Joyce,1984). The following two paragraphs, that show the hydrologic complexity of the Camp Verde area and the resident ditches, are from the abstract of Owen-Joyce, S. J.,1984, Hydrology of stream-aquifer system in the Camp Verde area, Yavapai County, Arizona, by Arizona Dept. of Water Resources Bulletin 3. (page 1). The following is important because it shows the hydrology along the irrigated areas near the Verde River is complex and beyond the limited resources of an NAU grad, student to define. This means that there are many flow components, such as subflow entering a ditch, that were not defined by Robert Ross. It also implies that the complex relations between flow entering, leaving and passing through the ditches, river and stream-aquifer are unique to a specific area and not transferable because of the complexity.

A dynamic interaction between the distribution of 30,000 acre-feet of water diverted from the Verde River to irrigate fields on the alluvium and the inflow of about 1,000 acre-feet of water from the underlying artesian aquifer in the Verde Formation determines the quantity and quality of water in the alluvium south of Camp Verde, Arizona. About 70 percent or 21,800 acre-feet of the diverted irrigation water returns to the Verde River as subsurface flow, which with 14,000 acre-feet of water flowing through the alluvium from West Clear Creek to the Verde River flushes the alluvial aquifer. About 9,300 acre-feet of water is lost to evapotranspiration. Inflow from the Verde Formation locally increases the concentration of dissolved solids, sulfate, chloride, and arsenic in the alluvium. Water quality in the alluvium would deteriorate without the dilution effect caused by the deep percolation of irrigation water applied on the alluvium and ground water in the alluvium along the Verde River is an important source of domestic water.

Ground water in the alluvium is unconfined and hydraulically connected to the Verde River and Verde Formation. Ground-water inflow to the alluvium from the Verde Formation occurs in areas where the hydraulic head in the Verde Formation is higher *than the hydraulic head in the alluvium; wells open to both formations are another path of ground-water inflow. Near the southern extent of the alluvium, the hydraulic head in the Verde Formation is lower than the hydraulic head in the alluvium and some water flows from the alluvium into the underlying Verde Formation. In 1981 water levels in wells ranged from about 5 to 50 feet below the land surface and fluctuated as much as 5 feet owing to deep percolation of irrigation water. Saturated thickness in the alluvium ranged from 0 to about 30 feet in February to April 1981; the annual minimum amount of water stored in the alluvium occurs prior to irrigation and was estimated to be 17,500 acre-feet.*

Burtell Item D--In addition to the problems of his method for transferring irrigation diversion information to different reaches of the Verde River, supposedly to estimate natural conditions, this paragraph clearly describes the non-stationary conditions within the reach of river studied by Ross. Thus, estimation of the natural flow in the Verde River within the Ross reach appears a daunting task using available data. Mr. Burtell's method of using 2009 conditions supposedly to estimate natural river conditions appears flawed largely because of the changing human impacts that started in the 1860s, as described in Hjalmarson's report to ANSAC on the navigability of the Verde River, and as described below.

The following is from the introduction of Owen-Joyce (1984) on page 2.

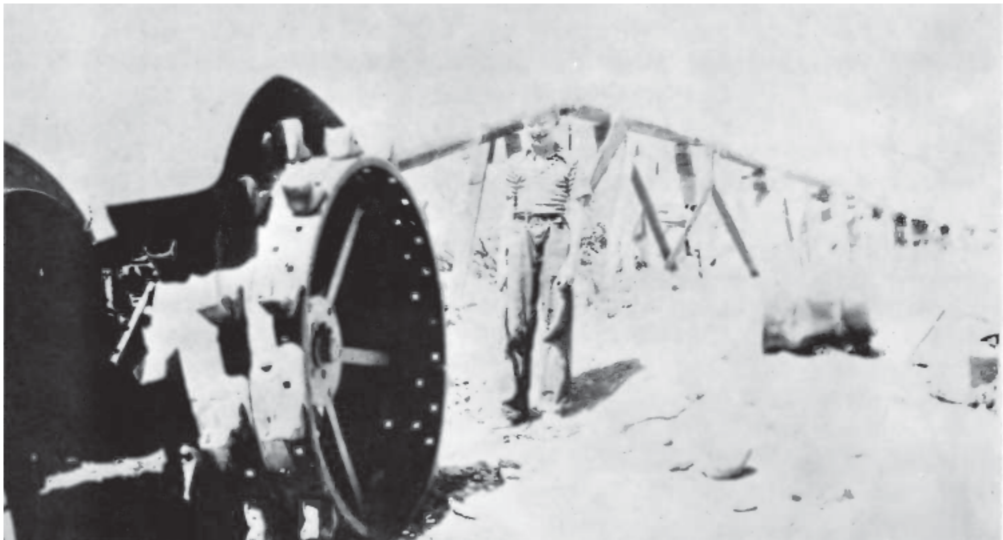
> Increases in population and concentration of development along the Verde River flood plain are occurring in the Verde Valley in central Arizona, which is changing the way that land is used along the river. Some areas previously used for agriculture are being subdivided and the amount of ground water used for a domestic and public water supplies is increasing. Some of the residents continue to irrigate with river water, In other areas of the flood plain, land previously covered by natural vegetation has been cultivated.

And another example of non-stationary ditch conditions:

"The people all exhibited a lively interest in our visit. any of them feel that, sooner or later, there is bound to be a struggle with the people of the Salt River Valley; many of them are in doubt as to their power to retain the use of the water they are taking; while on the other hand these regular trips of observation which result in no action taken encourage them to continue widening and deepening and lengthening their ditches." (page 18 of Exhibit E of the Hayden Report, 1940).

Also, the present diversion characteristics of the Central Verde (CV) ditch are significantly different than the original diversion method in effect at statehood. (See the lengthy description of changes starting on p. 119 of Hayden, 1940).

Below is an old tractor supplying power for water delivery on the O. K. ditch. Effects of old water delivery methods on Burtell's 2009 based method could be significant.



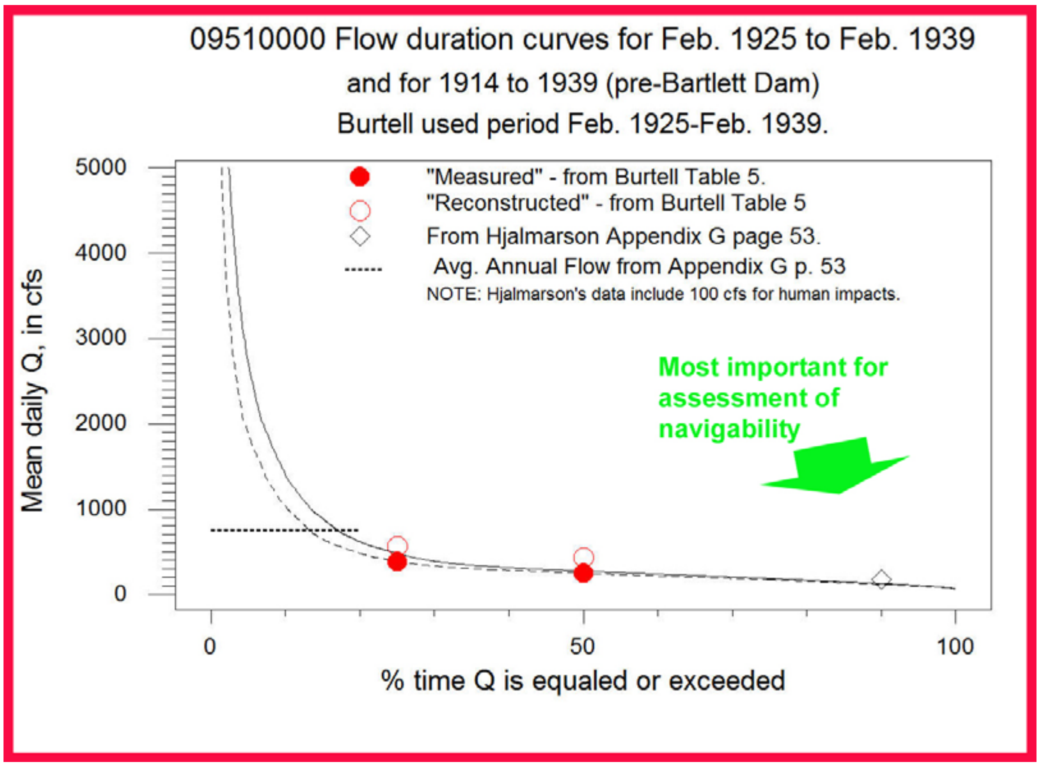
Discharge Pipe delivering water to land from O.K. Ditch from 6" Centrifugal pump operated by old tractor. June 7, 1940.

(Hayden, 1940, p. 118)

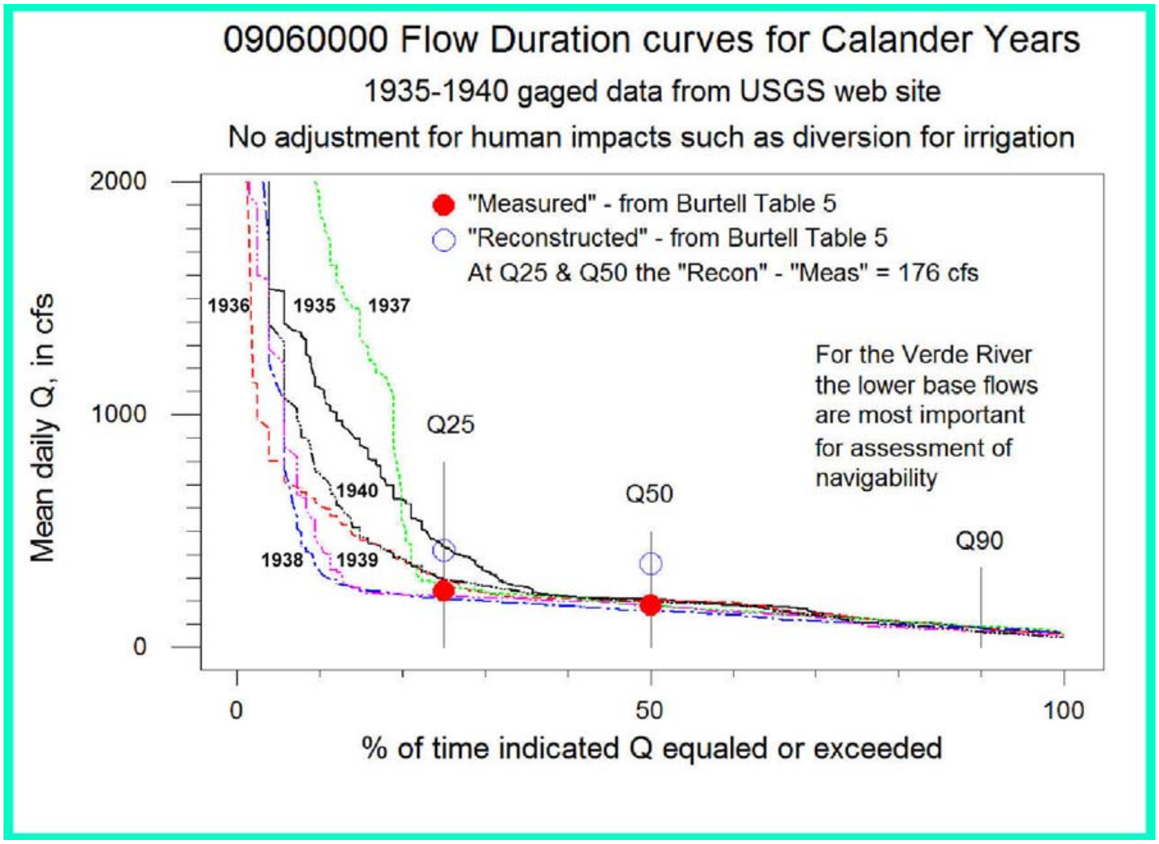
Burtell Item E--Another example that shows problems with Mr. Burtell's method for transferring irrigation diversion information to different reaches of the Verde River is revealed by seepage investigations and water–quality information. Three seepage investigations (Owen-Joyce, 1984, p. 21 and also the 3 dots in the time series figure in Burtell Item B of this report) and water-quality data showed that the low flows in streams were not always ground-water outflow from the alluvium. Also, inflow to the alluvium from the Verde River does not occur during base-flow conditions in all reaches. During the seepage investigations, no losing reaches were identified (Owen-Joyce, 1984, p. 33). During high flows in the Verde River, some water flows into the alluvium as bank storage but drains back to the river after the high flows subside. Thus, there are complex hydrologic conditions unique to the area of Ross's study, that was in an alluvial area, and therefore potentially and unknown limitations to Mr. Burtell's method for transferring irrigation diversion information to different reaches of the Verde River.

Burtell Item F –Lets examine flow conditions between 1914 and 1940 (See Mr. Burtell's opinion item 70 and his Table5) at 09510000 Verde River below Bartlett Dam (listed with four other gages in Burtell opinion item 71). The period of record for 09510000 is given as February 1925 to February 1939 (Burtell Table 5) when, in fact, there are daily discharges for the entire 1914 to 1940 period (USGS website). No explanation is given by Mr. Burtell for using only part of the available record of streamflow. The flow-duration curve for USGS gage 09510000 follows.

I'm left to wonder why Mr. Burtell is using the rather large flow defined by Q25 for the assessment of navigability of the Verde River. Frankly, even the median (Q50) value of discharge has limited use relative to say Q80 (e. g. use on the John Day River (Northwest Steelheaders Ass'n, Inc. v. Simantel, 199 Or.App. 471 (2005)) or Q90 values of discharge. The minimum depth of flow is associated with the lower discharges defined by the lower part of the flow-duration curve. Thus, Q80 or Q90 is most important because depth limits navigability along the Verde River. Maximum depth (e.g. the measured 15 ft. depth at USGS gage 09506000 (p. 17 of the Addendum)) is important but not as an important decision threshold for navigability because it only facilitates navigability.



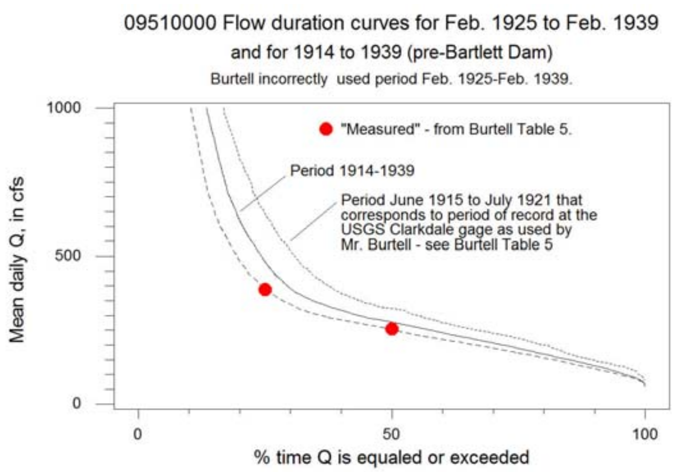
Calendar year flow duration curves for USGS gage 09506000 Verde River near Camp Verde cause me to wonder why Mr. Burtell used Q25 for his assessment of navigability. The curves below are for gaged data with no adjustment for human impacts. A limited number of years (April 1934 to Dec. 1940, Burtell Table 5) is used to define the hydrology of ASLD stream segment 3. The reconstructed discharges seem too great with a human impact of 176 cfs—versus 100 cfs determined by Hjalmarson (Appendix G, p. 52).



Again, **Q80 or Q90 is most important for assessment of navigability because minimum depth limits navigability along the Verde River.

** An 80% exceedance level was used for the John Day River in Oregon. See SUPPLEMENT 10. John Day River in Oregon of this 2nd Addendum

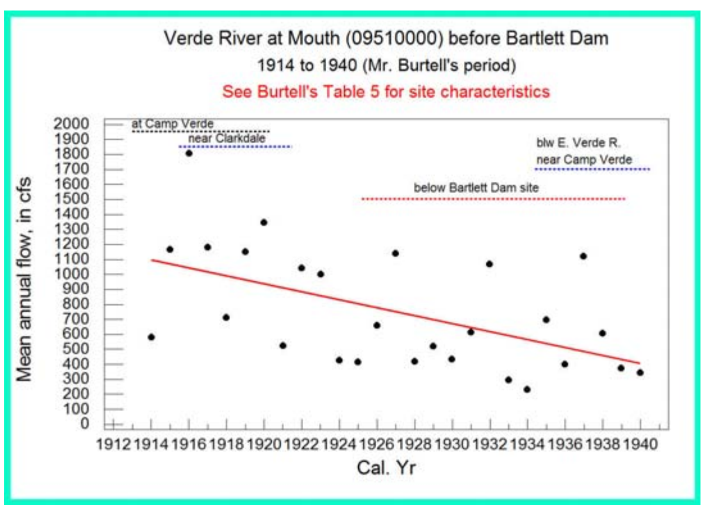
The undesirable affects of using short and different periods of record (partial periods within 1914-1940, Burtell opinion item 70) for the five gages in Figure 5 is demonstrated using the following flow duration curves for USGS gage 09510000. The flow duration curve is computed using record at 09510000 for the period June 1915 to July 1921 that corresponds to the period record used by Mr. Burtell at the gage near Clarkdale. The median for this relatively short period of gaged record is 324 cfs or 29% greater than the median of 252 cfs (red dot in figure) computed by Mr. Burtell.



The decreasing amount of mean daily discharge over the 1914-40 period can also be demonstrated for other USGS gages in Burtell's Figure 5 where, for example, the computed median flow at 09510000 using the period of record at the gage near Camp Verde is less than 252 cfs. Obviously, this is because the mean daily flow at 09510000 decreases within the 1914-40 period that Mr. Burtell selected for his analysis.

The above flow-duration curves clearly show the error Mr. Burtell made when he used only part of the available USGS data. The lower curve (with red dots) in the above figure corresponds to the partial period of record (shown by horizontal dashed line) for the *below Bartlett Dam* site in the figure below.

The short periods of record for the gages used by Mr. Burtell are shown by the dashed lines to the right. The regression line shows a decreasing mean annual flow for the period. Thus, I would expect the non-stationarity to be present in Burtell's data. A great example of this problem is shown by the defferences between the two flow-duration curves for 09510000 in the above Figure.



Burtell Item G-- What about the headwater area upstream of the USGS 09503700 gage near Paulden that includes important sources of the Verde River such as Granite Creek, Walnut Creek, Big Chino Wash and Williamson Valley Wash? There was farming on land immediately adjoining perennial tributary streams where they leave the mountains. In terms of early human impacts (e.g. irrigation and railroad dams) this area is most interesting and important because the early settlers easily diverted a lot of streamflow to cultivated land. The original GLO surveys show a considerable amount of cultivated land in this headwater area (Appendices C, D and E and Supplement 11 of this Second Addendum).

G1: Also, there are significant recorded appropriations along tributary streams for irrigation given on page 15 of Exhibit E of the Hayden Report (1940). These appropriations are for the late 1800s and total several thousand miners inches with two appropriations for all the water in Granite Creek and another one for all the water in Walnut Creek. For Walnut Creek alone the appropriations are for 50 cfs with an additional appropriation for all the water (page 15 of Exhibit E of the Hayden Report, 1940 and p. 25 of Appendix E and p. 66 of Appendix F). A table of the appropriations in more familiar units of cfs follows:

Row	Walnut Ck cfs	Granite Ck cfs	Big Chino Ck cfs	Willianson Valley Ck cfs
1	25.0	1.875	100	3750
2	12.5	20.000	200	
3	12.5	5.000	50	
4	All Water	12.500	25	
5		**All Water**		
6		**All Water**		
Total	**50 cfs**	**40 cfs**	**375 cfs**	**3750 cfs**

Total of Walnut, Big Chino and Willianson Valley Creeks = 4275 cfs + all for Walnut Ck

GRAND TOTAL = 4315 cfs + all for Granite Ck (twice) and Walnut Ck

I'm left to wonder why Mr. Burtell (Table 6, DECLARATION OF RICH BURTELL, Sept. 2014) apparently ignored the above information. To me, an appropriation of 4,315 cfs potentially is a lot of water. Mr. Burtell should further explain why he used only a couple of cfs depletion on the Verde River below Granite Creek (Table 6, DECLARATION OF RICH BURTELL, Sept. 2014).

G2: Along Granite Creek, for example, diversions mostly for irrigation were so great that the unregulated water supply was insufficient for all demands. The numerous small diversions (ditches and shallow pumps) took a volume of water in excess of the amount flowing in that stream, and there were lawsuits concerning rights to use the water. (e.g. Appendix C, p. 10)

G3: Furthermore, in regard to irrigation, “Among the principal tributaries of the Verde are Walnut, Granite, Oak, Beaver, and Clear Creeks. Walnut Creek is dry during a portion of the year, its waters being entirely diverted upon the adjacent land.” (Newell, 1891, pp. 309-310).

Newell, F. H., HYDROGRAPHY OF THE ARID REGIONS, in Powell, J. W., 1890-91, Twelfth Annual Report of the USGS, Part 2 Irrigation; WASHINGTON, GOVERNMENT PRINTING OFFICE 1891, 576p. (pp. 309-310).

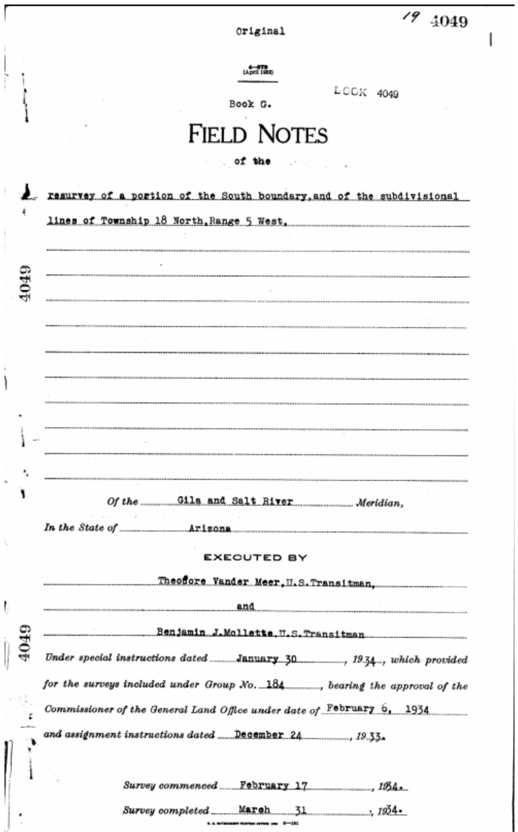
G4: “In an early account of lower Big Chino Valley, the Bureau of Reclamation (1946) described the relation of streams in the Verde River headwaters as follows: “the head of the Verde, formed by the junction of Chino Creek (*Big Chino Wash?*) and Williamson Valley Wash, is fed by permanent ground water.” The confluence of Big Chino Wash and Williamson Valley Wash at that time was located about 1 mi upstream from Sullivan Lake. This segment of Big Chino Wash is now ephemeral, and aggraded with sediment above Sullivan Lake dam...” (Wirt, L., 2005, p. A17)

Wirt, L., 2005, The Verde River headwaters, Yavapai County, Arizona *in* Wirt, Laurie, DeWitt, Ed, and Langenheim, V.E., eds., Chapter A, Geologic Framework of Aquifer Units and Ground-Water Flowpaths, Verde River Headwaters, North-Central Arizona: U.S Geological Survey Open-File Report 2004-1411, 33 p.

Below is a photograph of base flow in the Verde River that obviously is more than the flow described by Mr. Burtell. (from page 3 of my Appendix A and also shown on p. 36 of Appendix C).

Construction of Sullivan Lake Dam in 1935. The base flow that is diverted around the construction area is mostly from tributary streams (Qmf and Qqa). A very rough estimate is 5cfs.

G5: Farming along Walnut Creek in 1934. There was farming along Walnut Ck. before and after Arizona statehood.



19 4049

Original

4-979 (April 1933)

BOOK 4049

Book G.

FIELD NOTES

of the

resurvey of a portion of the South boundary, and of the subdivisional lines of Township 18 North, Range 5 West,

4049

Of the Gila and Salt River Meridian,

In the State of Arizona

EXECUTED BY

Theodore Vander Meer, U.S. Transitman,

and

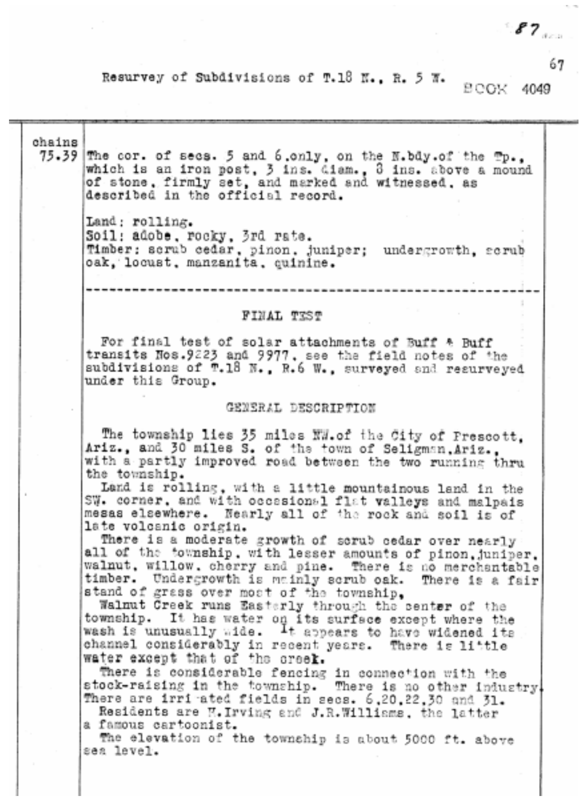
Benjamin J. Mollette, U.S. Transitman

4049

Under special instructions dated January 30, 1934, which provided for the surveys included under Group No. 184, bearing the approval of the Commissioner of the General Land Office under date of February 6, 1934 and assignment instructions dated December 24, 1933.

