

UNITED STATES
~~DEPARTMENT OF THE INTERIOR~~
GEOLOGICAL SURVEY
Albuquerque, New Mexico

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Estimated mean-monthly and annual runoff at selected sites
in the Pojoaque River drainage basin,
Santa Fe County, New Mexico

By

Louis J. Reiland

Open-file report 74-150

Prepared by the U.S. Geological Survey in cooperation
with the U.S. Bureau of Indian Affairs

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Contents

	Page
Introduction -----	5
Purpose and scope -----	6
Methods of study -----	7
Streamflow data for the Pojoaque River drainage basin -----	8
Site 1 -----	10
Site 2 -----	12
Sites 3 and 4 -----	13
Site 5 -----	16
Site 6 -----	18
Summary of results -----	20
References cited -----	21

Illustrations

Page

Figure 1.--Map showing the Pojoaque River drainage basin,
Santa Fe County, New Mexico ----- In pocket

Tables

	Page
Table 1.--Mean-monthly and annual runoff at selected sites in the Pojoaque River drainage basin -----	11
2.--Runoff-elevation relationship for two areas in the Pojoaque River drainage basin -----	14
3.--Comparison of estimated mean-annual runoff with mean-annual runoff from streamflow records extended to long-term means -----	15

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Introduction

This report was prepared in cooperation with, and at the request
of, the U.S. Bureau of Indian Affairs as a result of litigation --
State of New Mexico, ex rel. S. E. Reynolds, State Engineer,
United States of America, et al., v R. Lee Aamodt, et al.,
Civil No. 6639, U.S.D.C., N. M.,--involving the use of water in
the Pojoaque River drainage basin, Santa Fe County, New Mexico.

Purpose and scope

The purpose of this report is to provide estimates of the natural mean-monthly and annual runoff at selected sites in the Pojoaque River drainage basin. Natural runoff is defined for this report as the runoff that would occur if there were no manmade changes. The selected sites are:

<u>Site No.</u>	<u>Description</u>
1.	Rio Nambé at Nambé Falls, near Nambé
2.	Rio Nambé near Nambé, plus Nambé canal
3.	Rio En Medio at Nambé Pueblo boundary
4.	Rio Chupadero at Nambé Pueblo boundary
5.	Rio Tesuque at Tesuque Pueblo boundary
6.	Pojoaque River at mouth

The locations of the sites are shown on figure 1.

Methods of study

The definition of the natural surface-water runoff at the specified sites was determined by different techniques. One technique extends short-term records to the equivalent of long-term records by linear regression analysis using records for nearby streams. The second technique involves the development of a runoff-elevation relationship for gaged areas that can be used to estimate the runoff from the different elevation zones of the ungaged areas. A third technique involves the use of multiple-graphical regression to define the channel loss in a reach of channel between gaging stations where there are variable diversions for irrigation that have also been gaged.

The first technique was used to estimate the mean-annual runoff at site 2 and for Tesuque Creek, the main tributary above site 5. The second technique was used to estimate the mean-annual runoff for sites 3 and 4 and for parts of sites 1, 5, and 6. The third technique was used to determine part of channel loss upstream from sites 5 and 6.

This report supplements a reconnaissance report (Trauger, 1967) that was prepared, in connection with the subject litigation, to provide a general description of the geology and hydrology of the Pojoaque River system. A second supplementary report discusses quantitative aspects of the ground-water system in the drainage basin (written commun., F. C. Koopman, 1970).

Streamflow data for the Pojoaque River drainage basin

The principal components of the Pojoaque River drainage basin are the Pojoaque River, Pojoaque Creek, and its tributaries-- Rio Nambe, Rio en Medio, and Rio Chupadero--and the Rio Tesuque and its tributaries--Tesuque Creek and Little Tesuque Creek. Rio Nambe is considered to be the head of the Pojoaque River. Below the confluence of the Rio Nambe and Rio En Medio, the stream is known as Pojoaque Creek and below the confluence of Pojoaque Creek and Rio Tesuque, it becomes Pojoaque River.