Survey commenced February 17, 1934.

Survey completed March 31, 1934.



87

67

Resurvey of Subdivisions of T.18 N., R. 5 W. BOOK 4049

chains	
75.39	The cor. of secs. 5 and 6, only, on the N.bdy. of the Tp., which is an iron post, 3 ins. diam., 8 ins. above a mound of stone, firmly set, and marked and witnessed, as described in the official record.

Land: rolling.
Soil: adobe, rocky, 3rd rate.
Timber: scrub cedar, pinon, juniper; undergrowth, scrub oak, locust, manzanita, quinine.

FINAL TEST

For final test of solar attachments of Buff & Buff transits Nos. 9223 and 9977, see the field notes of the subdivisions of T.18 N., R.6 W., surveyed and resurveyed under this Group.

GENERAL DESCRIPTION

The township lies 35 miles NW. of the City of Prescott, Ariz., and 30 miles S. of the town of Seligman, Ariz., with a partly improved road between the two running thru the township.

Land is rolling, with a little mountainous land in the SW. corner, and with occasional flat valleys and malpais mesas elsewhere. Nearly all of the rock and soil is of late volcanic origin.

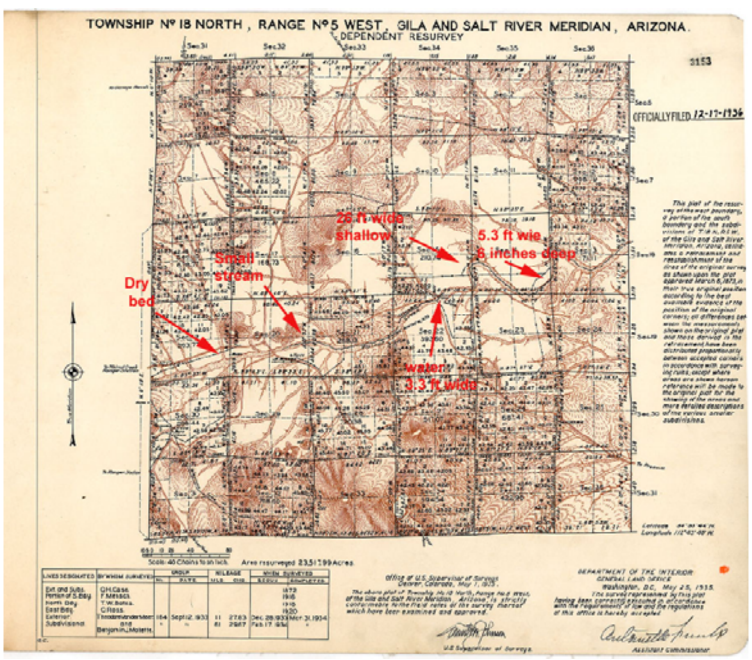
There is a moderate growth of scrub cedar over nearly all of the township, with lesser amounts of pinon, juniper, walnut, willow, cherry and pine. There is no merchantable timber. Undergrowth is mainly scrub oak. There is a fair stand of grass over most of the township.

Walnut Creek runs Easterly through the center of the township. It has water on its surface except where the wash is unusually wide. It appears to have widened its channel considerably in recent years. There is little water except that of the creek.

There is considerable fencing in connection with the stock-raising in the township. There is no other industry. There are irrigated fields in secs. 6, 20, 22, 30 and 31.

Residents are H. Irving and J.R. Williams, the latter a famous cartoonist.

The elevation of the township is about 5000 ft. above sea level.



Apparently Mr. Burtell overlooked readily available information that showed there was considerable farming along tributary streams upstream of the Verde River near Paulden gage.

Mr. Burtell appears to have relied only on Mr. Hancock's exhibit in the Hayden Report (1940) while ignoring other information in the Hayden Report and the GLO surveys.

G6: Farming along Walnut Creek in 1914 and bridge needed in 1922.

WEEKLY JOURNAL-MINER WEDNESDAY MORNING, APRIL 14, 1915

Water in Walnut Creek

SUPREME COURT GIVES CRANE VERDICT

(From Sunday's Daily)

The Supreme Court of Arizona handed down an opinion on Friday reversing the judgment of the lower court in the case of H. J. Crane versus T. L. Franklin. This action was appealed from the Superior court of Yavapai county by Anderson & Lamson, attorneys for Crane.

It was originally tried in July, 1914, and was brought by Franklin, who alleged that he had rendered services to Crane as a laborer and upon Crane's ranch, on Walnut creek. Franklin claimed a total of $1,340. The evidence showed that Crane and Franklin had made a verbal agreement by which Franklin leased Crane's ranch and that he took possession and worked the same for one year. According to the agreement Franklin was to receive one-half of the crops raised, but he did not receive his share. The parties were unable to agree on the terms of the written lease, and at the close of the first year Franklin left the ranch. The case was tried by Judge F. O. Smith, and under his instructions the jury returned a verdict for Franklin for $540. This judgment has now been reversed and the case remanded to the Superior court of this county for a new trial.

WEEKLY JOURNAL-MINER, WEDNESDAY MORNING, JULY 5, 1922.

WALNUT CREEK BRIDGE WANTED

Residents of District Petition Board for Wood Viaduct Across Troublesome Creek; School Bonds Sold.

(From Tuesday's Daily)

A bridge over Walnut creek is earnestly desired by residents of that district, according to representations of a committee of Walnut Creek people who called at the office of the board of supervisors yesterday to see what could be done about it.

The concrete dip recently constructed over the creek is all right as far as it goes, committee members admitted; the trouble is, it doesn't go far enough. Serviceable in seasons of ordinarily high water, real high water is too much to wade a wagon or an automobile through, even over the dip. A wooden bridge would be serviceable at all times, preventing stalling of machines right among a lot of water and also obviating the necessity to drive down through the creek at ordinary times.

After hearing the statements of the Walnut Creek delegation, the board said it was inclined to give the petition a favorable hearing and to pass upon it in a short time. It was intimated that construction of such a bridge as is desired by residents of Walnut Creek will be undertaken in a short time.

The board was in regular first-of-the-month session at the court house yesterday, and in addition to hearing the Walnut Creek petitioners, ordered the county's bills paid, and passed on final proceedings in the sale of the school bonds for schools in Cedar Glade and in south Prescott.

Clearly there were human impacts (e.g. irrigation and railroad dams) in the upper watershed when Hancock visited the area. (Hayden, 1940) contains exhibit F by H. L. Hancock (1914).

Burtell Item H.--Steps leading to the Burtell-Hood computation of reconstructed flow (cfs)—aka natural flow.

In regard to questions of Mr. Hjalmarson by Mr. Hood concerning Hjalmarson's impression of Mr. Burtell's declaration. I've had the time and interest to review the subject report and can respond to Mr. Hood's question.

VERDE RIVER VOLUME 5 12/19/2014 1076

BEFORE THE

ARIZONA NAVIGABLE STREAM ADJUDICATION COMMISSION

IN THE MATTER OF THE NAVIGABILITY OF THE VERDE RIVER FROM ITS HEADWATERS AT SULLIVAN LAKE TO THE CONFLUENCE WITH THE SALT RIVER, YAVAPAI, GILA AND MARICOPA COUNTIES, ARIZONA.	) NO. 04-009-NAV) ADMINISTRATIVE HEARING

REPORTER'S TRANSCRIPT OF PROCEEDINGS
VOLUME 5
Pages 1076 through 1226, Inclusive

On page 1223 Mr. Hjalmarson said ---

And that's where I'm going to stand. I did not look at it in detail, but I have a lot of experience. I've reviewed I don't know how many reports, hundreds of scientific reports, and I get pretty good at seeing when something smells a little bit.

Q. Aside from telling us all that it smells a little bit, do you have any information or evidence to indicate that Mr. Burtell's estimate of return flow percentage is erroneous?

A. Only my suspicion.

Q. Okay.

MR. HOOD: That's all I have. Thank you for your patience, Mr. Hjalmarson. Thank you to the Commission. Appreciate it.

This is a critical examination of Mr. Burtell's reconstruction of what he calls natural streamflow conditions on p. 15 of his Declaration of September 2014 for ANSAC. Mr. Burtell's opening remarks follow. My focus is on the accounting approach he used.

> **VII. STREAMFLOW RECONSTRUCTION**
> 64. In this section of my declaration I describe how ordinary and natural streamflow conditions were reconstructed at five USGS gaging stations on the Verde River. The purpose of reconstructing these streamflows was to further assess how the river looked prior to the effects of man and determine whether it was susceptible to navigation in this undisturbed condition. Undepleted streamflows were determined using an accounting approach that adjusted (increased) gaged flows for upstream cultural depletions. In the paragraphs that follow, the period that stream flows were reconstructed is described first, followed by a discussion of the gages used and upstream diversions and depletions. Results from the analysis are presented next and then compared to other undepleted flow estimates.

NOTE: ANSAC is encouraged to read section VII. STREAMFLOW RECONSTRUCTION of Burtell's Declaration if any part of my following examination is unclear.

A. Analysis period

Mr. Burtell discusses available USGS records of streamflow and decides on 1914 to 1940 for his study period. This period was discussed previously in my Burtell Item A and Burtell Item F of this SUPPLEMENT 7. The last figure in my Burtell Item F is a relation between mean annual flow and time and is potentially especially informative when used with Burtell's Table 5.

B. Gages

Burtell uses five USGS gages along the Verde River as shown in his Table 5 (next page). The record lengths for the five gages are shown in the "last figure" mentioned above. A simple cursory examination of the "last figure" shows a non-stationary problem with the data used by Mr. Burtell. The first 6 columns of Table 5 are standard stuff as explained by Mr. Burtell. Let's focus on columns 7 and 8 — the reconstructed discharges for Q25 and Q50 (median).

Columns 5-6 of Mr. Burtell's Table 5 are annual amounts of daily mean flow.

TABLE 5. RECONSTRUCTED VERDE RIVER STREAM FLOWS AND DEPTHS

USGS GAGE	ASLD STREAM SEGMENT	DRAINAGE AREA (square miles)[a]	PERIOD OF RECORD	DURATION OF DAILY MEAN FLOW (cfs)[b, c]				RECONSTRUCTED MEAN STREAM DEPTH (feet)[f]	
				Measured[d]		Reconstructed[e]			
				25%	50%	25%	50%	25%	50%
near Clarkdale	2	3,530	June 1915 to July 1921	92	84	101	93	1.6	1.6
at Camp Verde	2	4,220	January 1913 to March 1920	265	149	432	316	1.4	1.1
near Camp Verde	3	5,000	April 1934 to December 1940	243	184	419	360	2.0	1.9
below East Verde River	4	5,610	July 1934 to December 1940	404[g]	257[a,g]	587	440	2.2	1.8
below Bartlett Dam	5	6,180	February 1925 to February 1939	387	254	570	437	1.6	1.5

Notes:

[a] From USGS (1954, pp.685-693).
[b] cfs = cubic feet per second.
[c] 25% indicates that, over the period of record, daily mean flows at the gage equaled or exceeded the specified value during 25% of the time. Similarly, 50% indicates that the specified flow was equaled or exceeded 50% of the time. The latter is equivalent to the median daily flow over the period of record.
[d] Daily mean flow data from USGS (2014a).
[e] Calculated by adding the estimated stream depletions from **Table 6** to the measured flows listed here.
[f] Based on the reconstructed flow rates listed here and the rating curves presented in **Figures 8** through **10**.
[g] Daily mean flow data were unavailable for this gauge so monthly mean flow data were used instead.

C. Diversions and Return flows

My examination continues following Mr. Burtell's Figure 6 below. The data in columns 7 and 8 of Table 5 above are the sum of the measured values in columns 5 and 6 of Table 5 and data at the bottom of columns 4-8 shown in Table 6.

TABLE 6. CULTURAL DEPLETION OF VERDE RIVER STREAMFLOWS ABOVE USGS GAGING STATIONS CIRCA 1914 TO 1940

GENERAL LOCATION[a]	TYPICAL SURFACE WATER DIVERSION RATE (cfs)[a, b]	ESTIMATED STREAMFLOW DEPLETION BELOW DITCH RETURN (cfs)[b, c]	ESTIMATED REDUCTION IN FLOW UPSTREAM OF USGS GAGING STATIONS (cfs)[b, d]				
			near Clarkdale	at Camp Verde	near Camp Verde	below East Verde River	below Bartlett Dam
Del Rio	4	2	2	2	2	2	2
Granite Creek	4	2	2	2	2	2	2
Upper Verde (above mouth of Sycamore Creek)	8	4	4	4	4	4	4
Verde (between Sycamore and Oak Creeks)	80	46	*below station*	46	46	46	46
Phelps Dodge at Clarkdale	9	9		9	9	9	9
Verde (between Oak and Clear Creeks)	95	54		67[e]	54	54	54
Small creeks and springs tributary to Verde	5	3		3	3	3	3
Oak Creek (in Forest Reserve)	20	11		11	11	11	11
Lower Oak Creek	41	23		23	23	23	23
Beaver Creek	19	11		*below station*	11	11	11
Clear Creek	17	10			10	10	10
East Verde River	14	8			*below station*	8	8
		Total Upstream Depletion:	***9***	***167***	***176***	***183***	***183***

Notes:

[a] From Hancock (1914, p.32) and Hayden (1940, p.9); higher rate used if two values available for same location.
[b] cfs = cubic feet per second.
[c] See footnote d in **Table 2**; no portion of the surface water diverted by Phelps Dodge for mining was assumed to return to the river.
[d] Does not account for diversions that return to the river through subsurface seepage or natural evapotranspiration (ET) losses between the diversion and the gage site. As such, these values overestimate actual streamflow depletions.
[e] Adjusted to account for ditches within this reach where (i) the diversion and return are both below the gage (Diamond S); (ii) the diversion and return are both above the gage (OK); and, (iii) the diversion is above but the return is below the gage (Eureka and Woods).

The first 2 columns of Table 6 are from pages 9 and 317 of the Hayden (1940) report. The sites (reaches) are along the Verde River and the diversion rates were estimated by T. A. Hayden (1940) and H. L. Hancock (1914). Both Hayden and Hancock used crude methods to estimate ditch capacity such as the making of an estimate of maximum capacity of dry ditches and using reported maximum and normal capacity. Hayden refers to his estimate of ditch flow as “A rough estimate was made in July of the continuous flow of water running simultaneously in the, main ditches of the Verde area....” Thus after reading the Hayden and Hancock reports, the diversion rates in column 2, Table 6, are considered by me as very rough and potentially biased estimates.

ANSAC, it’s important to be aware that the water diversion rates in column 2, Table 6, are for the irrigation season of May to September. Mr. Burtell’s diversion rates in column 2 and his corresponding computed depletion rates in column 3 of Mr. Burtell’s Table 6 are not for a year—the rates are for 5 months or 42% of a year. According to the Hayden (1940) report the irrigation season in the Verde River watershed is about 5 months each year.

> “The irrigation season is approximately five months - May-Sept. inclusive.” P. 5 of T.A. Hayden (1940).
>
> “Water is used for approximately five months from May to September inclusive - the period being shorter in the higher elevations around Prescott and on Upper Oak Creek and longer in and near the main Verde Valley.” P. 8 of T.A. Hayden (1940).
>
> “On the basis of 250 sec.-ft. flow in all ditches, 500 acre-feet daily, or 75,000 acre-feet annually, is being diverted over a five-months period for 7,000 acres of land in Upper Verde Valley, Oak, Beaver & Clear Creeks.” .” P. 10 of T.A. Hayden (1940).
>
> “No system of complete control could be carried out without some method. of measuring the water and the physical difficulties involved in doing this on so many widely scattered farms end ditches would be great and would reçuire a number of men continuously for over five months out of each year.” P. 14-15 of T.A. Hayden (1940).
>
> “This is estimated at not less than three men for five or sin months a season,......” P. 16 of T.A. Hayden (1940).
>
> “Uses water about 5 months of the year.” P. 304 of T.A. Hayden (1940).

The depletion data in column 3, Table 6, were computed by Mr. Burtell using information from a study of four ditches in the Camp Verde area by Rob Ross. (Mr. Ross's Masters Thesis was about the measurement of diverted water to ditches and the effect of the diversion on flow hydraulics along the Verde River. Rob is presently with the USGS at Flagstaff and we've discussed his work on the Verde at length). The depleted data are discussed by Burtell in his opinion 77 of his Declaration of September 2014 and also on pages one and five, and also at length in Burtell Item A of this SUPPLEMENT 7. Data (for 5-month irrigation season) in column 3 are the product of values in column 2 and 0.57. The multiplier 0.57 mathematically is 1 - 0.43 as discernable in the following Attachment F of Burtell's Declaration of September 2014.

ATTACHMENT F. ROSS (2010) DIVERSION AND RETURN FLOW DATA FOR VERDE VALLEY IRRIGATION DITCHES

DITCH	MEASUREMENT PERIOD	AVERAGE DIVERTED FROM VERDE RIVER INTO HEAD GATE (cfs)[a]	AVERAGE DIRECTLY RETURNED TO VERDE RIVER (cfs)[a,b]	PERCENT DIVERTED THAT DIRECTLY RETURNED TO VERDE RIVER	PAGE REFERENCE
Diamond S	November 2008 to May 2010	26.25	15.10[c]	58	pp.125,127
Eureka	October 2008 to May 2010	9.13	3.70	41	pp.122,124
OK	March 2009 to May 2010	16.37	6.22	38	pp.121,123
Verde	May 2009 to May 2010	26.35	8.38	32	pp.124-126
	Total:	*78.10*	*33.40*	*43*	---

Notes:
[a] cfs = cubic feet per second.
[b] Does not include infiltration beneath irrigated fields and along ditches that returns to the Verde River as baseflow.
[c] Calculated based on Ross' statement that, on average, 11.15 cfs diverted into this ditch does not return to the river.

Also, it's important to be aware that the water diversion rates in columns 2, 3 and 5-8, Table 6, are for the irrigation season of May to September. A possible exception is the depletion associated with the mine at Clarkdale (opinion 79 of Mr. Burtell Declaration of September 2014) that may be an annual amount.

D. How are Burtell's Tables 5 and 6 related?

Mr. Burtell totaled the estimates of flow depletion for the five USGS gages at the bottom of columns 4-8, Table 6. He then "reconstructed" the Q25 and Q50 discharges in columns 5 and 6 (Table 5) with the corresponding results in columns 7 and 8 (Table 5). For example, for the *near Camp Verde* gage the reconstructed Q50 of 360 cfs is 184 cfs + 176 cfs (see column 6 of Table 6). He reconstructed Q25 and Q50 discharges by, for example, erroneously summing 184 cfs (annual flow) and 176 cfs (5 month flow) to create 360 cfs (an annual flow) for the nr Camp Verde USGS gage. This procedure erroneously assumes there was 7 months of 176 cfs of reduced (by diversion) flow when, in fact, there was no diverted flow during winter months according to at least six accounts by Hayden (1940). In other words, flow was created (more than 74,000 ac-ft/yr) that, in fact, is imagined and exists only in the amounts of reconstructed flow listed in columns 7 and 8 of Mr. Burtell's Table 5.

E. What about ATTACHMENT F and Ross's data in Mr. Burtell's report?

First Issue: It's unclear if the diversion and return data are averages for the measurement period. If so, because the periods for each ditch are different and represent different irrigation seasons of the year where ditch flow varies, then the averages for the four ditches may not represent the same irrigation seasons (e.g. Diamond S has 2 ditch closure periods (Fig. 56 of Ross, 2010) and the Verde ditch has only one(Fig 55 of Ross)). Second Issue: One obvious example of a potential problem is the Diamond S ditch where on Ross's p. 125 and Figure 56 is unclear and shows an average consumption of 11.15 cfs that does not agree with the difference between the average discharge and average return (26.25 cfs - 20.55 cfs.). Mr. Burtell assumed the 11.15 cfs amount was correct (footnote c of Attachment F) but a cursory examination of Figure 56 by me shows that such a large avg. consumption is impossible if the periods of ditch closure are included in the computation of the consumption.

Ross, R.P., 2010, One-dimensional hydraulic model of Verde River near Camp Verde, Arizona, including irrigation ditch discharge: Northern Arizona University, Masters thesis, 149 p.

Another example of Mr' Burtell's use of Ross's confusing data for the Eureka Ditch on Ross, 2010, p. 122 and Figure 54, p. 124. Ross shows an average consumption of 9.48 cfs that does not agree with the difference between the average discharge and average return (9.13 cfs – 3.70 cfs)

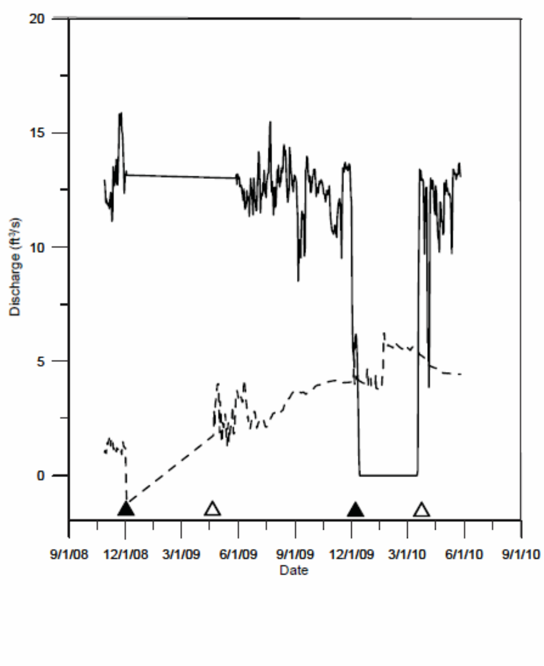


Figure 54 - Discharge and return flow of the Eureka Ditch, Camp Verde, central Arizona. Black arrows show ditch closure, and white arrows show resumption of operations. Solid black line is diverted flow, and dashed black line is returned flow.

Third Issue: To make matters worse Mr. Burtell was inconsistent in his use of Ross's (2010) data as shown in Attachment F. As mentioned above, Mr. Burtell used the average consumption of 11.15 cfs for the Diamond S Ditch (Ross 2010, p. 125) instead of the difference between the average diversion and return (26.25 cfs - 20.55 cfs). However, for the Eureka Ditch he used 9.13 cfs – 3.70 cfs.

Thus it is unclear to me because (1) what periods the average diverted and returned discharges represent, (2) if the average amounts of the 4 ditches are comparable and (3) if the data are accurate.

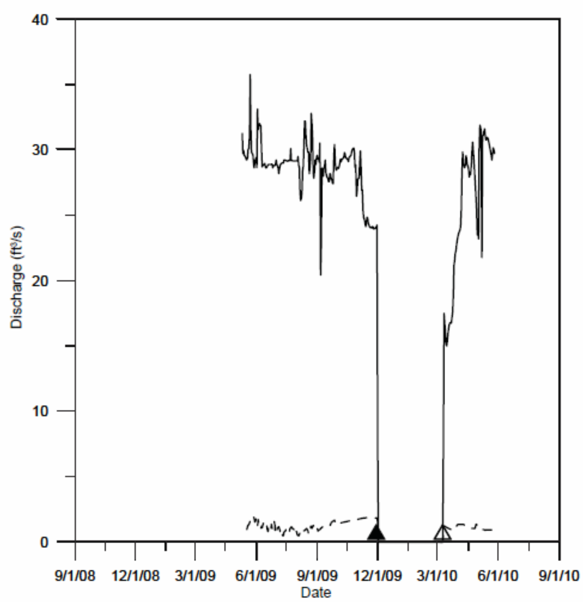


Figure 55 - Discharge and return flow of the Verde Ditch, Camp Verde, central Arizona. Black arrow shows ditch closure, and white arrow shows resumption of operations. Solid black line is diverted flow, and dashed black line is returned flow.

A cursory examination of Ross's report and in particular his Chapter 7 shows a few large differences among the graphs of discharge and return flow. One example is the Verde ditch (Figure 55) where the return flow is about 1 cfs but in Attachment F the return flow is 8.38 cfs.

The evidence suggests that Mr. Burtell relied on Mr. Ross's sometimes confusing thesis without properly examining Mr. Ross's work and he did not consult with or ask Robert Ross for permission to use his unsigned thesis. Because of both Mr. Burtell's and Mr. Ross's confusing analyses I attempted to contact Mr. Ross in early January 2015 and learned through Mr. Brad Garner, author of Garner and others (2012) that "Rob Ross (rross@usgs.gov) was now a USGS employee and works on Grand Canyon projects nowadays." It took some time for Rob to get with me because he was very busy with his new job. We've discussed his report at length including the purpose and limitations of his study as an NAU grad. student with limited funding. Rob was open and honest about limitations and errors of his study and graciously allowed me to use the following quote:

win hjalmarson <hjalmar275@gmail.com> Tue, Feb 10, 2015 at 10:24 AM
To: "Ross, Robert" <rross@usgs.gov>

Very helpful. Can I quote you on this? Please respond.

Win

Ross, Robert <rross@usgs.gov> Tue, Feb 10, 2015 at 10:31 AM
To: win hjalmarson <hjalmar275@gmail.com>

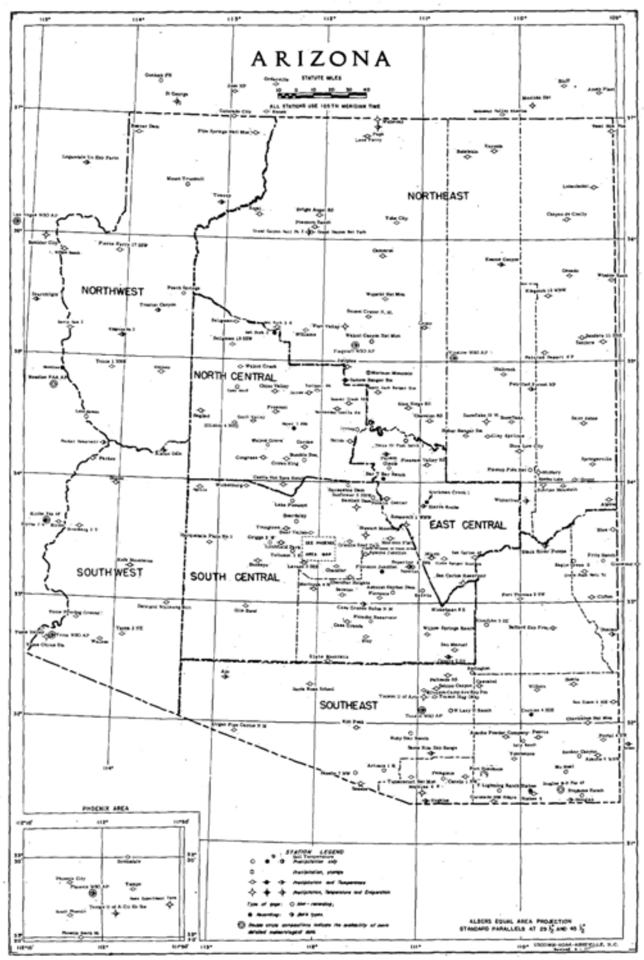
As long as it is clear that you are quoting me as a former NAU student who wrote the thesis used, and not in my official current capacity, then you may quote me as such: "I feel that the data gathered for four large ditches from 2008 to 2010 are neither temporally or spatially adequate to model historic flows for the Verde River."
Thanks,
Rob
[Quoted text hidden]

"I feel that the data gathered for four ditches from 2008 to 2010 are neither temporally or spatially adequate to model historic flows for the Verde River" Robert Ross Feb. 10, 2015

SUPPLEMENT 8. Comparing results of Hjalmarson's Methods 1 and 2 at the mouth of the Verde River (USGS gage 09510000) and the USBR (1952) average annual virgin flow with the annual precipitation for the North Central Region using precipitation data from the National Climatic Data Center (NCDC).

As shown below, the computed mean annual Virgin Flow of 763.6 cfs agrees marvelously well (only 1.8% difference) with the Virgin flow of 751 cfs (USBR, 1952) in Table 1 of 2 on p. 20 of my report. This scientific based independent method of estimating the Virgin flow at the mouth of the Verde River by using a simple precipitation vs runoff relation (using current data) suggests the methods used by Hjalmarson for ANSAC are accurate.

The following map and table shows the North Central region and the associated precipitation gages. (NOAA, 1977, CLIMATOLOGICAL DATA, ANNUAL SUMMARY, ARIZONA; VOLUME 81 NUMBER 13, 20 p.) (page 19)



The table below is simply a sample of the NE region for 1977 showing stations in the North Central region. NOAA, 1977, CLIMATOLOGICAL DATA, ANNUAL SUMMARY, ARIZONA; VOLUME 81 NUMBER 13, 20 p. (page 5)

TABLE 2 — TOTAL PRECIPITATION AND DEPARTURES FROM NORMAL — ARIZONA 1977

STATION	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		ANNUAL	
	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE	PRECIP.	DEPARTURE
NORTH CENTRAL 03																										
ASH FORK 5 N	.92		.18		.46		.47		.63		.60		.87		2.50		2.23		1.77		.28		1.37		12.28	
BAGDAD	1.33		.19		.31		.71		1.24		.00		1.28		3.05		.72		1.60		.19		.94		11.56	
BEAVER CREEK R S	1.63		.88		.53		.76		.65		.60		1.15		2.10		2.86		1.50		.14		.52		13.32	
BUMBLE BEE	1.73		.30		.51		.47		.34		.30		2.40		1.04		2.97		.72		.07		1.49		12.34	
CAMP WOOD	1.72		.23		.27		.66		1.50		.67		1.21		2.41		1.11		E 1.55		.13		1.32		E 12.78	
CASTLE HOT SPRS HOTEL	E 2.41		.40		.30		.50		.31		.00		.58		T		1.96		.83		T		2.64		E 9.93	
CHILDS	2.40	.61	.25	-.99	.50	-1.04	1.00	.08	.39	.04	.08	-.36	.93	-1.23	2.17	-.58	2.63	1.09	1.05	-.01	.25	-.92	1.11	-1.00	12.76	-4.31
CHINO VALLEY	1.18	.22	.38	-.48	.16	-.81	.83	.06	.47	.19	.71	.45	.64	-1.40	3.29	.90	2.09	1.12	1.01	.26	.08	-.56	.97	-.09	11.81	-.14
CONGRESS	.83		.12		.36		.71		.91		.06		.18		1.27		1.74		1.30		.00		1.28		8.76	
CORDES	1.18	-.03	.20	-.81	.36	-.79	.50	-.18	.32	.02	.46	.17	1.53	-.24	1.45	-1.09	2.58	1.28	2.02	1.16	.02	-.88	.90	-.63	11.52	-2.02
COTTONWOOD	1.28		.37		.28		.47		.27		-		-		-		-		-		-		-		-	
CROWN KING	4.13	1.15	.51	-1.74	.95	-1.67	.97	-.37	1.07	-.67	.00	-.46	4.40	.68	.00	-5.09	3.93	2.01	1.49	.07	.06	-1.66	2.34	-1.26	19.85	-7.67
HILLSIDE 4 NNE	1.30		.28		.45		.75		1.24		.16		1.67		2.80		1.64		.93		.08		.89		12.19	
IRVING	2.73	.77	.47	-1.04	.48	-1.34	1.36	.27	.85	.44	.28	-.21	1.89	-.11	1.82	-1.11	2.84	1.16	1.20	-.06	.60	-.68	1.16	-.95	15.68	-2.86
JEROME	1.93	.37	.75	-.61	.53	-.99	1.75	.55	.25	-.27	.95	.56	2.95	.24	3.95	.46	2.25	1.04	1.91	.78	.35	-.74	E .68	-1.05	E 18.25	.34
MONTEZUMA CASTLE N M	F .95	.00	.41	-.47	.16	-.88	.42	-.36	.52	.25	.82	.52	.19	-1.28	2.13	.14	2.44	1.10	1.44	.64	.09	-.63	.56	-.60	E 10.13	-1.57
PRESCOTT	1.32	-.38	.57	-.79	.39	-.97	1.35	.43	.37	.02	.49	.07	3.07	-.07	1.81	-1.57	2.15	.71	1.73	.74	.04	-1.13	.79	-1.02	14.08	-3.96
SELIGMAN	.73	-.17	.07	-.64	.28	-.63	.48	-.04	.54	.30	.41	-.05	2.20	.59	1.13	-1.10	1.04	.30	.79	.16	.25	-.29	1.25	.30	9.17	-1.27
SELIGMAN 13 SSW	.86		.35		.17		.10		.38		.37		1.03		3.19		1.34		.96		.17		.75		9.67	
SKULL VALLEY	1.35		.36		.43		1.13		1.20		.51		.76		3.66		2.07		1.40		.02		1.18		14.07	
TUZIGOOT NATL MON	-		-		-		-		-		-		1.47		3.75		2.18		1.54		.13		.55		-	
WALNUT CREEK	1.09	-.26	.39	-.72	.18	-1.05	.41	-.36	.92	.55	.24	-.22	1.66	-1.02	1.97	-1.10	1.37	.04	1.74	.82	.16	-.70	.84	-.56	10.97	-4.58
WALNUT GROVE	1.57	.02	.28	-1.09	.45	-1.06	.88	.02	.58	.35	.00	-.35	.87	-1.17	2.06	-1.29	E 1.99	.51	1.15	.35	E .03	-.97	1.23	-.50	E 11.09	-5.18
DIVISION	1.49	.14	.37	-.80	.38	-.89	.74	-.15	.65	.36	.38	.02	1.48	-.61	2.23	-.47	2.07	.80	1.39	.51	.13	-.78	1.09	-.39	12.40	-2.26

The relation between annual precipitation for the north central region and annual runoff is examined. Calendar year streamflow data for USGS gage 09510000 were from the USGS website and USGS WSP 1313. Time series of precipitation amounts for the north central region of AZ were obtained from the National Climatic Data Center (NCDC) website. The time series for the precipitation (green graph) was shown previously in this analysis (Burtell Item B).

Wells, J.V.B., 1954, Compilation of Records of Surface Waters of the United States through September 1950, Part 9. Colorado River Basin, GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1313, 748p. pp. 694 and 695.

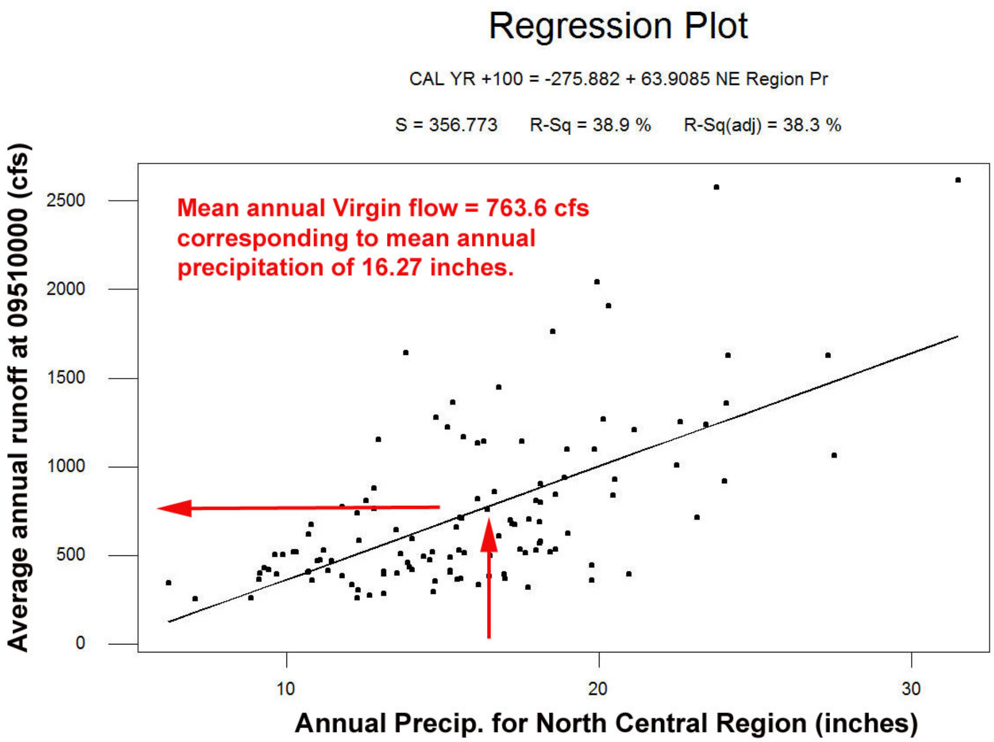
Mostly because of the different types of storms, the variable antecedent watershed conditions and the spatial variation of precipitation, a lot of scatter about a relation between annual precipitation for the north central region and annual runoff is expected. See the last paragraph on p. 6 of Appendix J for a discussion of types of storms that produce runoff from Arizona watersheds.

The streamflow and precipitation data used for the analysis are shown on the next page. A Minitab regression analysis that uses the tabled data follows the data. Minitab is a statistical software owned by a private company headquartered at State College, Pennsylvania with subsidiaries around the world. Minitab is used by several government agencies including the USGS WRD.

Year	Annual Precip. for NE region (inches)	Mean annual Q (cfs)
1895	12.94	1053.0
1896	14.66	417.0
1897	12.56	709.0
1898	11.32	313.0
1899	9.14	301.0
1900	8.88	161.0
1901	10.30	417.0
1902	10.67	304.0
1903	10.80	576.0
1904	11.00	371.0
1905	31.50	2516.0
1906	21.13	1108.0
1907	16.12	1033.0
1908	20.51	828.0
1909	18.14	805.0
1910	12.81	662.0
1911	18.99	999.0
1912	17.32	572.0
1913	14.02	494.0
1914	17.22	580.0
1915	20.15	1166.0
1916	20.30	1808.0
1917	14.80	1180.0
1918	17.98	711.0
1919	22.61	1152.0
1920	16.79	1346.0
1921	19.02	523.0
1922	17.53	1042.0
1923	19.87	999.0
1924	11.20	429.0
1925	15.70	416.0
1926	16.42	658.0
1927	23.42	1139.0
1928	10.23	419.0
1929	10.70	521.0
1930	18.60	435.0
1931	23.14	614.0
1932	15.67	1070.0
1933	13.11	295.0
1934	12.11	232.0
1935	18.13	699.0
1936	16.51	400.0
1937	15.15	1121.0
1938	15.62	608.0
1939	14.59	373.0
1940	19.78	345.0
1941	24.14	1529.0
1942	9.64	402.0
1943	14.40	392.0
1944	15.55	614.0
1945	13.52	543.0
1946	15.58	268.9
1947	9.69	292.1
1948	11.78	284.0
1949	16.13	719.2
1950	9.29	328.0
1951	20.97	295.8
1952	18.89	840.7
1953	10.83	261.0
1954	15.23	388.2
1955	14.75	256.0

Continued

1956	6.23	243.2
1957	18.44	420.8
1958	18.10	587.1
1959	16.98	293.3
1960	11.78	676.0
1961	12.65	174.4
1962	12.31	482.7
1963	15.47	265.9
1964	13.12	308.8
1965	27.53	963.9
1966	12.81	778.4
1967	18.09	467.7
1968	12.26	641.3
1969	17.76	605.7
1970	16.99	269.7
1971	13.95	333.0
1972	15.52	431.3
1973	13.83	1541.0
1974	14.03	318.7
1975	11.09	373.2
1976	16.80	507.6
1977	12.30	202.3
1978	27.33	1529.0
1979	15.32	1263.0
1980	19.93	1943.0
1981	16.16	232.6
1982	22.49	907.7
1983	24.07	1257.0
1984	17.64	413.2
1985	17.17	598.8
1986	17.48	432.5
1987	18.13	478.1
1988	15.45	560.0
1989	9.88	404.0
1990	17.73	217.6
1991	18.00	426.9
1992	24.01	817.5
1993	23.76	2478.0
1994	13.89	358.7
1995	16.31	1044.0
1996	9.12	264.2
1997	16.48	283.1
1998	20.44	738.2
1999	13.53	301.2
2000	14.70	192.7
2001	13.66	408.4
2002	7.08	156.5
2003	15.23	304.8
2004	19.78	261.5
2005	18.52	1662.0
2006	10.72	309.8
2007	13.11	182.4
2008	16.65	760.7
2009	9.43	318.1
2010	18.61	743.5
2011	11.44	367.1
2012	12.28	160.7
2013	15.23	316.1



Polynomial Regression Analysis: CAL YR +100 versus NE Region Pr

The regression equation is
CAL YR +100 = 528.488 - 37.3295 NE Region Pr
+ 2.95439 NE Region Pr**2

S = 346.920   R-Sq = 42.7 %   R-Sq(adj) = 41.7 %

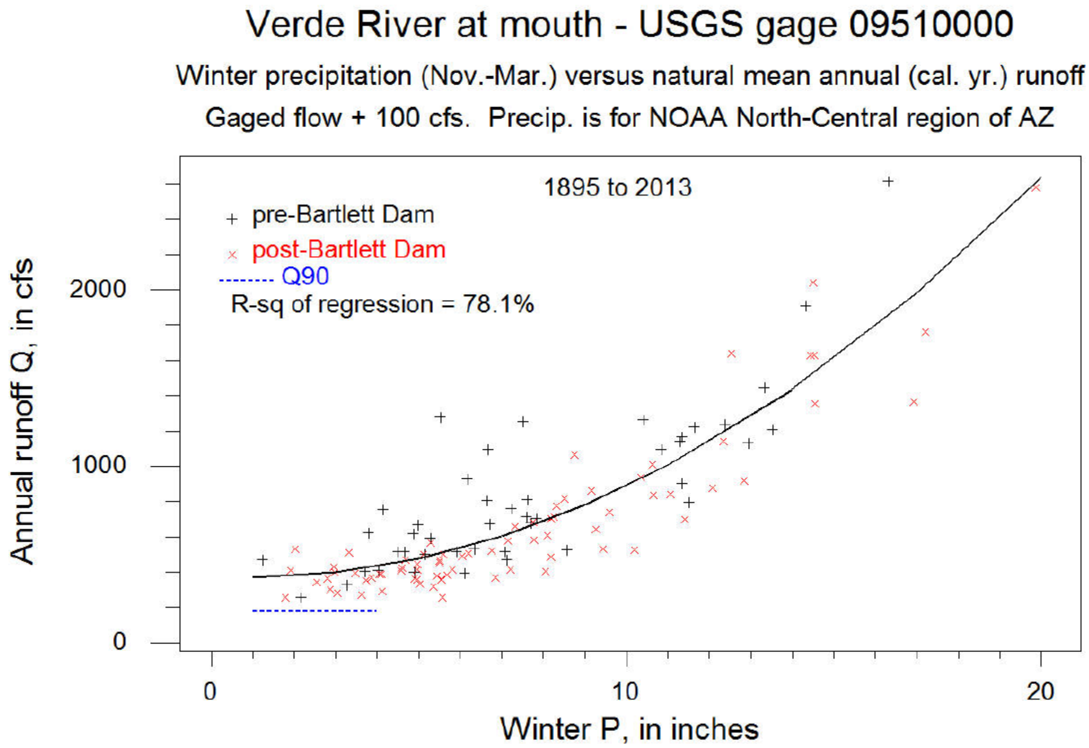
Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	10396076	5198038	43.1898	0.000
Error	116	13960978	120353		
Total	118	24357054			

Source	DF	Seq SS	F	P
Linear	1	9464496	74.3557	0.000
Quadratic	1	931580	7.7404	0.006

Note: To address any homoscedasticity issues from the apparent dissimilar amounts of variance across the range of values for the independent variable, the variables were transformed to logarithms; the resulting regression produced no significant difference in the estimate of mean annual Virgin flow for ANSAC.

The relation between winter precipitation and mean annual runoff at the mouth of the Verde River is shown below.



The lower end of the above precipitation-runoff relation shows the affect of large springs in the Verde River watershed. The relation is rather flat where for small amounts of winter precipitation the annual runoff is rather constant. In other words, much of the river flow for dry years is from spring flow in the watershed and this spring flow is from groundwater that was recharged from precipitation for previous years. This carryover storage in the ground is the source of springs like Big Chino (the headwater springs below Granite Creek), Fossil Creek, and several others (See Appendix G, section G1, pages 4 and 5) that have large source areas and supply a rather steady base flow for the Verde River. Apparently the total outflow of springs with carryover storage is a few cfs more than Q90 used for this study. Also, many other springs are recharged annually (more recently) and the flow is more closely related to recent precipitation and associated ground water recharge. See also my comments on p. 1007, 12/18/2014, Volume 4, Verde River (REPORTER'S TRANSCRIPT OF PROCEEDINGS 15 VOLUME 4, 16 Pages 839 through 1075, Inclusive).

SUPPLEMENT 9. Use of USBR (1952), also known as the White Book, for average annual virgin flow at the mouth of the Verde River for ANSAC.

Experts Hjalmarson and Gookin have used the Virgin flows for various rivers as part of the ANSAC hearings. Mr. Burtell also used Virgin flows (Table 21 of USBE, 1952) at four locations on the Gila River (Table 14 of Burtell's Gila declaration). Mr. Hjalmarson used Virgin flows for his Santa Cruz analysis and to check his results on the San Pedro and lower Gila analyses, and Mr. Gookin used the White Book for the San Pedro, Santa Cruz and the Gila. Thus, "experts" have considered USBR (1952) as a reliable source of hydrologic information for ANSAC.

Mr. Hjalmarson used Table 21 of the USBR (1952) for the source of virgin flow at the mouth of the Verde River and he also checked scientific literature for any recent valid deficiencies or issues with USBR (1952). Mr. Hjalmarson reported his findings on p. 59 of his Addendum of Nov. 14, 2014 – no issues with USBR (1952) were found. Because the Virgin flows of the USBR (1952) are for flow across state and international boundaries, Mr. Hjalmarson considers the Virgin flows as reliable, and generally not to be ignored, until the US Dept. of the Interior finds the data unreliable and makes revisions (this is pure speculation).

Mr. Gookin has testified before ANSAC that he considers the White Book as having the best information available. See for example Mr. Gookin's report below:

GOOKIN, T. A., 2009, ANNUAL VIRGIN FLOWS IN CENTRAL ARIZONA; 2009 Annual Water Symposium, MANAGING HYDROLOGIC EXTREMES, Arizona Hydrological Society, American Institute of Hydrology, 10 p., page 1: (http://azhydrosoc.org/memberresources/symposia/2009/papers/gookin.pdf)

> "The "White Book" represents approximately 15 man-years of work and is the most comprehensive study ever made concerning the virgin flows in the Lower Colorado River Basin. The extent to which human activity in the watersheds of the Lower Colorado River Basin has progressively altered the natural flow of the river was studied in greater detail in the "White Book" than at any time before or since. The "White Book," though not perfect, is the best study available."

Note: Mr. Hjalmarson and Mr. Gookin are registered engineers in AZ and have *sealed* their work on ANSAC issues.

Lets take a look at how the USBR views the "White Book" keeping in mind that USBR (1952) is an important part of this analysis as I stated on p. 19 of my report. The 1952 report follows the 1946 report (p. 17 of my report) and provides more detailed *"...data regarding the average natural flow of streams and rates of water use were needed to serve as the basis for planning future developments for the maximum use of available water supplies.* " (USBR, 2012, p. SR3-2). The report summarizes data over the period 1914 to 1945. *"This period was chosen* *because it was believed to be a representative period of average stream flow as well as a period for which sufficient reliable hydrologic data were available to make a comprehensive analysis of water resources and stream depletions. Furthermore, the 1914 to 1945 period included the above-average runoff years from 1914 to 1929, as well as the drought years from 1931 through 1940, and was therefore thought to be appropriate for considering storage problems of stream flow in drought years."* (USBR, 2012, p. SR3-2).

USBR, 2012, Colorado River Basin Water Supply and Demand Study, 95 pages: http://www.usbr.gov/lc/region/programs/crbstudy/finalreport/Study%20Report/StudyReport_Appendix3_FINAL.pdf; Appendix 3 Summary of Past Colorado River Basin Planning Studies, pages SR3-1 to SR3-13

The flow conditions during the 1914-1945 period used by the USBR to define natural flow of the Gila River watershed are important for the Verde River watershed and ANSAC. For example, my hydrology method 2 uses the virgin flow at the mouth of the Verde River that was computed by the USBR (1952) (See Table 1 of 2 on p. 2 of my report (Oct. 4, 2014) and also p. 59 of my Addendum of Nov. 14, 2014)). Thus, I chose to use the USBR 1952 report and agreed with the USBR determination of virgin flow at the mouth of the Verde River as discussed above. However, Mr. Burtell referenced the USBR 1952 report but chose to ignore the changing runoff, the wet and dry years, for the 1914-1945 period that are summarized above by the USBR (2012). Granted, the estimates of Virgin flow are most important while the details of USBR (1952) are not.

Mr. Burtell used data for 1914-40 that were part of the wet and dry years defined by the USBR (2012). Mr. Burtell would have been better off had he considered the internal non-stationarity of annual runoff defined by USBR (2012, p. SR3-2) as I have described in SUPPLEMENT 7 Burtell Item F of this Second Addendum.

SUPPLEMENT 10. John Day River in Oregon

The following is an analysis of the navigability characteristics of the John Day River using monthly discharge data found in Table 7 (page 24) of JOHN DAY RIVER FINAL NAVIGABILITY REPORT of 2014 by the Oregon Water Resources Department dated March 25, 2005, 44p. Depths of flow corresponding to Q80 and Q50 are computed and along with flow velocity are compared with the depths and velocities for the Verde River. The natural monthly stream flow at the 80% and 50% exceedance levels for two sites on the river that is represented by flow at USGS gages (14046500 Service Creek (watershed ID 210) and 14048000 McDonald Ferry (watershed ID 209)) on the John Day River is also contained in the Water Availability Analysis of the OR Water Resources Department for the John Day Basin as discussed later.

The Oregon Court of Appeals affirmed a finding that the John Day River was navigable. (Northwest Steelheaders Ass'n, Inc. v. Simantel, 199 Or.App. 471 (2005), Court of Appeals of Oregon, 99C12309; A118737, Argued and Submitted Dec. 20, 2004., Decided May 11, 2005.).