The Pojoaque River and its tributaries drain about 185 square miles. Rio Nambe above the confluence with Rio En Medio drains about 39 square miles. Rio En Medio and Rio Chupadero drain about 25 square miles. Rio Tesuque drains about 78 square miles. The remainder of the area in the basin, some 43 square miles, includes Pojoaque Creek and Pojoaque River and their tributaries below Rio Tesuque. Most of these tributaries are relatively short arroyos and contribute only a very minor part of total runoff. Runoff in the basin ranges from a fraction of an inch at lower elevations to about 35 inches at the higher elevations.

A hydrographic survey made by the New Mexico State Engineer Office in 1965 shows the irrigated area in the basin to be 3,503 acres, of which 2,125 are in the Rio Nambe-Pojoaque Creek sub-basin, 558 are in the Rio Tesuque basin, and 820 acres are along the Pojoaque River Valley downstream from the mouth of Rio Tesuque.

Streamflow records are available at 14 sites within the Pojoaque River drainage basin and at three sites in the adjoining and closely related drainage basins (U.S. Geological Survey, 1960, 1961-64, 1964, and 1965-68). Most of the records within the Pojoaque River drainage basin are short term, but they provide a fair sample of runoff from different elevation zones. Nineteen years of record are available for Nambe Canal, near Nambe (Station 8-2954) and Rio Nambe (Station 8-2950). Fifteen years of record are available for Tesuque Creek above diversions near Santa Fe (Station 8-3025). Five years of record are available for Pojoaque Creek at Pojoaque Bridge near Nambe (Station 8-3010) and most of the 29 ditches in the basin. Long-term records are available in adjoining basins for Santa Cruz River near Cundiyo (1930-68), Santa Fe River near Santa Fe (1913-68), and Pecos River near Pecos (1919-68).

Site 1

Site 1 is 1.7 miles upstream from site 2, and its drainage area is only 4.2 square miles smaller than the drainage area of site 2. For this report, the mean-annual runoff at site 1 was obtained by reducing the mean-annual runoff at site 2 by the estimated long-term mean-annual runoff for the intervening area. The mean-monthly runoff was computed from the mean-annual runoff on the basis of the ratio of each mean-monthly runoff to the annual runoff at site 2. Estimated flow values are presented in table 1.

Table 1.--Mean-monthly and annual runoff in acre-feet at selected sites in the Pojoaque River basin.

Month	Site 1 ^{a/}	Site 2 ^{a/}	Site 3 ^{a/}	Site 4 ^{a/}	Site 5 ^{a/}	Site 6 ^{a/}
Jan.	226	228	51	0	0	267
Feb.	190	192	43	0	0	235
Mar.	306	310	69	50	63	493
Apr.	892	903	201	80	168	1,337
May	1,986	2,011	446	120	252	2,782
June	1,547	1,567	348	40	154	2,076
July	702	711	158	10	21	877
Aug.	584	591	131	0	14	717
Sept.	519	526	117	0	14	642
Oct.	470	476	106	0	14	578
Nov.	333	337	75	0	0	396
Dec.	245	248	55	0	0	300
Annual	8,000	8,100	1,800 ^{b/}	300 ^{b/}	700 ^{c/}	10,700 ^{c/}

^{a/} See page 6 for description and fig. 1 for location.

^{b/} Estimated on basis of runoff-elevation relationship.

^{c/} See text for basis.

Site 2

Natural flow records are available at site 2 for the period 1932-51, as the sum of flow in Nambe Canal, near Nambe (Station 8-2945) and Rio Nambe, near Nambe (Station 8-2950). During this period concurrent records were obtained on Santa Cruz, Santa Fe, and Pecos Rivers. A regression relationship developed from concurrent records at site 2 and at other sites where long-term records are available provides a reliable basis for extending the mean-annual runoff record at site 2 over the same period as for the other stations. The mean-monthly runoff was computed from the mean-annual runoff on the basis of the ratio of the monthly values to the annual value at site 2 for the period of record (table 1).