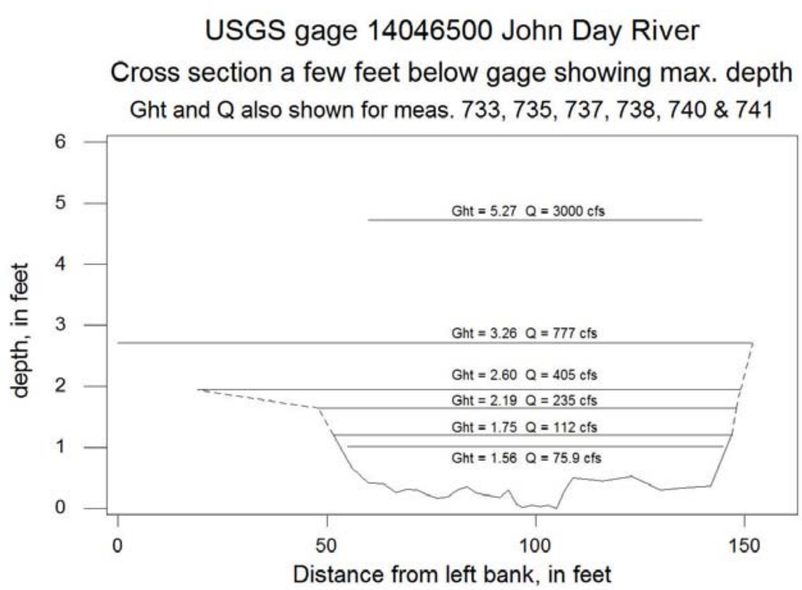
Also, another report provides an explanation of how the natural stream flow was calculated, including how base flow was determined and how consumptive use was calculated. (, Determining Surface Water Availability in Oregon, State of Oregon Water Resources Department, Open File Report SW 02-002, 158p.). In regard to the navigability issue and natural streamflow, the following is from the Abstract of Cooper, R. M. (2002), p.1:

> Exceedance stream flows are determined directly from gage records, or for ungaged streams, by estimation through modeling. When determined from gage records, the exceedance flows must be corrected to a common base period, and then, to natural stream flow. When determined through modeling, the exceedance flows are estimated from statistical models that relate watershed characteristics to natural stream flow. The models are derived by multiple linear regression.

USGS gage 14046500 John Day River near Service Creek

A view looking upstream at the gage area is shown below. Cableway is about 80 ft upstream of the gage where there is bedrock on the left bank and a small pool. Wading measurements of Q are typically made about 150 ft below the gage where flow depth is small and typically can be waded during dry weather . There is a small overflow area on the left bank side of the wading area that is shown on the photo below and in the following measured cross section of the channel.

A cross section of the channel for a measurement of base discharge made in the "wading measurement" area is shown below. The gage height, maximum depth and discharge for a few other USGS measurements of discharge that were made in the same area below the gage are also shown on the cross section.

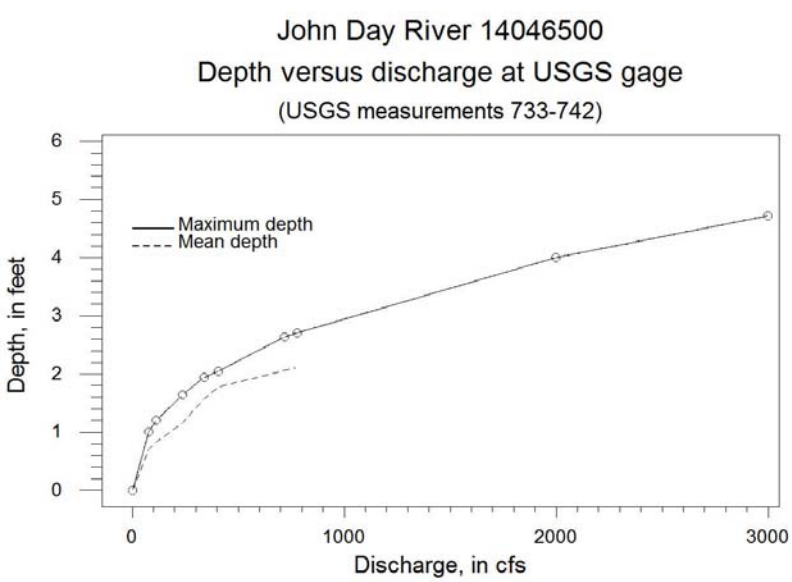


The relation between channel depth and discharge that corresponds to the previous cross section is shown below. The maximum depth corresponds to a navigability "lane" that at this location is about 10 ft wide.

Some of the cross section shape is estimated using the approximate depth of the channel banks (including the overflow area on the left side). This is shown by the dashed line in the figure below. Average depth for higher flows is not shown because it is not useful for this assessment and because measurements of Q were made by the USGS at the cableway upstream of the gage.

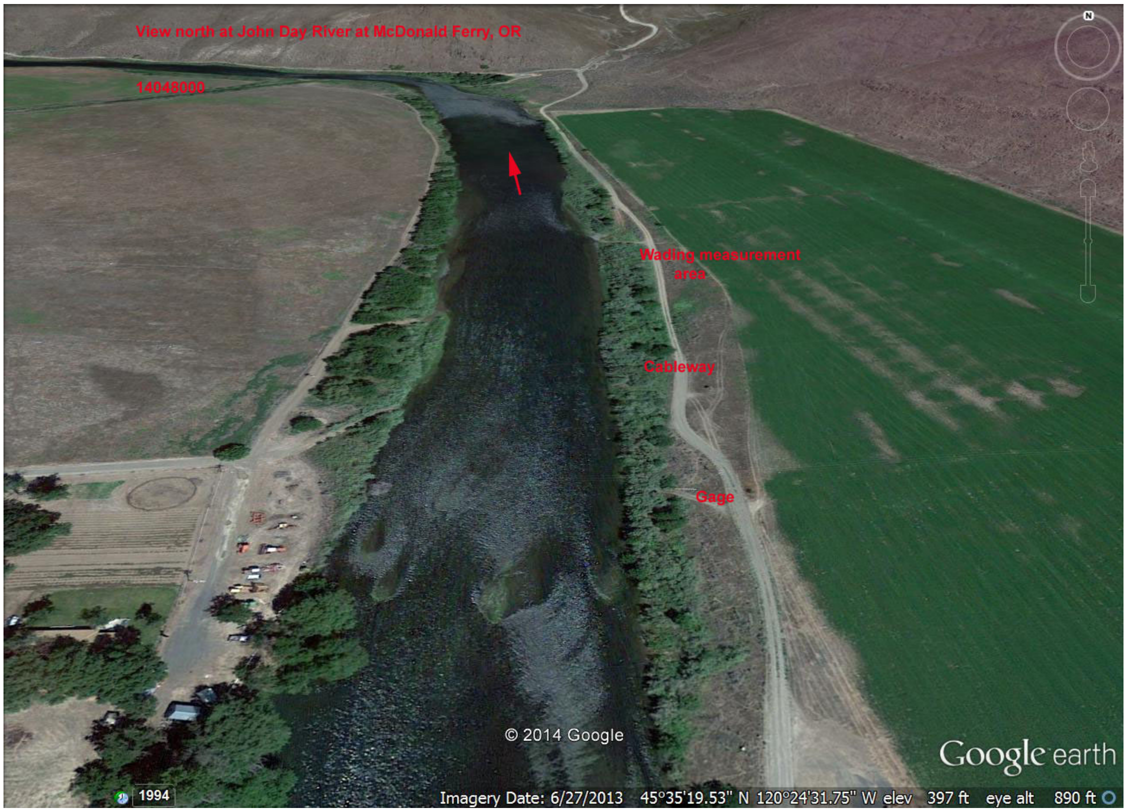
Based on my professional experience the average depth corresponding to the main channel including the flood plain area produces a useless result for assessment of navigability. Because navigability is for the main channel, the assessment is related to hydraulic conditions for use of small watercraft only in the main channel. The overflow segment of the channel area is not related to the assessment. Depth along the thalwag area is most important for canoes and small boats.

The depth-Q relation shown below is simply defined by straight line connection of the USGS measurements of Q. The mean depth is the same as the average depth.

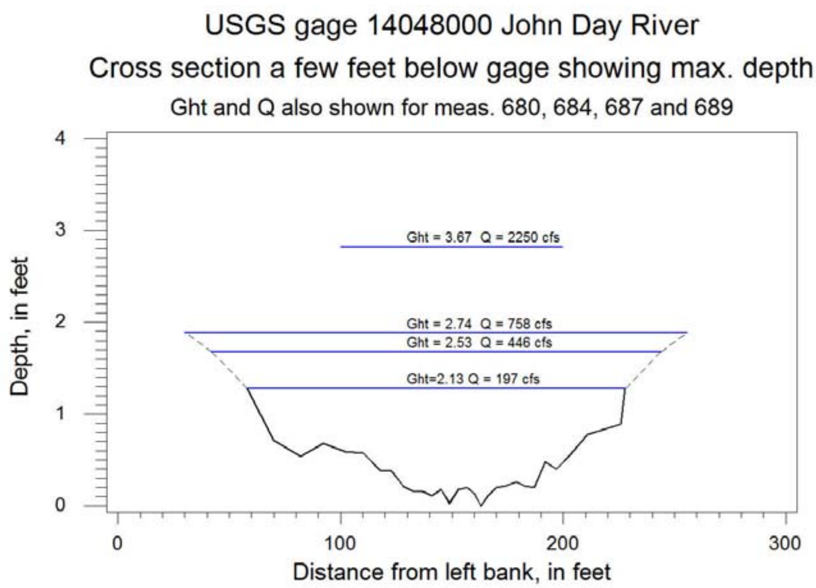


USGS gage 14048000 John Day River near McDonald Ferry

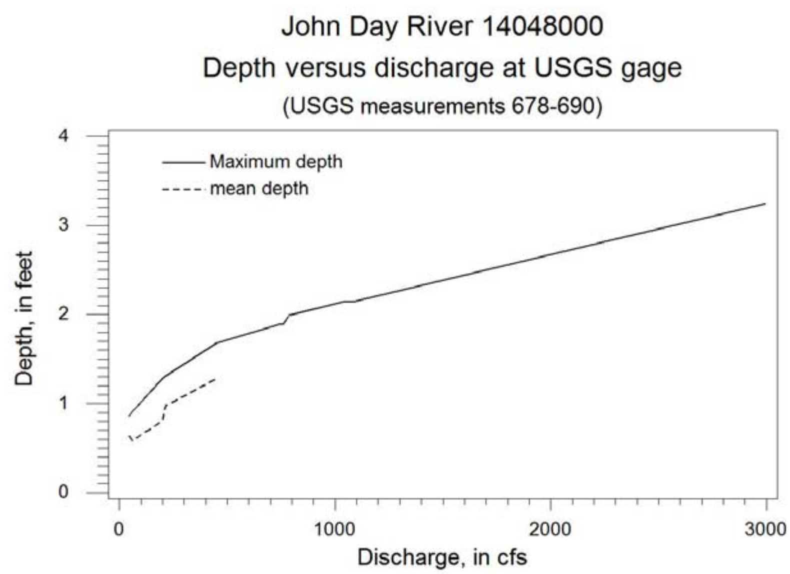
A view looking downstream at the gage area is shown below. The cableway is about 350 ft downstream of the gage. Wading measurements of Q are typically made about 800 ft below the gage where flow is rather uniform across the channel and typically easily waded during dry weather . Distribution of flow across the channel at the gage reach is not uniform with a shallow riffle area (shown by the reflection of sunlight off the water) in the center and left bank area and with a deeper area on the right at the gage.



The following cross section is for the wading measurement area shown in the above figure. Cross section data furnished by the USGS follows this analysis.



The relation between channel depth and discharge that corresponds to the previous cross section is shown below. The relation is simply defined by straight line connection of the USGS measurements of Q. The maximum depth corresponds to a navigability "lane" that at this location is about 37 ft wide. Because navigability is for small watercraft (e.g. small boats) a "lane" along the thalwag of the main channel is used for the assessment. If barges, for example, were being assessed for ANSAC then an average depth for the main channel segment might be relevant.



As previously discussed, The Oregon Water Resources Department (OWRD) has developed a model called the Water Availability Reporting System that can be used to determine what the average monthly flow at two sites on the John Day River (near gages 14046500 and 14048000) was if normal rainfall is assumed and no consumptive uses or flow regulation existed (Oregon Water Resources Department, 2004).

These conditions are the same as those that existed at the time of Oregon's statehood in 1859. The model provides mean monthly flow for two exceedence levels, 50% and 80% at the two locations previously discussed (gages 14046500 and 14048000). The flow data below are from Table 7 (page 24) of the JOHN DAY RIVER FINAL NAVIGABILITY REPORT (OWDR 2004).

Access, with steps as of January 2015, to the OR water website follows:
http://www.oregon.gov/owrd/pages/PUBS/ToolsData.aspx

1. Click on the WARS link under Surface Water, 2. Select View Water Availability, 3. Pick John Day Basin and then the subbasin: either SERVICE CREEK>JOHN DAY R.-AT MOUTH OR JOHN DAY R>COLUMBIA RIVER-AT MOUTH and then pick either the 50 of 80 exceedance --- submit, 4. Select Complete Water Availability Analysis tab instead of picking 1, 2, or 3.

For a selection of Service Creek the following table is part of the display.

Monthly Streamflow in Cubic Feet per Second
Annual Volume at 50% Exceedance in Acre-Feet

Month	Natural Stream Flow	Consumptive Uses and Storages	Expected Stream Flow	Reserved Stream Flow	Instream Flow Requirement	Net Water Available
JAN	1,250.00	21.20	1,230.00	57.20	500.00	672.00
FEB	2,440.00	30.40	2,410.00	117.00	1,000.00	1,290.00
MAR	3,250.00	56.30	3,190.00	163.00	2,000.00	1,030.00
APR	4,860.00	163.00	4,700.00	272.00	2,000.00	2,420.00
MAY	5,050.00	319.00	4,730.00	245.00	2,000.00	2,490.00
JUN	2,700.00	294.00	2,410.00	67.60	2,000.00	338.00
JUL	715.00	269.00	446.00	0.00	500.00	-54.40
AUG	340.00	197.00	143.00	0.00	500.00	-357.00
SEP	271.00	133.00	138.00	0.00	500.00	-362.00
OCT	380.00	57.80	322.00	0.00	500.00	-178.00
NOV	542.00	15.00	527.00	4.53	500.00	22.50
DEC	940.00	18.40	922.00	36.10	500.00	385.00
ANN	1,370,000.00	95,400.00	1,270,000.00	57,800.00	753,000.00	519,000.00

The column *Natural Stream Flow* on the left is one of the four columns in the Table: **Likelihood of flows and depths of flow at various points along the John Day River at statehood,** presented later in this supplement.

The flow depths corresponding to the Q50 (median) and Q80 flows from the preceding depth-discharge relations for the two USGS gages follow. These depths were computed using the depth-discharge relations shown previously.

Likelihood of flows and depths of flow at various points along the John Day River at statehood. All flows indicated are monthly averages in cubic feet per second (cfs) and all corresponding depths are in feet.

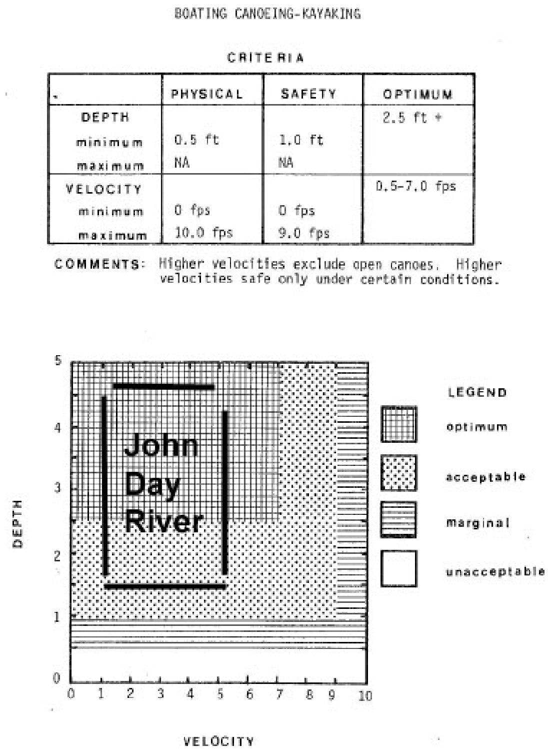
	14046500 Service Creek				14058000 McDonald Ferry			
	Q50	d50	Q80	d80	Q50	d50	Q80	d80
Jan	1130	3.1	556	2.3	1250	3.2	626	2.5
Feb	2060	4.0	953	2.9	2440	4.2	1050	3.0
Mar	2860	4.6	1560	3.5	3250	4.8	1680	3.6
Apr	4610	5.6	2710	4.5	4860	5.7	2920	4.7
May	4770	5.7	2860	4.6	5050	5.8	3020	4.7
June	2410	4.3	1270	3.2	2700	4.5	1440	3.4
July	652	2.4	420	2.1	715	2.7	470	2.1
Aug	312	1.8	242	1.7	340	1.9	246	1.7
Sept	260	1.7	203	1.6	271	1.7	194	1.5
Oct	385	2.0	280	1.8	380	2.0	283	1.8
Nov	508	2.2	384	2.0	542	2.3	393	2.0
Dec	859	2.8	473	2.2	940	2.9	513	2.2

The range of natural average monthly flow depth for d80 is from 1.5 ft (September) to 4.7 ft (April and May). Twenty percent of the time during a typical month of September the average monthly depth of flow will be less than 1.5 ft. Conversely, eighty percent of the time during a typical month of October the average monthly depth of flow will be at least 1.8 ft. Also, fifty percent of the time during a typical month of September the natural average monthly depth of flow will be less than 1.7 ft.

The natural flow depths in the table above are for the areas where wading measurements are made at the two gages. These areas are not riffles and they are not deep pools. The wading measurement areas are used by the USGS because flow velocities are rather uniformly distributed across the channel, flow depths are neither very shallow or to deep to wade (a transition zone between riffles and pools), and the shape of the cross section is rather uniform.

The navigability assessment for the John Day River is compared to the assessment for the Verde using the Hyra incremental method below. The cross sections at the John Day River gages (14048000 and 14046500) are used where many cross sections are used for the Verde River. Also, the results below are where canoeing and kayaking the Verde River is rated as optimum and acceptable 90% of the time for a typical year and the John Day River is rated optimum and acceptable 80% of the time for a typical year. For navigability, it is important to know how often water depth is available; the following rating for the Verde River is more stringent than that for the John Day River.

John Day River
Minimum Depth = 1.5 ft
Rating is acceptable 80% of time



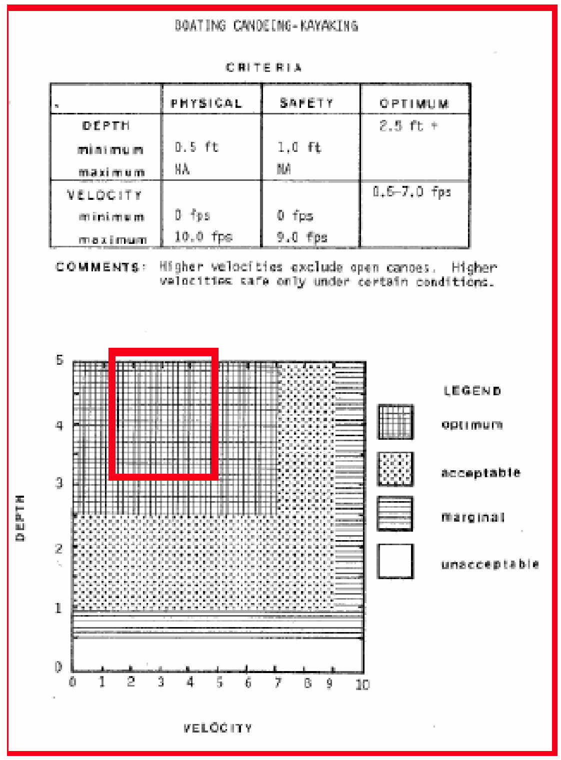
BOATING CANOEING-KAYAKING

CRITERIA

	PHYSICAL	SAFETY	OPTIMUM
DEPTH			2.5 ft +
minimum	0.5 ft	1.0 ft	
maximum	NA	NA	
VELOCITY			0.5-7.0 fps
minimum	0 fps	0 fps	
maximum	10.0 fps	9.0 fps	

COMMENTS: Higher velocities exclude open canoes. Higher velocities safe only under certain conditions.

Verde River
Minimum Depth = 3 ft
Rating is optimal 90% of time



BOATING CANOEING-KAYAKING

CRITERIA

	PHYSICAL	SAFETY	OPTIMUM
DEPTH			2.5 ft +
minimum	0.5 ft	1.0 ft	
maximum	NA	NA	
VELOCITY			0.5-7.0 fps
minimum	0 fps	0 fps	
maximum	10.0 fps	9.0 fps	

COMMENTS: Higher velocities exclude open canoes. Higher velocities safe only under certain conditions.

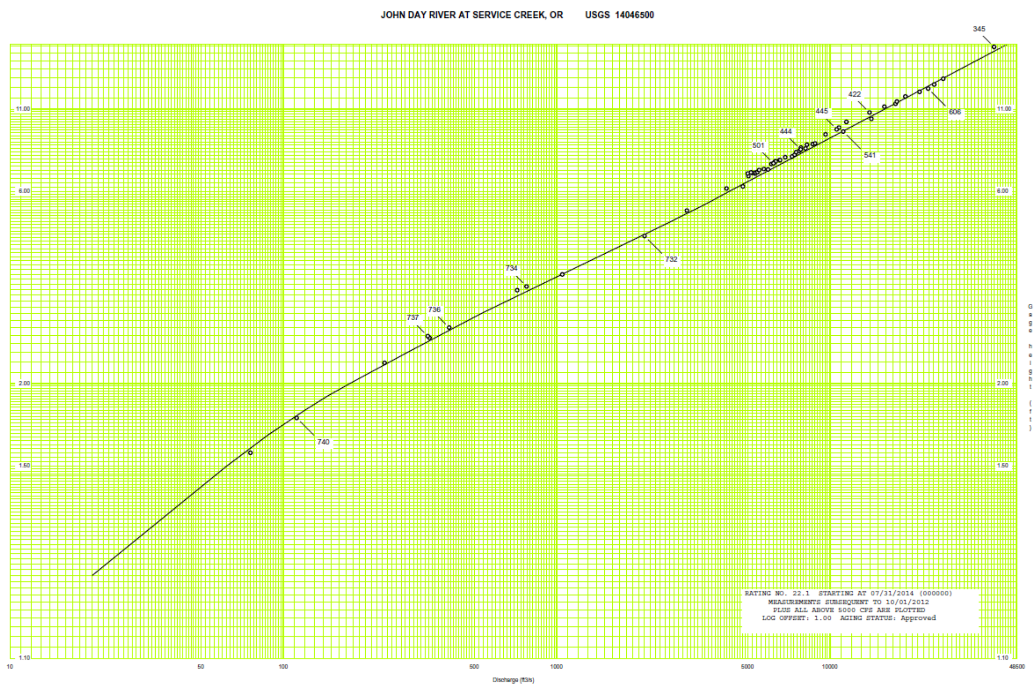
The above depth-velocity relations are for intermediate areas (Hyra, 1978, p. 5) and are not for deep pools or for riffles. For the depth-velocity relations used for the upper Verde River that includes riffles see page 104 of my report.

Keeping in mind the Oregon Court of Appeals affirmed a finding that the John Day River was navigable at statehood because it was susceptible to navigation by native American canoes, the flow depths shown above for the natural John Day River are considerably less than those for the natural Verde River.

Northwest Steelheaders Ass'n, Inc. v. Simantel, 199 Or.App. 471 (2005), Court of Appeals of Oregon, 99C12309; A118737, Argued and Submitted Dec. 20, 2004., Decided May 11, 2005.

The John Day River is similar to the Verde River but the main channel of the John Day River typically is wider with shallower base flow than the main channel of the Verde River. The channel of the upper Verde River is smaller but deeper than that of the John Day River. The depths of base flow (Q90) for the Verde River clearly are greater than the depths of base flow (Q80) on the John Day River.

Following are rating curve and measurement of discharge (cross section) data furnished by the USGS for 14046500 John Day River at Service Creek, OR



Discharge Measurement Summary

Date Generated: Mon Jan 5 2015

File Information	
File Name	14046500.740.WAD
Start Date and Time	2014/07/31 11:59:58

Site Details	
Site Name	
Operator(s)	JED

System Information	
Sensor Type	FlowTracker
Serial #	P3355
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units	(English Units)
Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty		
Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	1.5%
Velocity	0.8%	3.5%
Width	0.1%	0.1%
Method	1.4%	-
# Stations	1.7%	-
Overall	**2.5%**	**3.9%**

Summary			
Averaging Int.	40	# Stations	31
Start Edge	REW	Total Width	95.500
Mean SNR	17.7 dB	Total Area	79.564
Mean Temp	77.56 °F	Mean Depth	0.833
Disch. Equation	Mid-Section	Mean Velocity	1.4099
		Total Discharge	**112.1769**

Supplemental Data

#	Time	Location	Gauge Height	Rated Flow	Comments
1	Thu Jul 31 12:00:51 PDT 2014	13.000		100.0058	

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	11:59	3.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	11:59	8.00	0.6	0.830	0.6	0.332	0.1677	1.00	0.1677	4.150	0.6958	0.6
2	12:01	13.00	0.6	0.850	0.6	0.340	0.4537	1.00	0.4537	5.100	2.3143	2.1
3	12:02	20.00	0.6	0.900	0.6	0.360	0.4590	1.00	0.4590	6.300	2.8914	2.6
4	12:03	27.00	0.6	0.670	0.6	0.268	0.8120	1.00	0.8120	4.690	3.8080	3.4
5	12:04	34.00	0.6	0.750	0.6	0.300	0.9206	1.00	0.9206	5.250	4.8332	4.3
6	12:05	41.00	0.6	0.700	0.6	0.280	1.8770	1.00	1.8770	3.151	5.9136	5.3
7	12:06	43.00	0.6	0.900	0.6	0.360	1.8612	1.00	1.8612	1.800	3.3500	3.0
8	12:07	45.00	0.6	1.200	0.6	0.480	1.7828	1.00	1.7828	2.400	4.2792	3.8
9	12:08	47.00	0.6	1.140	0.6	0.456	1.8990	1.00	1.8990	2.280	4.3300	3.9
10	*12:09*	*49.00*	*0.6*	*1.170*	*0.6*	*0.468*	*1.8005*	*1.00*	*1.8005*	*2.340*	*4.2130*	*3.8*
11	*12:10*	*51.00*	*0.6*	*1.140*	*0.6*	*0.456*	*1.7877*	*1.00*	*1.7877*	*2.280*	*4.0764*	*3.6*
12	12:11	53.00	0.6	1.180	0.6	0.472	2.5502	1.00	2.5502	2.065	5.2667	4.7
13	12:12	54.50	0.6	1.130	0.6	0.452	2.1253	1.00	2.1253	1.977	4.2025	3.7
14	12:13	56.50	0.6	0.900	0.6	0.360	2.4009	1.00	2.4009	1.800	4.3213	3.9
15	*12:14*	*58.50*	*0.6*	*1.020*	*0.6*	*0.408*	*1.5669*	*1.00*	*1.5669*	*2.040*	*3.1966*	*2.8*
16	12:15	60.50	0.6	1.000	0.6	0.400	2.3478	1.00	2.3478	2.000	4.6955	4.2
17	12:16	62.50	0.6	0.980	0.6	0.392	2.1677	1.00	2.1677	1.960	4.2485	3.8
18	12:17	64.50	0.6	0.940	0.6	0.376	2.3458	1.00	2.3458	1.880	4.4099	3.9
19	12:18	66.50	0.6	0.840	0.6	0.336	2.2136	1.00	2.2136	1.680	3.7184	3.3
20	12:19	68.50	0.6	0.880	0.6	0.352	2.1995	1.00	2.1995	1.980	4.3546	3.9
21	12:20	71.00	0.6	1.010	0.6	0.404	1.7979	1.00	1.7979	2.525	4.5390	4.0
22	*12:21*	*73.50*	*0.6*	*1.030*	*0.6*	*0.412*	*1.4852*	*1.00*	*1.4852*	*2.575*	*3.8239*	*3.4*
23	*12:22*	*76.00*	*0.6*	*0.980*	*0.6*	*0.392*	*1.8127*	*1.00*	*1.8127*	*2.450*	*4.4410*	*4.0*
24	12:23	78.50	0.6	0.900	0.6	0.360	1.8333	1.00	1.8333	2.250	4.1247	3.7
25	12:24	81.00	0.6	0.880	0.6	0.352	1.8638	1.00	1.8638	2.200	4.1001	3.7
26	12:26	83.50	0.6	0.940	0.6	0.376	1.4810	1.00	1.4810	2.585	3.8282	3.4
27	12:27	86.50	0.6	0.800	0.6	0.320	1.3038	1.00	1.3038	2.600	3.3893	3.0
28	12:28	90.00	0.6	0.790	0.6	0.316	1.1388	1.00	1.1388	2.963	3.3737	3.0
29	12:29	94.00	0.6	0.540	0.6	0.216	0.6266	1.00	0.6266	2.295	1.4382	1.3
30	12:29	98.50	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

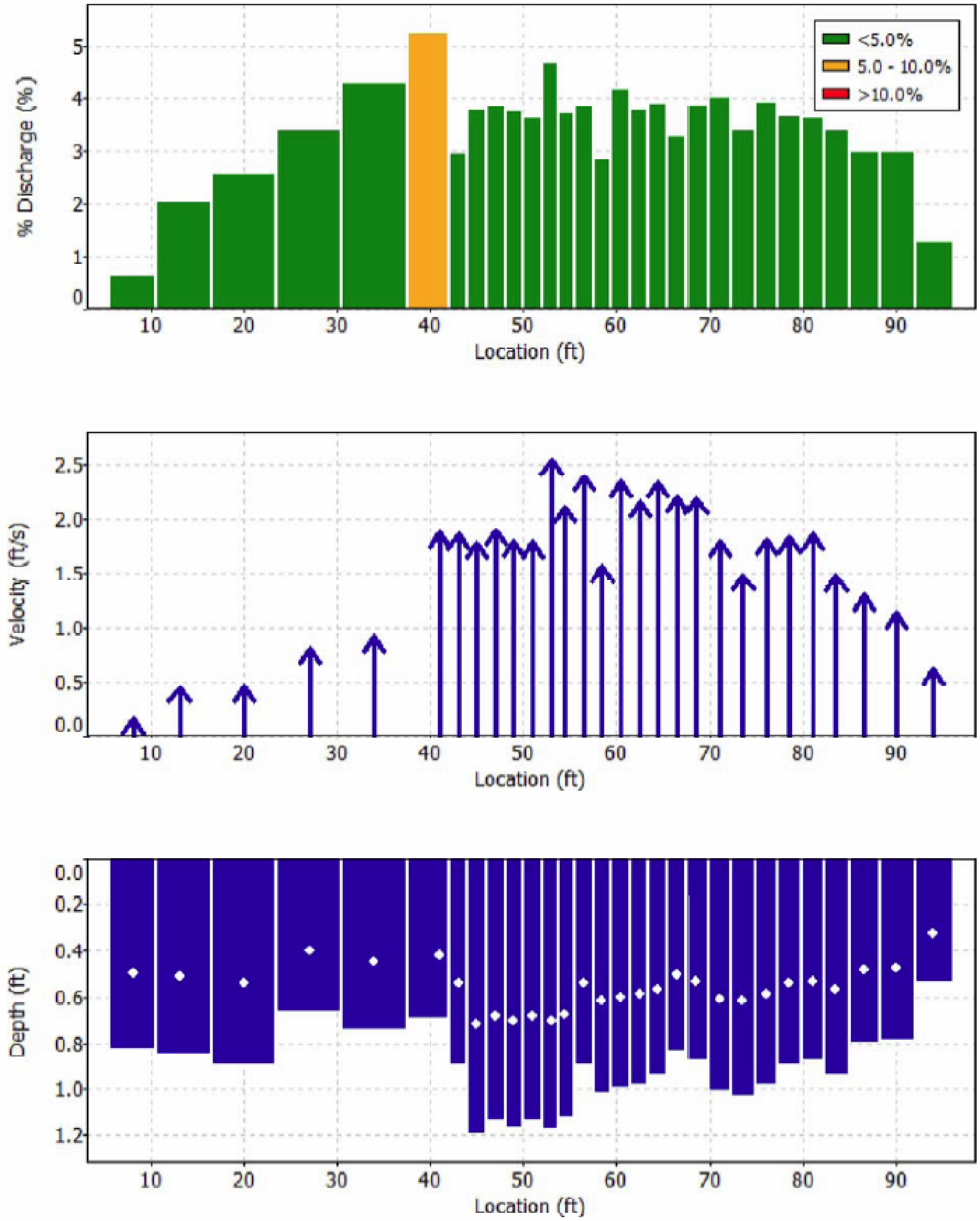
Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Data furnished by USGS

Discharge Measurement Summary

Date Generated: Mon Jan 5 2015

File Information		Site Details	
File Name	14046500.740.WAD	Site Name	
Start Date and Time	2014/07/31 11:59:58	Operator(s)	JED



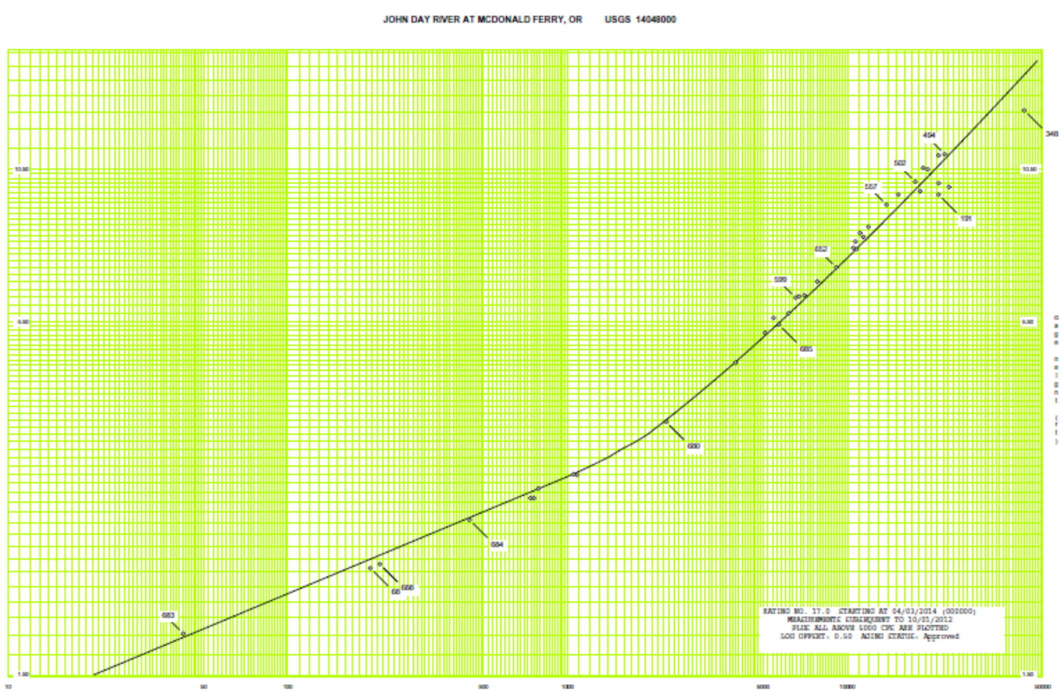
Gaged Monthly mean discharge for 14046500 John Day River at Service Creek, OR. From USGS website.

00060, Discharge, cubic feet per second,												
YEAR	Monthly mean in ft3/s (Calculation Period: 1929-10-01 -> 2014-06-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1929										170.0	221.3	475.7
1930	278.0	1,719	1,494	1,898	1,224	754.4	134.8	61.7	60.3	201.6	236.2	249.6
1931	479.3	503.7	1,727	3,795	1,732	415.8	97.3	26.7	38.1	80.6	187.5	315.8
1932	603.6	1,356	7,468	7,951	6,714	1,827	299.6	75.8	64.1	130.7	348.4	249.4
1933	373.4	366.5	2,008	4,974	6,093	3,889	461.5	105.6	106.5	175.5	320.1	812.6
1934	1,288	1,036	1,438	1,263	490.5	675.5	161.3	43.3	42.7	120.0	270.3	468.1
1935	505.2	850.0	1,100	3,703	2,735	991.8	214.3	51.8	31.4	72.4	192.1	215.9
1936	547.1	721.3	2,406	5,699	3,139	948.3	141.8	43.5	63.2	70.5	152.1	236.6
1937	195.2	358.1	2,651	5,523	4,998	1,664	340.5	68.2	60.4	188.0	454.2	1,871
1938	1,298	1,954	4,481	7,764	4,833	1,799	371.7	106.0	77.3	198.4	364.8	460.5
1939	452.7	540.7	5,261	5,018	2,297	745.9	184.7	42.9	49.6	125.4	222.2	333.8
1940	604.4	2,452	4,463	4,729	2,098	543.5	128.3	44.4	134.3	297.5	589.0	1,280
1941	1,141	1,367	3,063	2,623	3,480	2,868	644.7	298.3	491.7	567.3	1,328	2,576
1942	1,630	2,918	3,773	8,247	5,766	2,818	866.8	219.7	166.6	236.9	660.8	2,338
1943	3,244	3,828	5,109	9,812	5,900	3,798	1,295	316.3	232.7	361.3	580.5	520.2
1944	427.6	590.8	1,391	2,660	1,860	1,165	288.2	86.3	88.9	169.4	294.6	319.6
1945	623.7	1,890	2,062	4,352	6,358	2,607	448.1	137.5	130.7	219.7	572.4	1,834
1946	1,961	1,509	4,514	6,679	5,117	2,160	596.0	161.2	280.6	454.5	1,213	2,149
1947	1,026	2,742	3,299	4,403	3,253	1,850	357.2	157.4	177.8	301.2	1,306	2,025
1948	2,982	1,953	2,265	6,517	12,050	8,327	1,456	491.8	281.3	538.0	614.5	823.4
1949	587.9	2,913	5,623	6,582	6,295	1,455	309.5	143.5	153.5	372.7	459.1	515.8
1950	782.5	2,575	3,965	5,878	4,994	3,799	773.9	235.5	132.5	422.2	1,003	1,859
1951	2,280	5,141	3,863	7,403	5,109	1,568	369.0	133.1	120.6	409.2	470.1	741.5
1952	639.5	1,759	4,090	9,124	6,669	2,302	716.1	206.2	184.9	211.8	305.4	361.8
1953	2,282	3,181	3,260	5,629	6,646	5,699	1,277	326.7	249.8	347.2	547.8	1,411
1954	1,138	2,691	2,481	4,257	3,096	2,772	580.4	207.7	218.6	302.4	382.1	340.1
1955	437.4	443.1	709.1	3,040	4,903	2,692	646.7	126.4	115.3	281.7	695.5	3,999
1956	4,050	1,847	6,913	9,622	9,595	3,234	762.6	260.3	221.7	405.1	562.8	818.7
1957	463.4	2,187	5,624	6,960	7,193	2,327	435.8	165.5	148.5	636.3	626.7	1,412
1958	1,793	7,190	3,340	7,189	9,102	3,132	791.3	224.4	242.7	355.9	573.2	1,266
1959	2,378	1,996	2,068	3,862	3,235	1,506	266.2	92.0	265.6	531.9	578.4	494.2
1960	497.9	1,034	3,793	4,646	4,457	2,201	272.1	145.4	125.8	271.7	498.0	604.9
1961	530.3	2,622	3,016	2,758	2,918	1,686	186.7	61.0	98.1	192.6	329.6	491.5
1962	790.7	1,603	2,330	6,204	4,447	2,244	361.4	114.3	98.4	625.7	796.0	1,721

1963	627.2	4,710	2,063	4,791	5,631	1,794	452.4	129.3	221.7	245.2	491.3	511.7
1964	731.8	824.0	1,289	3,929	3,270	3,485	592.1	193.3	148.2	215.5	392.8	5,540
1965	6,335	6,230	2,996	7,763	6,100	3,182	784.1	476.5	307.4	319.0	465.5	386.3
1966	532.7	535.5	1,964	2,998	1,437	757.3	202.0	53.0	94.5	237.9	562.9	1,559
1967	1,917	1,908	2,149	2,488	6,234	2,915	454.9	81.8	84.6	257.2	383.2	514.7
1968	797.0	1,781	1,509	1,010	1,456	923.1	131.7	136.0	113.5	326.3	1,230	1,382
1969	2,707	1,677	3,184	7,592	5,495	2,329	767.6	116.0	100.1	344.6	375.7	570.6
1970	5,511	3,400	3,325	2,661	5,648	3,117	597.7	115.4	212.6	408.4	896.8	1,153
1971	4,599	3,153	2,958	5,510	6,522	2,900	624.7	125.7	143.4	347.1	504.5	1,330
1972	2,331	3,056	9,383	4,366	6,215	3,174	452.5	145.5	193.3	348.5	462.9	759.5
1973	1,178	861.9	1,418	2,015	2,542	703.7	90.6	15.2	79.7	243.5	2,284	4,727
1974	5,021	2,926	4,950	7,005	6,667	4,817	908.7	191.8	103.3	240.2	395.5	479.8
1975	1,365	1,652	3,286	3,982	7,530	4,738	1,344	299.2	163.8	413.0	540.4	1,313
1976	2,205	1,645	2,360	5,891	5,845	1,899	463.8	544.5	262.3	336.9	403.3	360.2
1977	341.5	427.0	597.2	1,850	1,780	1,036	137.1	43.6	132.0	299.9	596.1	2,347
1978	2,350	2,508	4,582	5,536	3,881	1,843	881.9	224.3	335.2	270.5	341.4	670.5
1979	586.5	2,635	5,823	6,777	8,589	2,147	429.6	207.2	232.9	354.4	562.8	820.9
1980	1,838	2,211	3,037	4,228	4,123	4,020	956.5	172.1	272.2	338.5	494.2	1,274
1981	990.9	2,867	3,072	4,320	4,642	3,277	675.4	140.1	120.3	413.8	661.6	2,915
1982	2,629	7,930	5,564	6,734	7,756	4,876	1,850	419.8	467.6	785.7	950.2	2,293
1983	2,850	4,966	9,773	6,393	8,987	3,914	1,588	500.9	417.8	527.3	917.6	1,931
1984	3,382	3,780	8,885	10,280	9,712	6,805	1,768	593.8	861.9	810.7	1,810	1,713
1985	1,100	1,376	3,739	8,910	3,812	1,671	314.8	255.4	399.3	534.4	598.7	614.5
1986	1,856	6,874	8,505	4,428	3,461	1,747	444.5	162.5	315.6	483.7	888.2	795.7
1987	757.4	2,261	5,089	4,672	2,281	854.2	406.3	143.6	109.7	236.3	377.0	447.9
1988	588.9	979.0	1,620	3,373	2,079	1,174	249.9	77.9	82.9	177.5	422.6	621.3
1989	847.2	1,470	7,545	8,738	6,704	1,950	453.6	223.5	350.3	383.5	518.6	489.6
1990	637.5	654.0	2,393	3,061	2,575	1,774	315.2	137.2	106.4	281.8	443.8	404.1
1991	760.2	1,714	1,947	3,219	6,717	2,931	902.4	201.4	107.8	259.2	816.4	1,335
1992	605.5	1,530	2,117	1,787	838.5	301.8	315.5	81.3	87.8	248.0	456.3	567.2
1993	666.2	1,257	8,960	8,410	8,579	2,988	875.4	459.4	254.3	410.0	359.4	518.5
1994	792.8	592.8	1,879	3,080	3,112	1,411	234.3	59.2	73.2	240.6	371.6	777.6
1995	1,780	4,845	5,251	4,808	6,387	2,792	806.0	235.5	135.6	411.3	871.9	3,044
1996	3,373	8,239	4,707	5,147	5,382	2,089	556.8	177.3	192.0	396.3	959.0	4,170
1997	6,553	4,972	6,040	7,278	5,314	1,954	659.1	284.1	302.8	440.9	529.0	473.6
1998	1,315	1,740	4,351	4,653	7,156	3,733	965.8	283.4	286.0	424.5	722.9	1,620
1999	2,745	2,271	6,026	6,507	6,564	3,028	635.3	289.3	180.8	366.7	518.8	612.1
2000	822.5	2,374	4,546	6,550	2,771	1,162	313.7	75.8	155.2	399.6	404.1	418.7
2001	434.1	571.4	1,811	2,917	2,549	667.0	187.4	76.6	77.4	267.5	405.0	664.2
2002	1,278	1,126	2,010	5,492	2,655	1,230	198.5	70.8	86.6	244.8	290.6	371.2

2003	1,031	2,155	3,431	4,547	4,089	1,637	211.4	69.7	110.6	233.2	312.2	561.4
2004	1,444	2,502	5,213	4,398	5,167	2,758	516.6	188.3	241.3	372.8	483.9	772.2
2005	753.1	757.1	1,394	2,817	5,996	1,417	325.4	64.3	78.6	286.3	421.7	1,393
2006	4,581	2,601	3,862	8,836	6,706	2,819	471.6	129.5	152.6	338.2	554.4	1,115
2007	1,014	2,146	4,199	3,536	2,223	674.5	120.4	44.0	74.7	307.0	459.6	784.7
2008	742.4	1,455	3,573	4,505	9,663	4,534	601.5	146.0	121.7	314.3	471.6	457.3
2009	1,320	975.2	3,065	6,502	7,057	2,261	371.4	153.7	88.0	322.5	409.4	350.1
2010	1,020	1,304	1,594	3,104	3,855	6,292	718.5	156.5	185.1	401.9	697.9	2,286
2011	4,688	2,693	4,399	9,414	11,970	8,268	1,679	380.1	205.0	453.1	518.4	439.6
2012	958.5	1,202	3,329	6,815	3,818	1,724	466.8	81.6	63.7	293.9	423.1	954.3
2013	716.1	1,664	3,657	4,665	2,477	963.8	210.6	53.3	116.8	400.6	428.8	384.6
2014	498.9	2,461	5,859	4,702	3,796	1,338						
Mean of monthly Discharge	1,590	2,290	3,730	5,240	5,000	2,460	559	175	176	330	574	1,150

Following are rating curve and measurement of discharge (cross section) data furnished by the USGS for 14048000 John Day River at McDonald Ferry, OR



Discharge Measurement Summary

Date Generated: Mon Jan 5 2015

File Information

File Name	14048000.687.WAD
Start Date and Time	2014/07/23 10:34:19

Site Details

Site Name	
Operator(s)	JED

System Information

Sensor Type	FlowTracker
Serial #	P3355
CPU Firmware Version	3.9
Software Ver	2.30
Mounting Correction	0.0%

Units (English Units)

Distance	ft
Velocity	ft/s
Area	ft^2
Discharge	cfs

Discharge Uncertainty

Category	ISO	Stats
Accuracy	1.0%	1.0%
Depth	0.2%	1.6%
Velocity	0.6%	1.8%
Width	0.1%	0.1%
Method	1.5%	-
# Stations	1.7%	-
Overall	**2.5%**	**2.6%**

Summary

Averaging Int.	40	# Stations	30
Start Edge	LEW	Total Width	170.000
Mean SNR	9.2 dB	Total Area	137.389
Mean Temp	72.52 °F	Mean Depth	0.808
Disch. Equation	Mid-Section	Mean Velocity	1.4313
		Total Discharge	**196.6468**

Supplemental Data

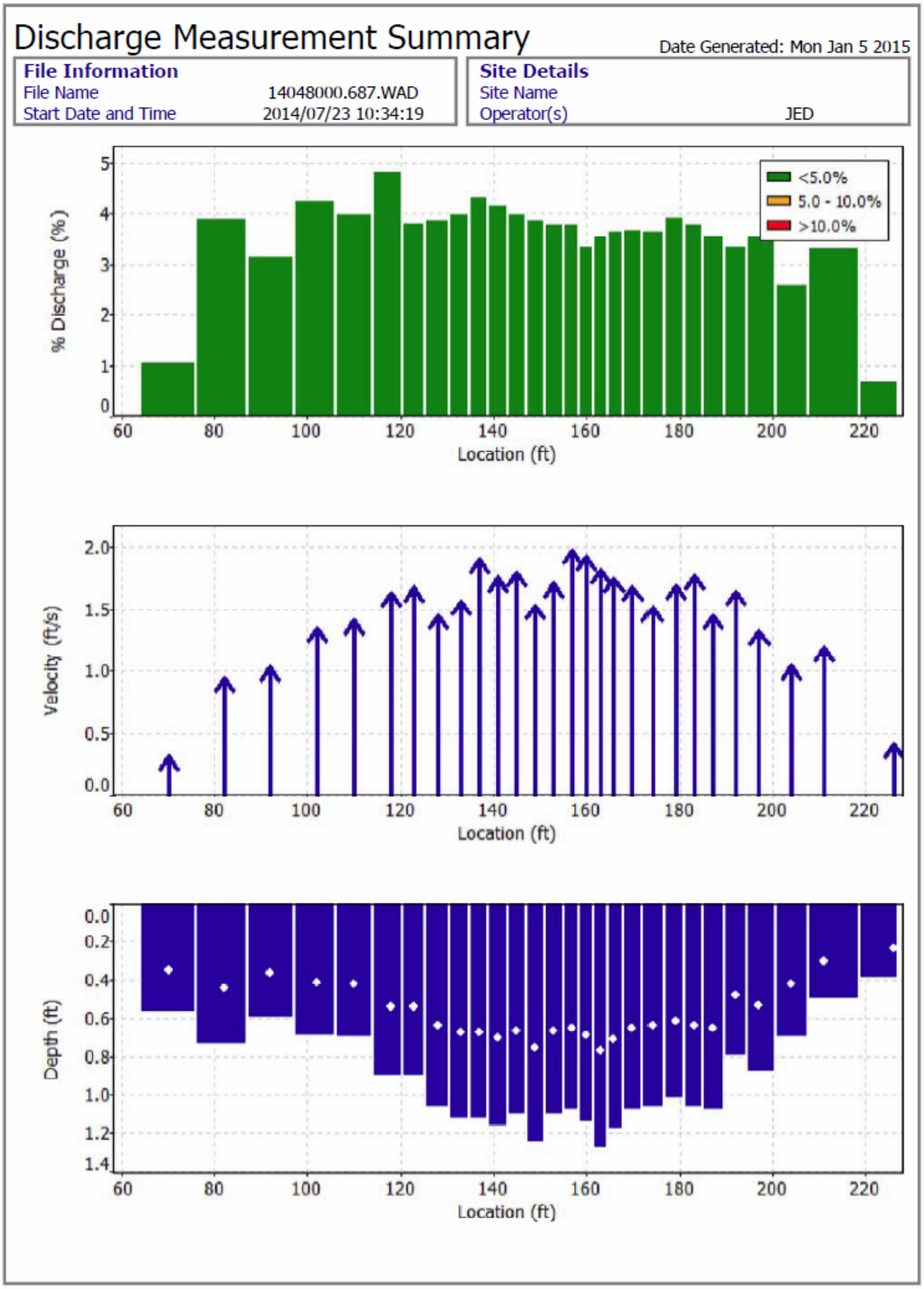
#	Time	Location	Gauge Height	Rated Flow	Comments
1	Wed Jul 23 10:32:31 PDT 2014	0.000		165.0096	
2	Wed Jul 23 10:35:12 PDT 2014	82.000		165.0096	