The variables used were the logarithms of the annual runoff, in acre-feet, and the linear regression relationships were developed by use of an electric calculator. The relationship between site 2 and Pecos River near Pecos was used to provide estimates for the period 1920-31. The standard error of this regression was found to be ± 12 percent. The relationship between site 2 and Santa Cruz River near Cundiyo was used to provide estimates for the period 1952-68. The standard error of this regression was found to be ± 10 percent.

Sites 3 and 4

The mean-annual runoff for sites 3 and 4 (table 1) was obtained by use of a runoff-elevation relationship. The relationship used is given in table 2 and was obtained by techniques described by Riggs and Moore (1965). The streamflow records from nearby gaging stations were used as a basis for the relationship.

A comparison of the runoff obtained by use of the Rio En Media relationship with the long-term runoff at gaged sites is made in table 3. Rio En Medio is a perennial stream at site 3 but becomes ephemeral a short distance downstream owing, most likely, to the change in geologic structure.

Rio Chupadero is an ephemeral stream in the 2-mile reach upstream from site 4, which is underlain by the Tesuque Formation (or Santa Fe Group). Losses to ground-water storage are significant in this reach. The runoff-elevation relationship indicated an annual runoff of 400 acre-feet, which must be adjusted for losses. The loss in this reach is estimated to be 100 acre-feet, leaving 300 acre-feet as adjusted runoff at site 4. The monthly values for site 3 were computed by using the same ratios as for site 2. The monthly values for site 4 were computed by using slightly higher ratios than were used for period March-July at site 5 so that the total agreed with mean-annual runoff.

Table 2.--Runoff-elevation relationship for two areas in the
Pojoaque River drainage basin.

Range of elevation zone (thousands of feet)	Runoff (inches per year)	
	Little Tesuque Creek	Rio En Medio
6.0 - 6.5	-	0.10
6.5 - 7.0	0.00	.11
7.0- 7.5	.00	.13
7.5 - 8.0	.05	.18
8.0 - 8.5	.16	.30
8.5 - 9.0	.37	.55
9.0 - 9.5	.85	1.14
9.5 -10.0	1.82	2.44
10.0 -10.5	3.75	5.20
10.5 -11.0	7.25	10.1
11.0 -11.5	12.7	17.4
11.5 -12.0	-	26.9
12.0 -12.5	-	35.2

Table 3.--Comparison of estimated mean-annual runoff with
mean-annual runoff from streamflow records extended
to long-term means.

Station and description	Mean-annual runoff (acre-feet per year)	
	From runoff-elevation relationship	From streamflow records
Rio Nambe near Nambe, plus Nambe canal	8,800	8,100
Rio En Medio near Santa Fe	700	700
North Fork Tesuque Creek near Santa Fe	1,100	1,330
Middle Fork Tesuque Creek near Santa Fe	275	271
South Fork Tesuque Creek near Santa Fe	240	227

Site 5

Streamflow records are not available at site 5 (Rio Tesuque at Tesuque Pueblo boundary). During the period 1938-41, a station was operated on Rio Tesuque at Tesuque (Station 8-3055) 1.1 miles upstream from the Pueblo boundary. Records are also available for longer periods on the two major tributaries (Tesuque Creek, Station 8-3025 and Little Tesuque Creek, Station 8-3050) some 3 miles upstream, and for four of the larger diversions for irrigation of 178 acres in the area.

The mean-annual runoff for site 5 (table 1) was estimated from records of mean-annual runoff of the two tributary sites upstream adjusted for the estimated natural depletion in the reach between the sites. The natural depletion was obtained by computing the net depletion in the 2-mile length of channel upstream from Station 8-3055 and by adjusting this depletion for consumptive use attributable to irrigation and for estimated additional channel losses in the 1.1 mile length of channel between Station 8-3055 and site 5.

A plot of the monthly loss between the two inflow stations and the outflow station (8-3055) against measured inflow shows that all flow is lost during months when inflow is 100 acre-feet or less. For flows above 100 acre-feet per month, a small percentage of increment is lost. These facts provide a basis for computing the distribution of mean-monthly flows from mean-annual flow at site 5.