Measurement Results

St	Clock	Loc	Method	Depth	%Dep	MeasD	Vel	CorrFact	MeanV	Area	Flow	%Q
0	10:34	58.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0
1	10:34	70.00	0.6	0.570	0.6	0.228	0.3143	1.00	0.3143	6.839	2.1494	1.1
2	10:35	82.00	0.6	0.740	0.6	0.296	0.9485	1.00	0.9485	8.142	7.7224	3.9
3	10:36	92.00	0.6	0.600	0.6	0.240	1.0348	1.00	1.0348	6.001	6.2093	3.2
4	10:37	102.00	0.6	0.690	0.6	0.276	1.3471	1.00	1.3471	6.210	8.3651	4.3
5	10:38	110.00	0.6	0.700	0.6	0.280	1.4127	1.00	1.4127	5.601	7.9128	4.0
6	10:39	118.00	0.6	0.900	0.6	0.360	1.6348	1.00	1.6348	5.850	9.5631	4.9
7	10:41	123.00	0.6	0.900	0.6	0.360	1.6775	1.00	1.6775	4.500	7.5482	3.8
8	10:42	128.00	0.6	1.060	0.6	0.424	1.4505	1.00	1.4505	5.300	7.6877	3.9
9	10:43	133.00	0.6	1.120	0.6	0.448	1.5676	1.00	1.5676	5.040	7.9012	4.0
10	10:44	137.00	0.6	1.120	0.6	0.448	1.9032	1.00	1.9032	4.480	8.5270	4.3
11	10:45	141.00	0.6	1.170	0.6	0.468	1.7536	1.00	1.7536	4.680	8.2065	4.2
12	10:46	145.00	0.6	1.100	0.6	0.440	1.7979	1.00	1.7979	4.400	7.9112	4.0
13	*10:47*	*149.00*	*0.6*	*1.250*	*0.6*	*0.500*	*1.5299*	*1.00*	*1.5299*	*5.000*	*7.6493*	*3.9*
14	10:48	153.00	0.6	1.100	0.6	0.440	1.7096	1.00	1.7096	4.400	7.5229	3.8
15	10:50	157.00	0.6	1.080	0.6	0.432	1.9787	1.00	1.9787	3.780	7.4798	3.8
16	10:51	160.00	0.6	1.140	0.6	0.456	1.9298	1.00	1.9298	3.420	6.6004	3.4
17	10:52	163.00	0.6	1.280	0.6	0.512	1.8202	1.00	1.8202	3.840	6.9888	3.6
18	10:53	166.00	0.6	1.180	0.6	0.472	1.7490	1.00	1.7490	4.130	7.2242	3.7
19	10:54	170.00	0.6	1.080	0.6	0.432	1.6831	1.00	1.6831	4.320	7.2712	3.7
20	10:55	174.00	0.6	1.060	0.6	0.424	1.5131	1.00	1.5131	4.770	7.2179	3.7
21	10:56	179.00	0.6	1.020	0.6	0.408	1.6900	1.00	1.6900	4.590	7.7570	3.9
22	10:57	183.00	0.6	1.060	0.6	0.424	1.7746	1.00	1.7746	4.240	7.5246	3.8
23	10:58	187.00	0.6	1.080	0.6	0.432	1.4495	1.00	1.4495	4.860	7.0448	3.6
24	10:59	192.00	0.6	0.800	0.6	0.320	1.6486	1.00	1.6486	3.999	6.5934	3.4
25	11:00	197.00	0.6	0.880	0.6	0.352	1.3274	1.00	1.3274	5.280	7.0082	3.6
26	11:01	204.00	0.6	0.700	0.6	0.280	1.0427	1.00	1.0427	4.901	5.1099	2.6
27	11:03	211.00	0.6	0.500	0.6	0.200	1.1965	1.00	1.1965	5.500	6.5809	3.3
28	*11:04*	*226.00*	*0.6*	*0.390*	*0.6*	*0.156*	*0.4131*	*1.00*	*0.4131*	*3.316*	*1.3696*	*0.7*
29	11:04	228.00	None	0.000	0.0	0.0	0.0000	1.00	0.0000	0.000	0.0000	0.0

Rows in italics indicate a QC warning. See the Quality Control page of this report for more information.

Data furnished by the USGS for 14048000 John Day River at McDonald Ferry, OR (continued)



Data from USGS website for 14048000 John Day River at McDonald Ferry, OR

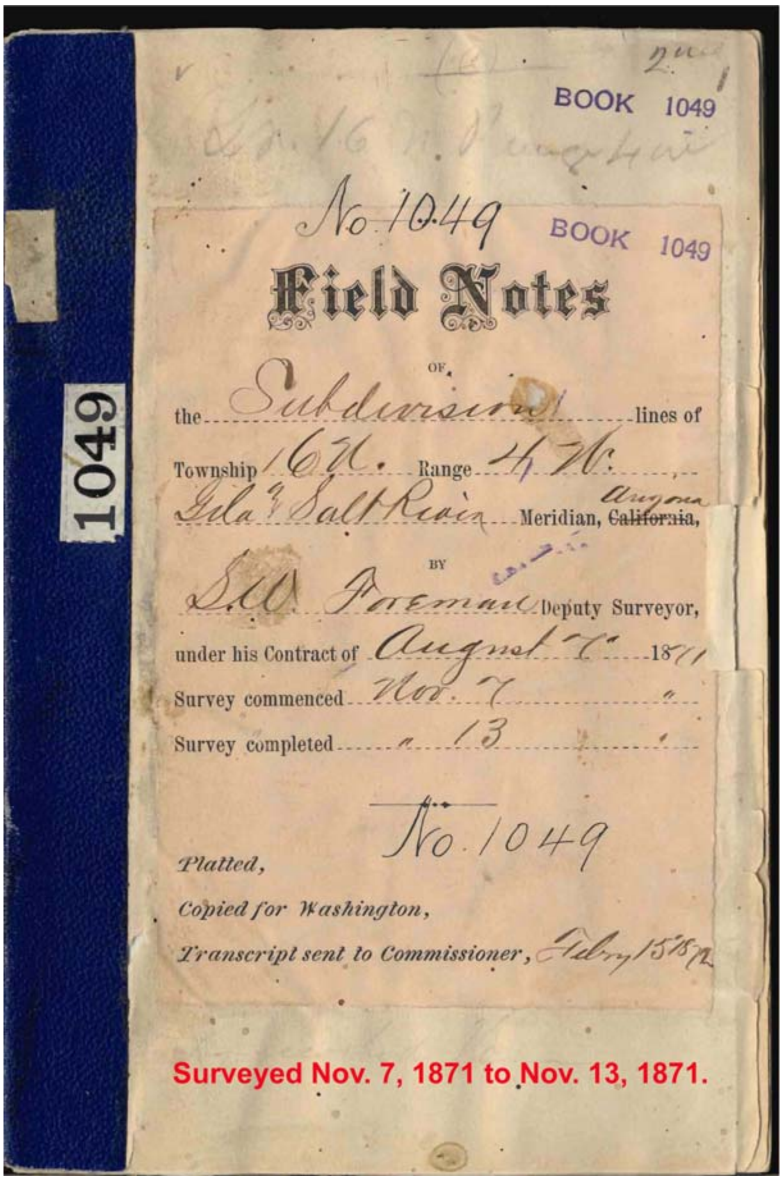
YEAR	00060, Discharge, cubic feet per second, GAGED Monthly mean in ft3/s (Calculation Period: 1905-10-01 -> 2014-03-31) Calculation period restricted by USGS staff due to special conditions at/near site											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1905										317.6	354.6	397.4
1906	671.9	1,276	3,760	6,929	3,388	5,559	759.7	236.3	233.7	288.0	506.2	968.7
1907	1,472	8,025	6,505	8,557	5,305	2,628	808.7	324.5	233.7	320.6	432.7	790.8
1908	908.5	700.2	2,909	4,386	2,774	2,000	659.0	182.1	183.4	357.1	438.0	399.6
1909	1,511	1,310	2,393	3,377	3,239	2,623	470.0	157.6	177.8	238.4	1,094	1,229
1910	1,701	1,897	9,622	5,615	2,379	646.5	193.1	77.7	115.4	256.1	461.2	1,119
1911	631.2	698.7	3,426	3,320	2,940	2,113	607.5	108.0	191.0	331.5	458.0	437.2
1912	2,769	4,004	2,808	8,861	11,660	6,437	1,291	503.1	396.7	422.8	604.0	548.1
1913	865.3	1,124	2,957	9,716	7,334	3,708	1,365	453.7	202.0	510.4	709.8	678.9
1914	1,658	1,808	6,351	6,470	3,927	2,141	703.6	146.6	200.3	416.5	405.8	353.4
1915	571.7	889.4	1,912	2,942	2,424	1,418	511.1	164.7	100.2	234.8	442.3	960.1
1916	786.2	7,066	8,095	8,120	6,601	4,585	1,925	464.4	285.4	373.6	526.1	548.8
1917	607.1	854.0	1,362	10,560	13,180	7,277	1,508	281.2	201.5	301.6	390.2	1,436
1918	3,671	3,312	4,068	4,879	2,786	1,314	289.1	175.4	171.4	356.3	414.3	398.0
1919	703.4	1,130	2,608	9,309	4,577	1,251	254.2	88.7	126.2	270.4	657.5	2,164
1920	1,787	1,644	1,870	6,317	6,604	2,749	598.2	140.0	289.3	469.4	772.8	895.6
1921	3,330	5,947	8,732	8,179	9,953	3,912	678.4	344.5	214.1	328.5	1,610	2,022
1922	745.4	1,398	2,851	9,637	10,790	5,096	577.7	200.0	136.8	271.4	456.2	667.4
1923	2,020	1,241	2,427	6,493	4,793	3,385	1,388	276.8	149.5	300.0	400.0	683.9
1924	667.8	3,627	1,691	2,854	2,254	567.6	150.1	83.6	89.6	189.5	552.6	549.5
1925	1,523	4,686	2,893	7,130	5,154	1,852	370.8	155.5	239.4	304.5	363.7	496.1
1926	431.5	2,434	3,187	3,516	1,552	376.3	88.0	46.8	93.6	201.1	408.1	1,144
1927	1,676	3,391	4,071	5,320	5,390	4,301	698.5	155.9	277.0	642.7	2,018	2,226
1928	3,947	2,590	6,052	6,480	5,979	1,322	427.1	105.5	124.3	248.0	350.7	349.0
1929	346.5	469.0	3,081	3,867	4,658	2,198	370.0	82.0	65.0	171.9	214.1	497.7
1930	351.7	1,996	1,473	1,948	1,228	773.8	145.1	62.9	54.3	189.6	253.0	265.4
1931	485.3	515.4	1,589	3,822	1,852	470.2	124.5	20.3	25.1	75.9	225.1	480.8
1932	764.3	1,438	7,535	7,692	6,796	1,934	327.6	84.7	50.7	122.0	343.0	267.4
1933	379.9	374.4	1,991	4,835	6,023	4,086	561.2	114.7	91.3	171.0	330.4	711.6
1934	1,305	1,078	1,378	1,299	533.1	625.6	189.8	38.5	23.8	88.4	268.5	452.4
1935	524.7	872.2	1,053	3,664	2,710	1,085	271.1	48.5	29.2	65.4	192.0	234.9
1936	612.9	1,004	2,512	5,378	3,267	993.5	190.2	34.4	49.1	59.9	156.7	220.9
1937	216.8	452.8	2,954	5,906	5,118	1,849	410.9	78.9	67.5	187.9	436.6	1,947

1938	1,369	2,081	5,098	7,934	5,121	1,995	438.7	118.4	79.1	197.6	380.6	466.5
1939	466.2	534.4	4,906	5,036	2,515	815.6	204.5	30.7	39.0	90.0	205.4	323.1
1940	582.3	2,359	4,875	5,430	2,276	634.5	109.5	45.9	121.7	272.5	496.6	1,432
1941	1,390	1,429	3,191	2,747	3,611	3,039	744.3	307.5	520.1	562.5	1,462	2,814
1942	2,027	3,857	4,210	8,424	6,061	3,137	1,029	237.9	167.4	245.2	616.1	2,777
1943	4,074	4,738	5,427	10,350	6,449	4,002	1,384	359.6	259.7	349.1	604.4	531.8
1944	501.0	638.4	1,465	2,653	1,926	1,150	329.1	92.8	80.1	175.6	306.8	354.9
1945	635.4	1,996	2,160	4,425	6,605	2,864	494.8	141.6	123.3	205.5	497.1	1,783
1946	2,327	1,377	4,814	6,572	5,056	2,132	612.2	147.4	264.6	418.1	991.4	2,086
1947	1,090	2,759	3,192	4,202	3,094	1,810	408.3	146.2	155.3	313.3	1,258	2,186
1948	3,271	2,360	2,747	7,143	12,500	9,531	1,847	588.1	410.5	622.1	676.5	946.2
1949	658.7	3,156	5,972	6,489	6,228	1,614	321.1	155.5	142.8	346.5	434.9	558.4
1950	820.4	2,769	4,517	6,023	5,103	4,319	887.9	260.6	156.1	427.1	1,160	2,223
1951	2,746	5,933	4,565	7,723	5,485	1,814	416.5	141.6	133.1	385.8	490.7	756.8
1952	687.0	2,035	3,995	9,341	7,087	2,608	853.9	208.1	186.6	207.9	342.9	401.6
1953	2,463	3,521	3,380	5,551	6,945	5,887	1,375	344.0	276.5	385.5	576.1	1,483
1954	1,252	2,996	2,610	4,165	3,106	2,799	635.5	197.9	225.6	317.4	421.3	407.6
1955	486.7	509.8	717.5	3,038	4,946	2,795	719.4	125.8	82.7	260.1	614.1	4,462
1956	4,955	2,419	6,401	9,376	9,654	3,577	954.1	278.4	273.9	433.7	634.2	847.2
1957	509.9	2,021	6,277	7,500	7,526	2,652	439.4	174.5	157.1	657.2	671.1	1,487
1958	1,949	7,838	3,852	7,425	9,186	3,374	923.7	272.9	259.1	376.0	607.9	1,299
1959	2,507	2,314	2,333	3,895	3,283	1,625	271.6	85.7	209.7	611.6	603.8	523.0
1960	481.9	1,144	3,855	4,861	4,327	2,412	296.8	115.5	112.4	237.2	492.4	628.8
1961	573.2	2,968	3,276	2,894	2,883	1,883	189.1	55.3	89.3	191.1	389.6	613.5
1962	1,010	1,814	2,543	6,373	4,597	2,509	413.1	133.6	94.6	575.1	843.8	2,009
1963	752.2	5,143	2,311	5,182	6,368	2,128	570.4	157.6	225.3	285.6	544.9	559.7
1964	849.1	947.9	1,202	4,035	3,274	3,479	642.4	184.7	130.0	213.8	398.7	7,030
1965	6,402	8,027	3,646	7,466	6,414	3,521	875.6	478.8	343.8	345.0	528.8	464.1
1966	688.1	603.4	2,089	3,195	1,443	785.0	233.0	26.6	54.5	191.7	569.9	1,777
1967	2,015	2,405	2,217	2,657	6,354	3,074	553.9	91.3	76.3	219.9	404.3	474.4
1968	843.9	1,779	1,534	963.8	1,293	934.1	133.7	89.2	89.6	273.4	1,144	1,454
1969	2,902	2,133	3,421	8,370	5,850	2,518	871.5	128.5	97.9	332.2	407.5	619.7
1970	6,165	4,045	3,777	2,936	5,474	3,327	681.9	131.6	177.7	412.7	907.5	1,331
1971	4,798	3,177	2,783	5,400	6,513	2,989	686.6	111.5	96.8	324.6	483.7	1,426
1972	2,690	3,004	10,260	4,443	6,165	3,454	502.1	132.7	145.4	333.1	436.0	698.4
1973	1,062	856.3	1,502	1,874	2,423	722.0	97.7	5.70	27.3	222.7	2,310	5,641
1974	6,245	3,583	5,283	7,910	7,195	5,326	1,024	213.4	92.3	226.8	423.8	506.5
1975	1,399	1,953	3,736	4,464	7,771	5,266	1,548	296.5	174.2	403.4	572.4	1,232
1976	2,399	1,672	2,438	5,923	5,921	1,928	497.5	585.4	276.8	338.4	444.2	382.5
1977	372.8	424.1	556.7	1,724	1,725	1,056	114.8	11.2	97.0	289.3	534.0	2,443

1978	2,867	2,747	4,594	5,827	4,273	1,971	1,025	232.1	361.8	306.7	370.7	720.0
1979	547.9	4,204	6,476	7,412	9,789	2,251	488.0	183.9	266.1	374.4	654.0	973.6
1980	2,422	2,619	3,761	4,293	4,358	4,194	1,012	194.3	272.8	325.9	520.0	1,242
1981	1,106	3,232	3,244	4,628	4,903	3,641	706.4	136.2	93.0	393.9	558.6	3,434
1982	3,115	8,882	6,454	7,161	8,326	5,166	2,101	507.5	523.0	821.0	1,075	2,559
1983	3,192	5,760	11,450	7,360	9,977	4,946	1,859	580.2	471.4	592.5	1,047	2,191
1984	4,365	4,589	10,200	11,900	10,420	7,714	2,131	700.0	922.8	892.2	2,053	2,032
1985	1,449	1,988	4,273	9,486	4,110	1,924	351.9	272.8	407.3	559.5	658.4	659.1
1986	1,944	8,421	9,270	4,583	3,394	1,842	408.1	171.2	313.1	553.8	951.7	1,003
1987	902.1	2,644	5,667	4,668	2,474	934.5	413.2	173.3	117.4	249.4	405.5	532.9
1988	999.2	1,128	1,737	3,513	2,270	1,294	293.4	67.3	62.1	170.4	415.7	667.7
1989	964.4	1,516	8,251	9,277	7,426	2,117	499.7	220.8	352.5	389.3	529.7	523.9
1990	737.5	726.2	2,600	3,188	2,626	1,813	327.7	122.4	107.0	255.3	429.5	420.0
1991	840.1	1,696	2,102	3,167	6,422	2,955	1,016	236.9	114.6	240.8	761.7	1,453
1992	643.1	1,488	2,331	1,952	842.5	284.7	302.0	66.2	67.1	244.2	436.2	567.0
1993	850.7	1,600	10,460	9,349	9,298	3,581	1,007	518.7	290.5	429.7	409.4	570.3
1994	849.1	652.2	1,973	3,243	3,257	1,559	262.0	38.6	47.4	234.4	401.3	744.3
1995	1,719	5,723	5,794	5,094	7,008	3,034	886.6	277.9	141.9	426.9	687.8	3,115
1996	3,637	9,736	5,355	5,406	5,715	2,292	647.0	198.1	195.8			
1997										507.0	619.1	587.1
1998	1,530	2,167	4,599	4,893	7,598	4,551	1,134	376.0	279.1	470.3	762.2	1,656
1999	3,112	2,404	6,345	6,548	6,598	3,246	674.2	292.2	195.5	343.4	503.2	668.9
2000	889.3	2,583	4,977	6,582	2,961	1,246	321.6	84.3	138.3	379.3	440.9	479.9
2001	494.4	609.9	1,793	2,972	2,785	686.8	202.8	74.7	60.0	252.2	407.6	660.7
2002	1,367	1,098	2,013	5,463	2,724	1,369	228.3	46.4	70.6	250.3	315.0	361.3
2003	806.7	2,475	3,376	4,698	4,222	1,843	234.8	69.4	97.9	218.7	311.0	532.1
2004	1,407	2,958	5,231	4,600	5,257	3,096	556.0	185.9	262.4	375.1	517.2	793.6
2005	783.8	808.6	1,320	2,787	6,085	1,549	360.3	61.3	58.8	286.6	437.9	1,193
2006	5,384	2,951	4,060	8,735	6,848	3,122	595.5	150.2	148.0	352.2	546.4	1,188
2007	1,247	2,117	4,223	3,888	2,612	781.6	154.9	41.7	65.9	312.8	489.4	819.2
2008	839.8	1,577	4,119	4,613	9,643	5,273	754.5	170.3	117.3	308.7	463.2	462.5
2009	1,318	927.6	2,979	6,185	6,679	2,368	420.9	146.9	75.2	292.8	413.8	430.8
2010	1,094	1,483	1,625	3,323	4,099	6,762	781.7	177.7	176.1	346.5	618.0	2,413
2011	5,053	3,096	4,754	10,080	12,320	8,913	1,867	454.2	251.1	457.2	516.3	467.3
2012	1,027	1,235	3,288	7,041	4,244	1,863	571.3	86.2	53.9	269.5	482.5	967.1
2013	684.4	1,813	3,518	4,630	2,511	968.7	258.6	49.3	85.2	413.3	435.1	401.7
2014	450.8	2,530	6,033									
Mean of monthly Discharge	1,650	2,560	3,980	5,630	5,240	2,750	646	189	176	330	591	1,140

SUPPLEMENT 11. Sample of field notes for T16N R4W in Williamson Valley.

The following is a small sample of pages in book 1049 that show the boundaries of the fields of corn in the township (shown on page 6 of Appendix D). These field notes define a lot of good cultivated land with plenty of water. Following the survey notes is a comment about shallow groundwater and a newspaper article related to the farming and hydrology of Williamson Valley.



25 BOOK 1049

Township 16 North. Range 4 West
Gila and Salt River Meridian

Ch.	North
	between sections 27 and 28.
	var. 14° 08' East
40.00	Set a 1/4 section corner stone 14 x 10 x 5 inches as per instructions
	No trees near.
48.00	Enter smooth rolling land.
70.00	Enter cornfield. bears N.E. and S.W.
80.00	Set a post in a mound and pits as per instructions for the corner to sections
	21. 22. 27 and 28.
	No trees near
	Land - 1st half mile rough and broken, then gently rolling.
	Soil - 3rd and 1st rate.
	No timber
	Juniper and Oak brush

BOOK 1049 26

Township 16 North. Range 4 West
Gila & Salt River Meridian

Chs. East.

on random line between sections 22 & 27.
Var. 14° 08' East

20.00 Leave cornfield bears N.E. & S.W.
40.00 Set a temporary 1/4 section corner post.
57.50 Old road, bears N. & S.
58.00 Enter cornfield bears N. & S.
80.00 Intersect the N. & S. Line at the corner to sections 22.23.26. & 27. from which corner I run—

West.

on true line between sections 22 & 27.
Var. 14° 08' East

40.00 Set a 1/4 section corner post in a mound and pits as per instructions
No trees near.
80.00 The corner to sections 21.22, 27 & 28.

Land—gently rolling.
Soil—1st rate, No timber.

27 BOOK 1049

Township 16 North. Range 4 West
Gila & Salt River Meridian

Chs.	North.
	between sections 21 & 22
	Var. 14° 08' East
21.00	Leave cornfield bears N. E. & S. W.
40.00	Set a 1/4 section corner post in a mound and pits as per instructions
	No trees near.
50.00	Enter cornfield bears N. E. & S. W.
74.00	Leave do " " "
80.00	Set a post in a mound and pits as per instructions for the corner to sections 15. 16. 21 & 22.
	No trees near.
	Land - gently rolling.
	Soil - 1st rate.
	No timber.

59 BOOK 1049

General Description

This Townships embraces the extreme S.W. portion of Williamson Valley and contains much good land for farming and grazing. There is plenty of water and some fine meadow land. The scattering Juniper will also supply a considerable population with plenty of fuel.

S. A. Foreman.
Deputy Surveyor

The following description of the shallow depths to groundwater in Williamson Valley (USBR, 1974, pp 59-60) agrees with the previous land survey notes of book 1049. This description supports the fact that the early settlers could use shallow wells to irrigate of farm land.

Depth to water is 20 feet or less in wells tapping the valley fill in the central part of Big Chino and Williamson Valleys, principally along Williamson Valley Wash and south of Chino Creek. In Big Chino Valley a perched condition exists and deeper wells penetrating volcanic rocks have water levels, in places, reportedly as much as 100 feet deeper than that in the shallower wells.]

U.S. Bureau of Reclamation (USBR), 1974, Western United States Water Plan, State of Arizona, Chino Valley Unit, Appraisal Report: Bureau of Reclamation, 125 p.

SUPPLEMENT 12. Appropriations not of record and total appropriations.

The total amount of farming by early settlers in the Verde River watershed is unknown. Also, the water supply is less than the appropriations.

“Many of the appropriations on the Verde are not of record**....”**

(page 14 of Exhibit E of the Hayden Report, 1940 and p.10 of Appendix C.)

A “... total of 465,350 inches on the Verde proper in addition to two separate appropriations of the entire flow of the river.” (page 15 of Exhibit E of the Hayden Report, 1940). These appropriations of 11,600 cfs (excluding the two for the entire flow) directly from the Verde River (excluding tributaries) obviously suggest the flow in the river was/is over allocated.

SUPPLEMENT 13. Channel and vegetation from Sullivan Lake to Camp Verde area—unpublished USGS aerial photos.

The following unpublished areal photographs are from Anderson, T.W., 1976, Evapotranspiration losses from flood-plain areas in central Arizona: U.S. Geological Survey Open-File Report 76–864, 91 p. When the single channel is compared to the channel shown on the early USGS topographic maps in Appendix K, it appears very similar even with the much small scale of the early maps.

Following from Anderson, 1976:

Mapping of Vegetation Types and Densities

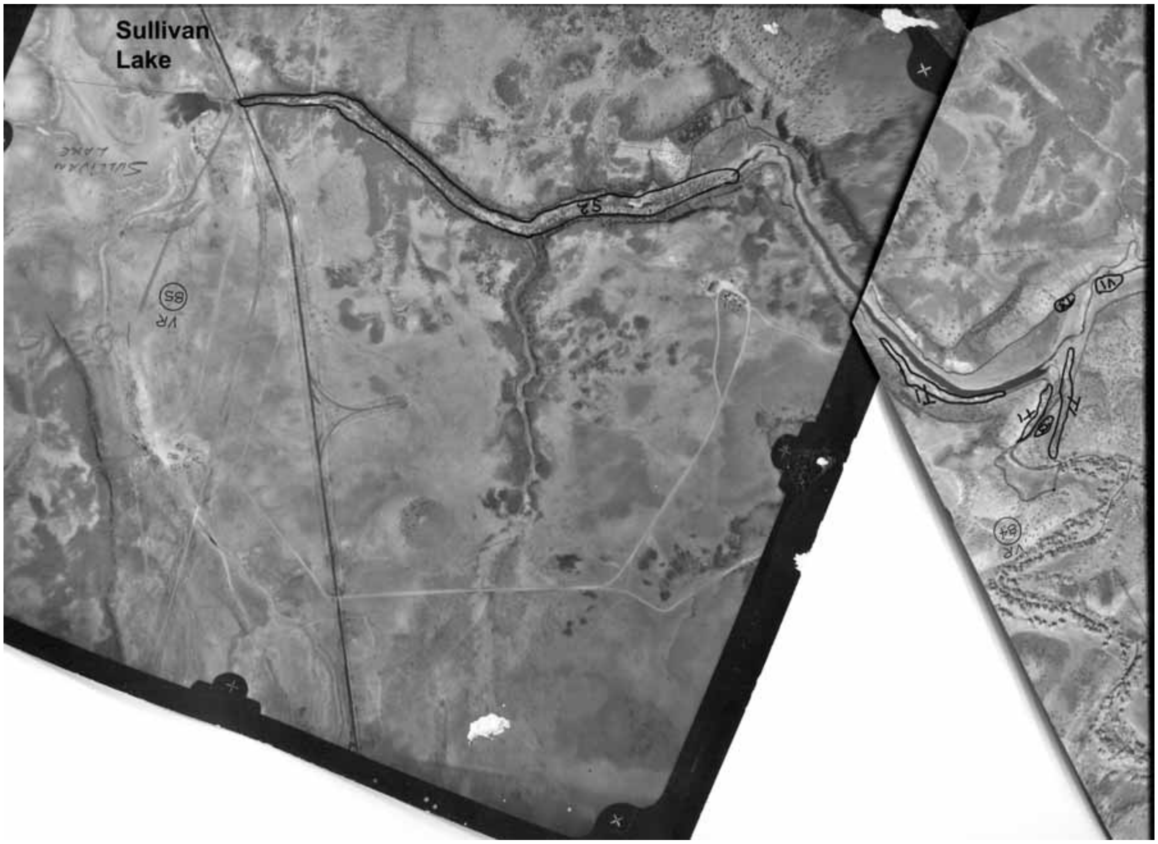
Aerial photographs were used to map the areal extent, areal density, and general type of vegetation. The photographs were taken between May 30 and June 18, 1973, using black and white modified infrared film. The film enabled easy identification and distinction of certain types of riparian vegetation because of the different infrared-reflectance characteristics of the different vegetation types. The vegetation was in full foliage at the time the aerial photographs were taken. The scale of the photographs is about 1:13, 000 or 1 in (25 mm) equals about 1, 100 ft (330 m).

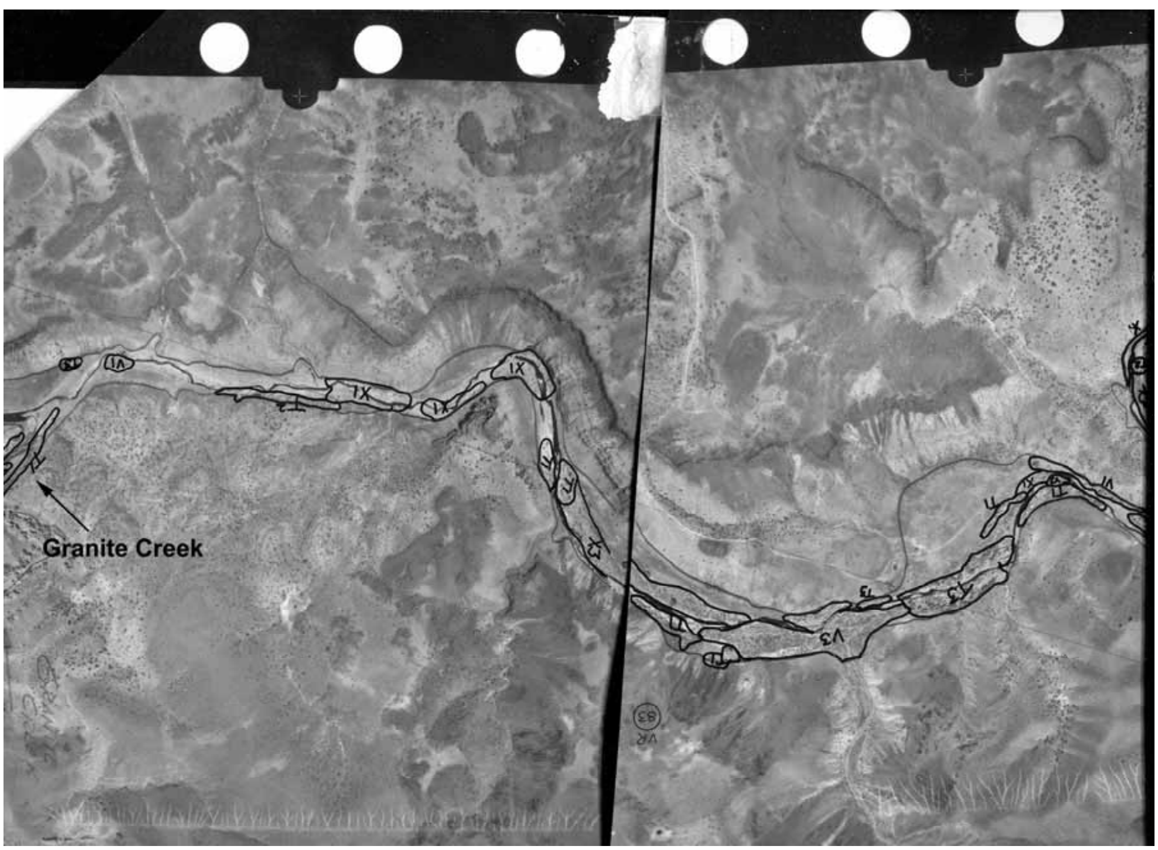
-37-

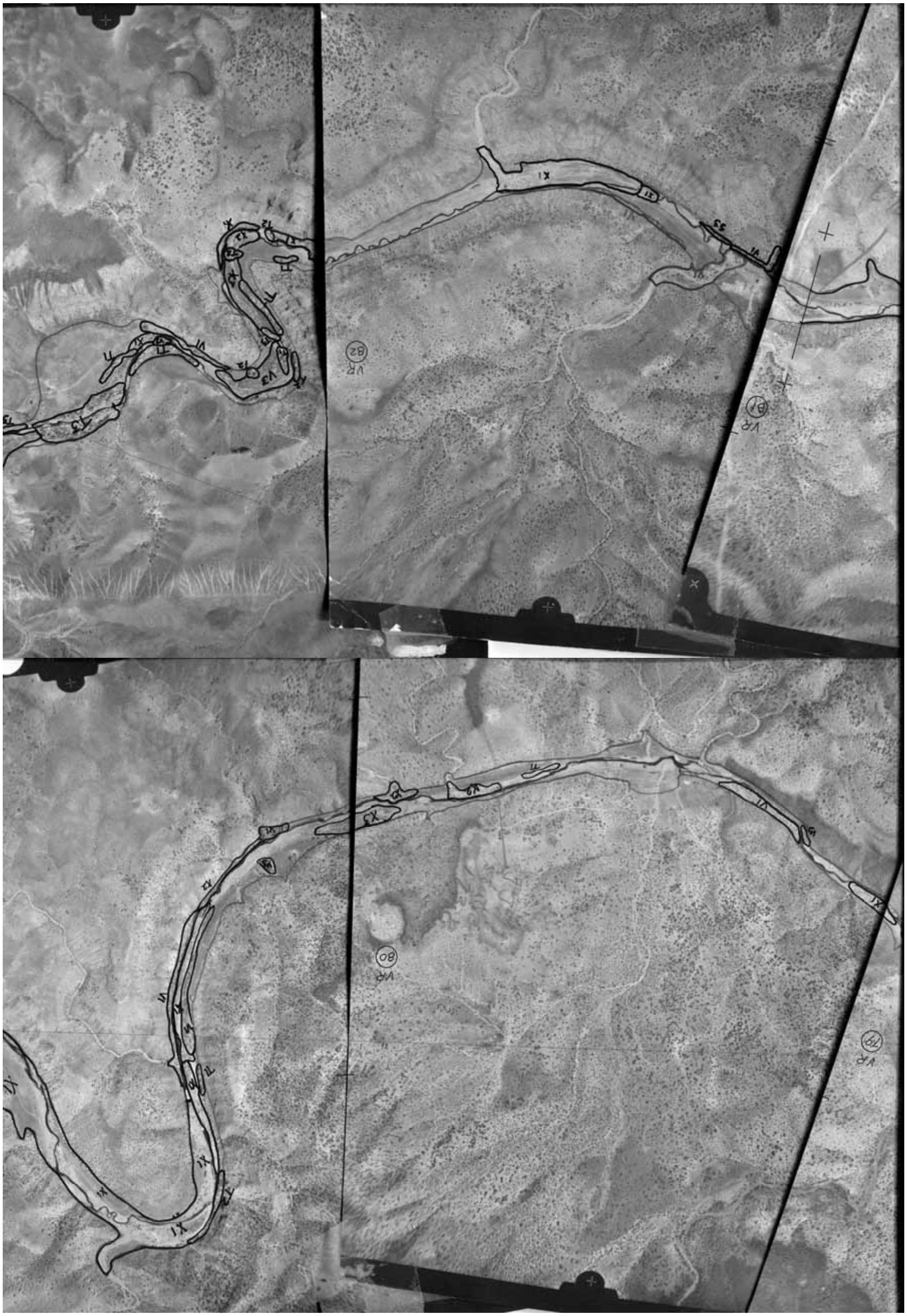
EXPLANATION

DESIGNATION OF VEGETATION TYPE AND DENSITY, 1

T Cottonwood-willow
V Mesquite
X Riparian scrub
1 Light density
2 Medium density
3 Heavy density