The mean-annual runoff for Tesuque Creek above diversion (Station 8-3025) was determined by regression techniques, as for site 2. Mean-annual runoff for Little Tesuque Creek (Station 8-3050) was obtained by use of the runoff-elevation relationship listed in table 2. Both of these means are listed below. An inflow-outflow study determined the net long-term depletion for the upper subreach to be 1,700 acre-feet per year.

The 110 acres of irrigated land in the upper subreach was estimated to consume about 200 acre-feet annually, leaving 1,500 acre-feet as the depletion attributable to consumptive use of natural channel and losses to subsurface storage in the upper subreach. The natural depletion in the lower subreach is estimated to be 600 acre-feet per year on the basis of relative length of the lower reach as compared with the upper reach. Possibly as much as 95 percent of the natural loss in these two reaches goes into subsurface storage. The computation of the natural flow for the station at Tesuque and at site 5 are as follows:

	<u>Acre-feet</u> <u>per year</u>
Inflow from Tesuque Creek (Station 8-3025) ----	2,300
Inflow from Little Tesuque Creek (Station 8-3050) ----	<u>400</u>
Total inflow -----	2,700
Natural loss in surface flow in upper subreach	<u>1,500</u>
Natural flow Rio Tesuque at Tesuque (Station 8-3055) -----	1,200
Estimated inflow intervening area -----	<u>100</u>
Subtotal -----	1,300
Estimated natural loss in streamflow in lower subreach -----	<u>600</u>
Estimated natural flow at site 5 -----	700

Site 6

Although no streamflow records are available at site 6 (Pojoaque River at mouth), 5 years of record are available for Pojoaque Creek at Pojoaque Bridge near Nambe (8-3010) and for longer periods on most all of the diversion ditches. These records provide a fair basis for determining the natural runoff for a part of the basin as well as the losses in that part of the basin.

The best estimate of natural runoff at site 6 can be obtained by adding the natural runoff from Pojoaque Creek to runoff obtained at site 5 and the estimated runoff from intervening area and subtracting therefrom the estimated loss between these sites and site 6.

It was determined, by graphical multiple regression of the annual values of inflow, outflow, and diversions, that the natural flow in Pojoaque Creek at the highway bridge was 10,200 acre-feet per year. The average of the measured diversions of 6,700 acre-feet per year for this period of record indicates an average depletion of 2,700 acre-feet per year. Also, in computing this value, the runoff from the 33 square miles of intervening drainage area and losses to the channel were both estimated to average 300 acre-feet per year.

Under the present operating conditions, the Pojoaque River at site 6 is dry at times during the summer months when the irrigation demand exceeds the supply; but under natural conditions, it would be flowing all of the time.

The estimate of the flow at site 6 is based in part on two factors that are difficult to evaluate, namely, evaporation loss and ground-water inflow. A companion report by Koopman (1970) gives data on movement of ground water.

The computation of natural flow at site 6 is as follows:

	<u>Acre-feet per year</u>
Natural flow Pojoaque Creek	10,200
Natural flow at site 5	700
Estimated runoff-intervening area	700
Estimate inflow from ground water	<u>100</u>
Total inflow	11,700
Evapotranspiration loss, 16 miles channel	<u>1,000</u>
Natural flow at site 6	10,700

The distribution of the mean-annual flow among the months is based on the distribution, by percent, of the combined inflow at sites 2, 3, 4, and 5.

Summary of results

Techniques of regression analysis and runoff-elevation relationships were used to estimate natural mean-annual runoff at five sites in the Pojoaque River drainage basin where no streamflow records or only short-term records are available. Comparison of estimated mean-annual runoff, using these techniques, with mean-annual runoff obtained from streamflow records at gaged stations within and near the area indicated that the estimated mean-annual runoff at sites unaffected by excessive channel loss was generally within 10 percent, or less, of the gaged runoff.

The natural runoff calculated for each of the six sites considered in this study is believed to be equivalent to runoff for the water years 1920-1968.

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Figure 1.--Map showing the Pojoaque River drainage basin

Santa Fe County, New Mexico

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