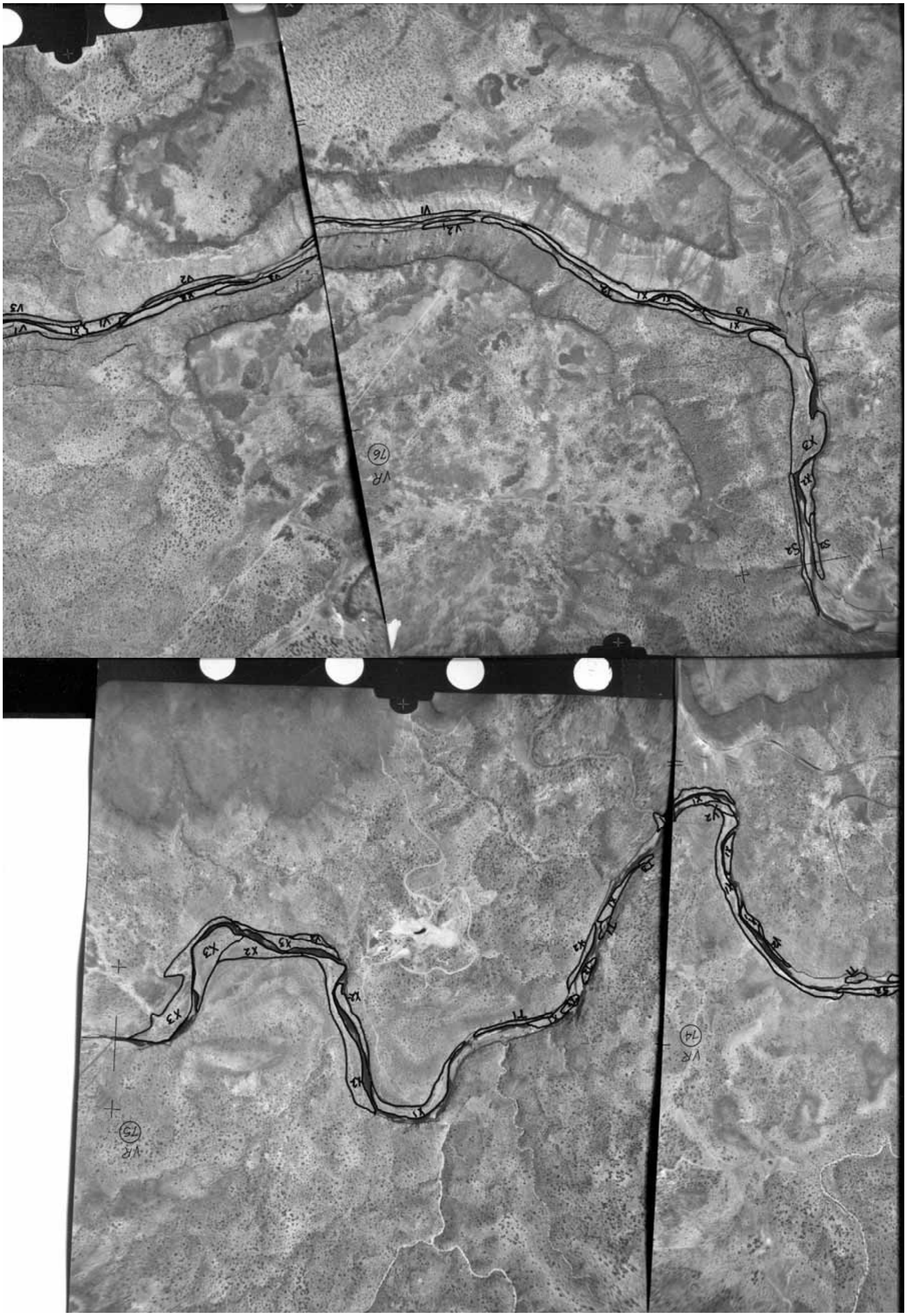

Sullivan
Lake

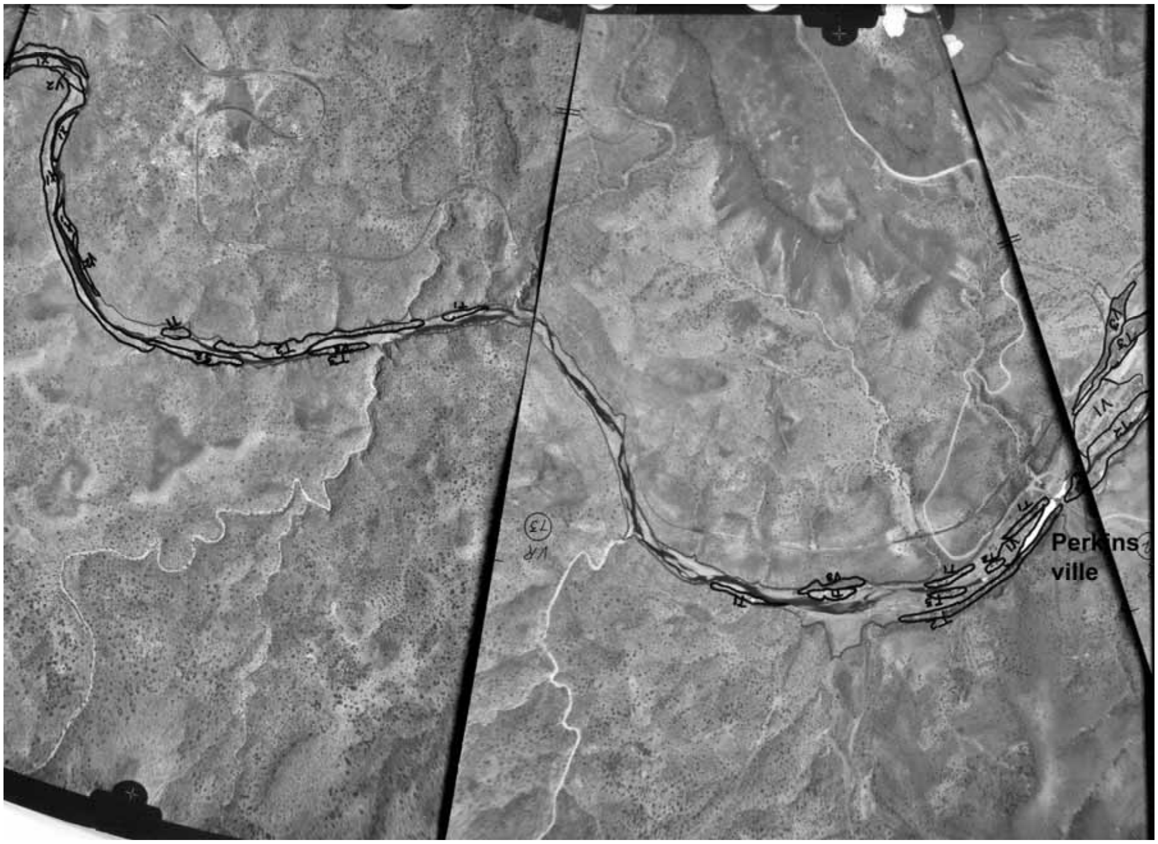

Granite Creek

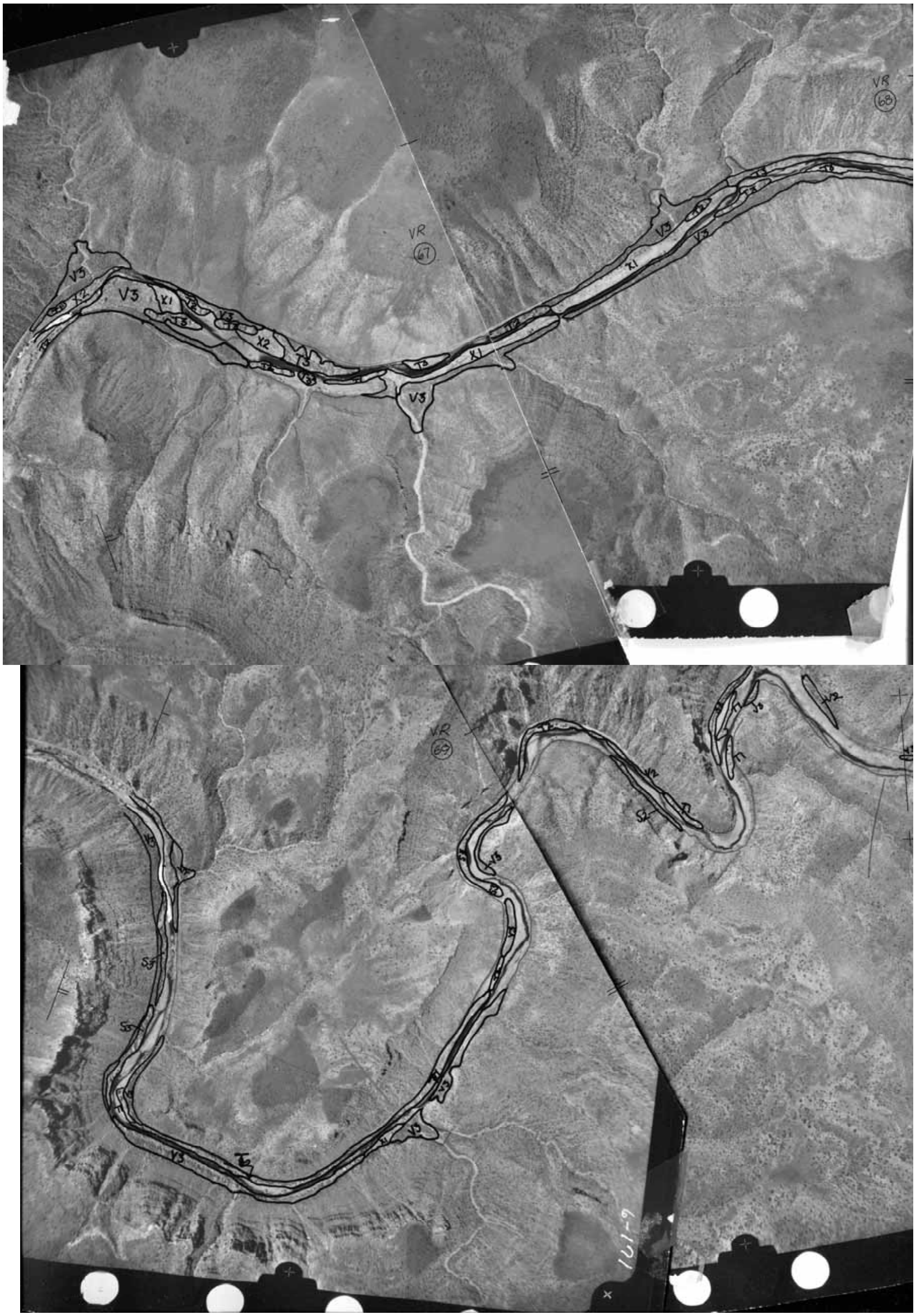


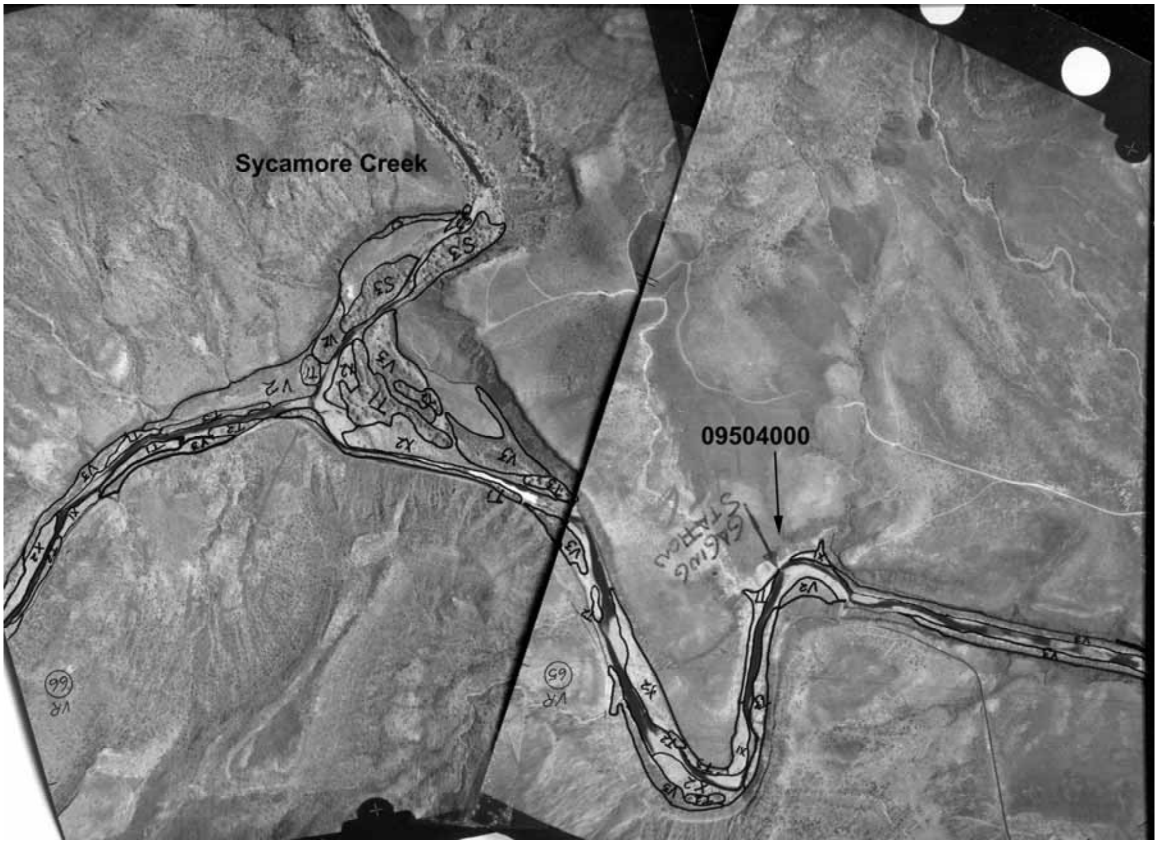
VR 82
VR 81
VR 80
VR 79

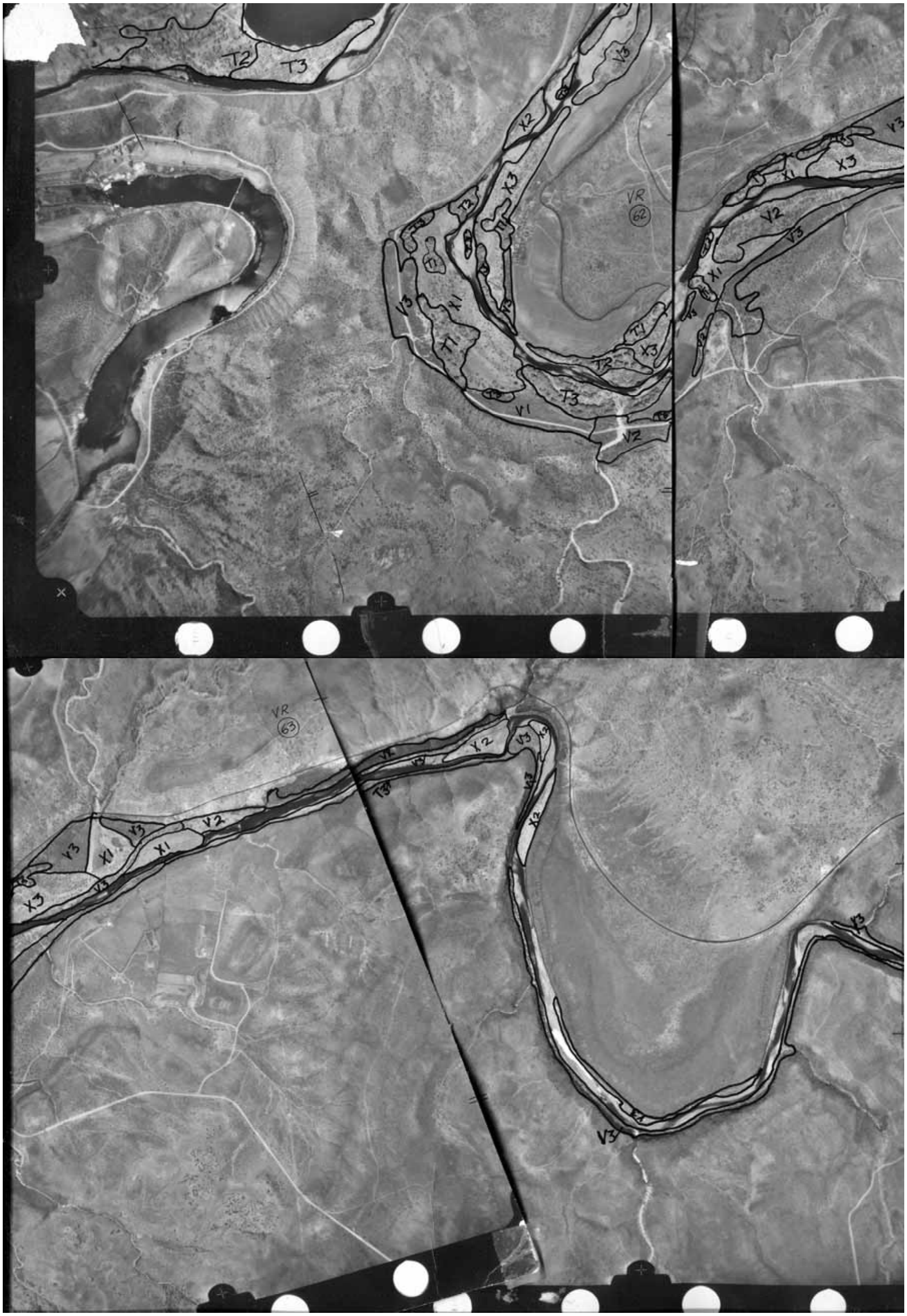

X1
V3
V1
X1
V1
V3
X1
V3
V3
X1
VR
78


VR 76
VR 75
VR 74

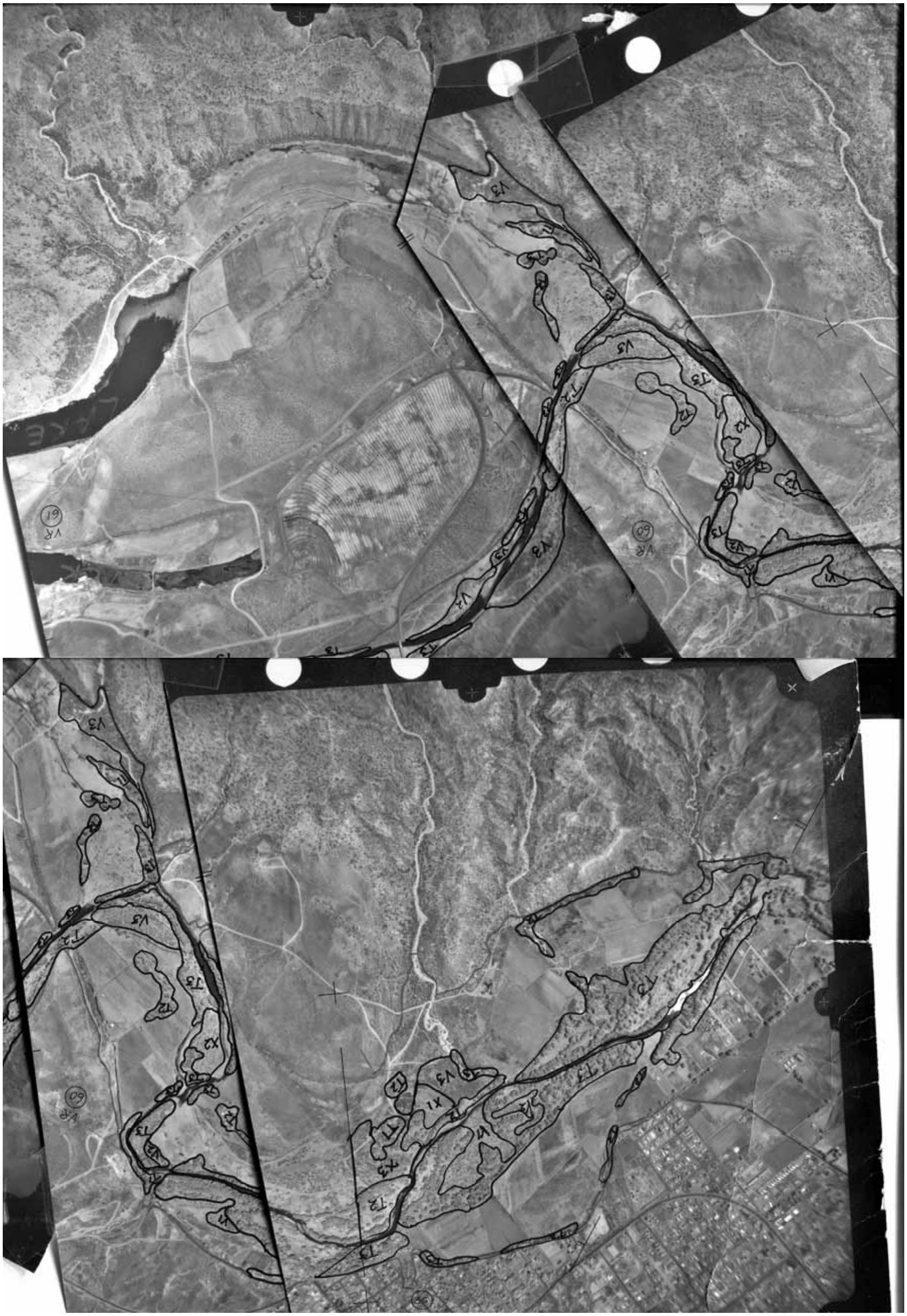

Perkins
ville

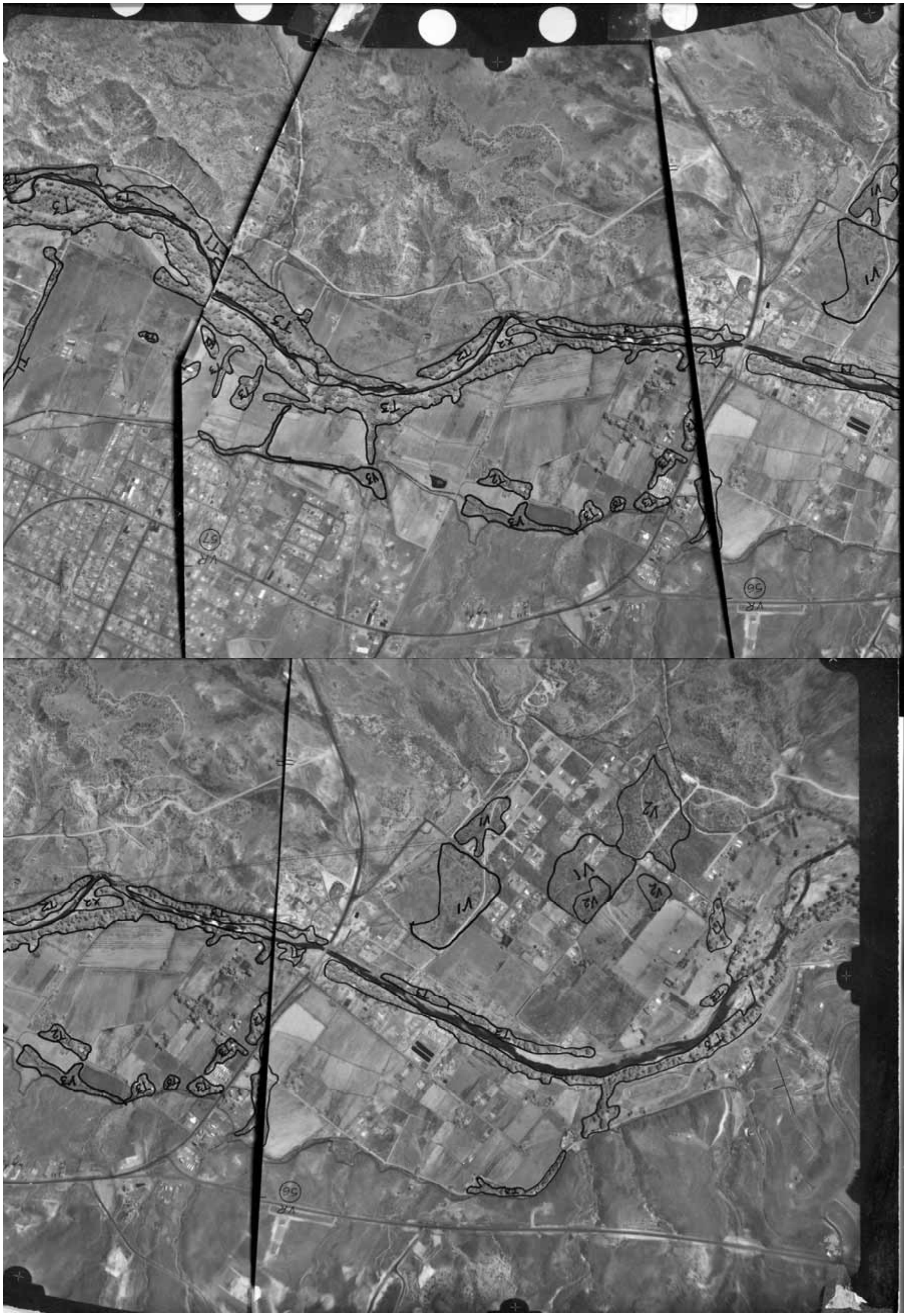

VR 68
VR 67
VR 69
V3
X1
X2
6-17-71

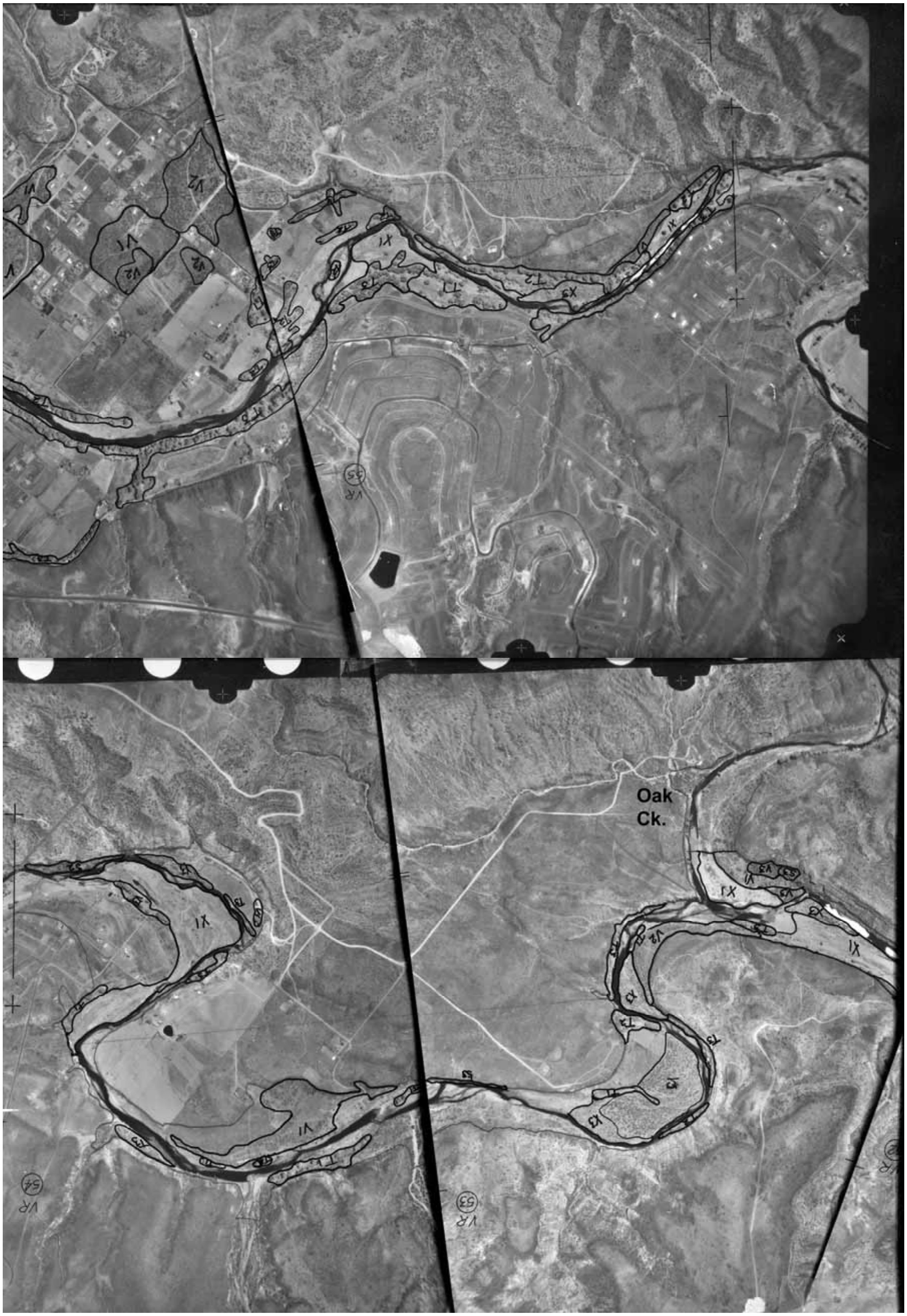

Sycamore Creek
09504000

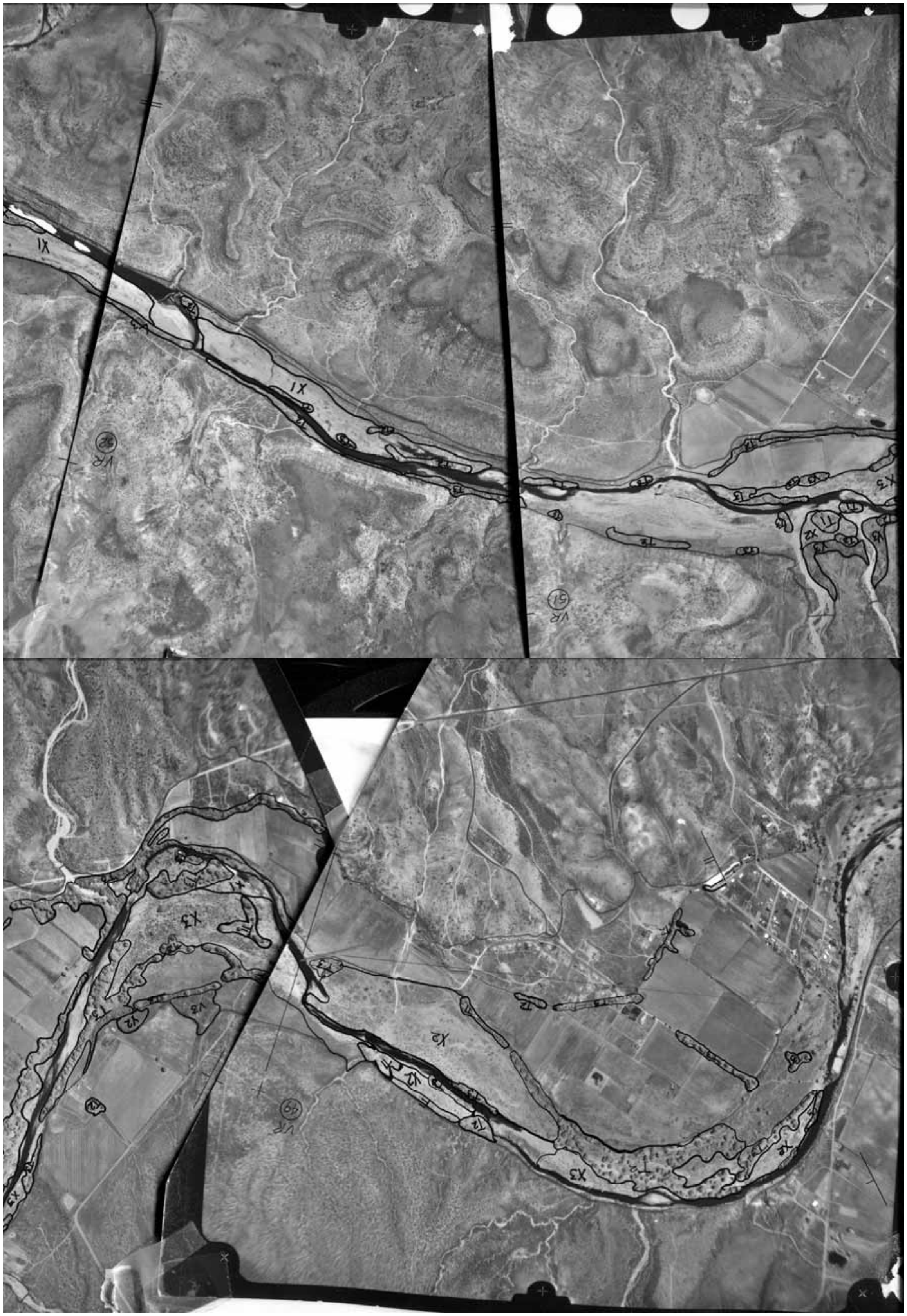


VR 62
VR 63
T2
T3
T1
V1
V2
V3
X1
X2
X3

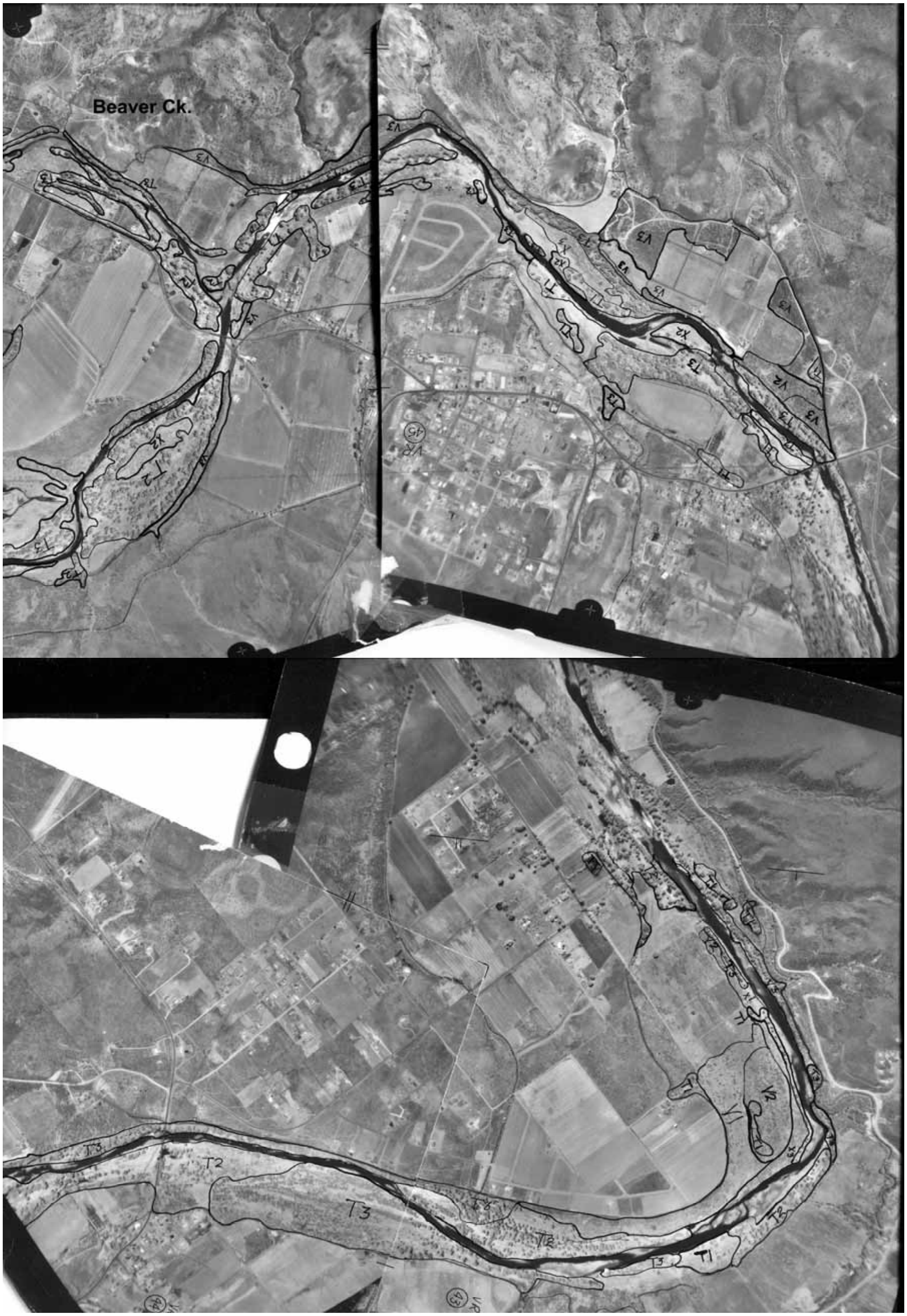


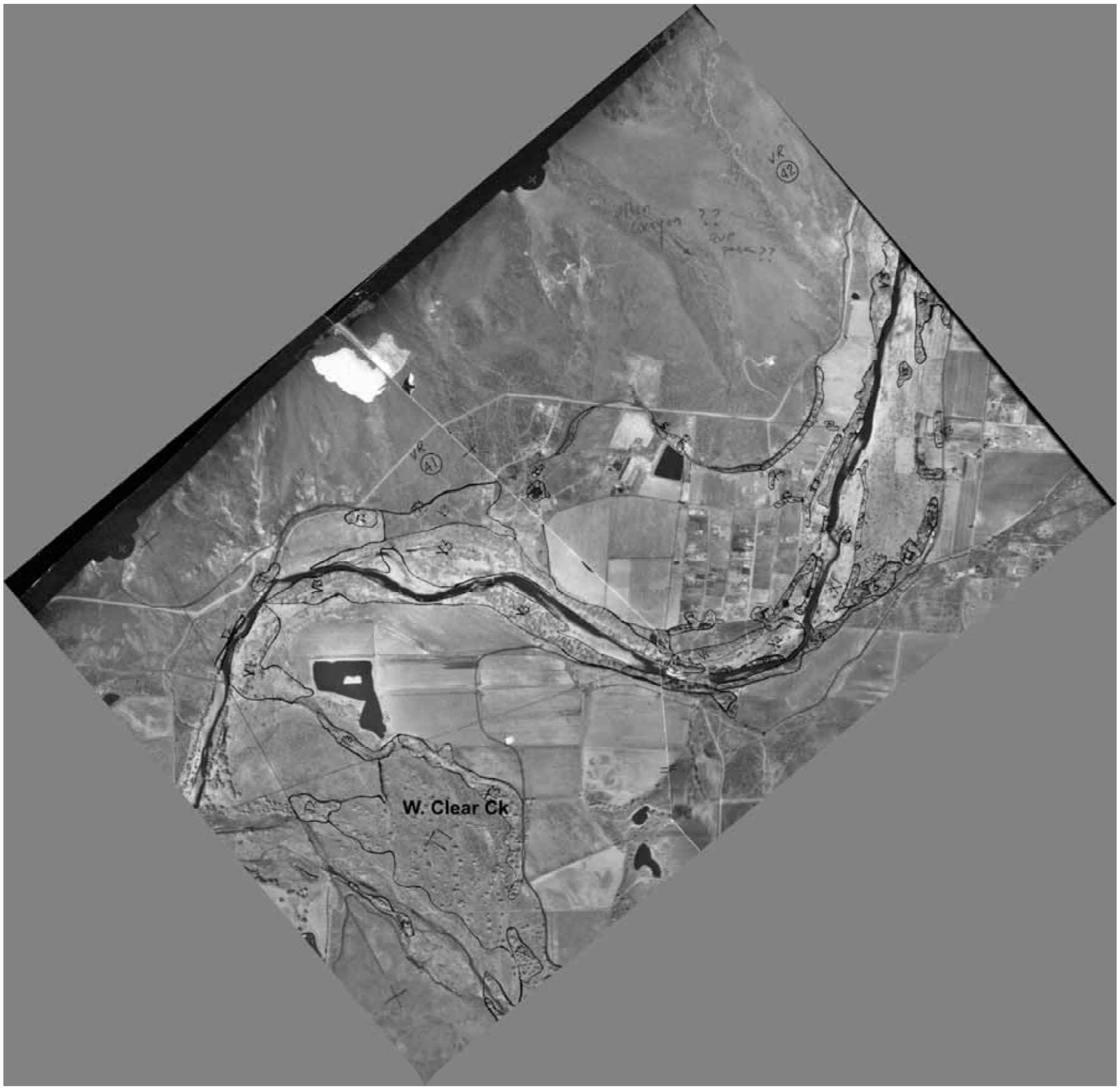



Oak
Ck.




T2
T3
46


Beaver Ck.



See p. 62 of Addendum for aerial photos downstream of West Clear Creek.