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Revised estimates of mean-annual runoff and summary of precipitation and discharge data for Post Headquarters area, White Sands Missile Range, New Mexico.

— Arthur G. Scott

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DEPARTMENT OF THE INTERIOR
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Revised estimates of mean-annual runoff and summary of precipitation and discharge data for Post Headquarters area, White Sands Missile Range, New Mexico

by

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Prepared in cooperation with White Sands Missile Range

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Revised estimates of mean-annual runoff and summary of precipitation and discharge data for Post Headquarters area, White Sands Missile Range, New Mexico

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Introduction

One phase of the Water Master Plan of White Sands Missile Range was to collect data on precipitation and runoff in the Post Headquarters area. These data will be used to determine whether runoff that now passes through the area and onto the barren desert could be used to augment the water supply of the Post area.

The U.S. Geological Survey has operated two streamflow gaging stations in the Post Headquarters area from August 1965 through June 1974. Precipitation stations consisting of recording and non-recording rain gages have been operated from February 1967 through June 1974. These data are presented in the appendix.

Additionally, a weather site to monitor temperature, wind, precipitation, and relative humidity has been operated since about 1947 in the Post area by military agencies.

The purpose of this report is to present revised estimates of runoff based on all available pertinent data and to present all precipitation and runoff data collected by the U.S. Geological Survey at White Sands Missile Range.

This report contains estimates of the long-term mean-annual runoff from the east slopes of the Organ Mountains at seven sites where the stream channels cross the north-south access road in the Post Headquarters area (fig. 1).

Figure 1.--Map of Post Headquarters area, White Sands, N. Mex., showing sites where mean-annual runoff was estimated.

Most numbers in this report are given in English units followed by metric units in parentheses. The conversions to metric units were made as follows:

English			Metric	
Unit	Abbreviation	Multiplied by	Unit	Abbreviation
Acre-foot	ac-ft	1233.5	Cubic metres	m^3
Acre-foot per square-mile	$ac\text{-}ft/mi^2$	476.1	Cubic metres per square kilometre	m^3/km^2
Inch	in	25.4	Millimetre	mm
Square mile	mi^2	2.59	Square kilometre	km^2

Previous investigations

Attempts were made previously to estimate runoff from limited data by the author (Scott, 1970; and 1973, written commun.). Also the runoff from a paved watershed on White Sands Missile Range was reported by Ballance and Basler (Ballance and Basler, 1967).

Methods of investigation

The following methods were considered to estimate the long-term mean-annual runoff from the Post Headquarters area:

1. An attempt was made to relate daily runoff to daily precipitation. This relation could then be used with a long-term daily rainfall record to estimate the mean-annual runoff. However, there was no apparent relationship. The results are shown on figure 2.
2. An attempt was made to relate precipitation to altitude. This relation could be used to help define the amount of runoff from certain zones of elevation in the mountains. The results are shown on figure 3. No relationship is indicated.
3. The annual runoff at Geological Survey gaging stations 08486250 Tularosa Valley tributary near White Sands, N. Mex., and 08486260 Tularosa Valley tributary at White Sands, N. Mex., was related to annual precipitation at 'A' Station (Post Headquarters) for each gaging station. The 24-year average-mean precipitation at 'A' Station was used with these relations to estimate a long-term mean-annual flow for each gage. The runoff estimates for each gage were then projected to the adjacent ungaged drainage basins on the basis of drainage area. The locations of the sites at which runoff was estimated are shown in figure 1 and listed as follows.

Figure 2.--Graph showing relation of daily runoff to daily precipitation ('A' station) for gaging station 08486260 Tularosa Valley tributary at White Sands, N. Mex.

3.--Graph showing relation of precipitation to altitude in the Post Headquarters area, White Sands, N. Mex.

Sites at which relation for gaging station 08486250 was used.

Site	Location
1	In NW¼SE¼ sec.31, T.21 S., R.5 E., on north access road.
2	In NE¼NW¼ sec.6, T.22 S., R.5 E., on north access road.
3	In SW¼SW¼ sec.6, T.22 S., R.5 E., on north access road.
4	In SE¼SE¼ sec.12, T.22 S., R.4 E., at gaging station 08486250, on north access road.

Sites at which relation for gaging station 08486260 was used.

Site	Location
5	In SE¼NE¼ sec.25, T.22 S., R.4 E., at gaging station 08486260, on south access road.
6	In SE¼NW¼ sec.3, T.23 S., R.5 E., at culvert on south access road. (Storage afforded by stock tanks upstream was not considered.)
7	In NW¼SE¼ sec.3, T.23 S., R.5 E., at culvert on south access road.

4 Mean-annual runoff for the period of record was determined for each gaged site. These estimates were corrected to a long-term mean by multiplying the estimate by the ratio of the mean-annual precipitation for the eight-year concurrent period of record to the 24-year mean-annual precipitation. Then these estimates were extended to the ungaged adjacent drainage basins on the basis of drainage area.

Results

Annual runoff for the period January 1966 through December 1973 for gaging stations 08486250 and 08486260 was related to annual precipitation at 'A' Station (Post Headquarters) for the same period (figs. 4 and 5). Average annual precipitation at Post Headquarters for this period was 12.25 inches (311 mm) and the average for a 24-year period is 10.59 inches (267 mm).

Figure 4.--Graph showing relation of annual runoff to annual precipitation ('A' Station) for gaging station 08486250 Tularosa Valley tributary near White Sands, N. Mex.

5.--Graph showing relation of annual runoff to annual precipitation ('A' Station) for gaging station 08486260 Tularosa Valley tributary at White Sands, N. Mex.

Results of this investigation are summarized below:

Station 08486250 Tularosa Valley tributary near White Sands

1.--Recorded mean-annual runoff based on eight calendar years of data is 68 acre-feet (83,900 m^3) or 4.0 acre-feet per square mile (1,900 m^3/km^2). This was corrected to a long-term mean by multiplying the yield by the ratio of the mean precipitation for the eight-year period to the long-term mean precipitation. This corrected yield is 3.4 acre-feet per square mile (1,620 m^3/km^2).

2.--Using the linear regression (fig. 4) and the long-term mean precipitation at Post Headquarters, a mean-annual runoff of 19 acre-feet (23,400 m^3) or 1.1 acre-feet per square mile (524 m^3/km^2) was computed.

Station 08486260 Tularosa Valley tributary at White Sands

1.--The recorded mean-annual runoff based on eight calendar years of data at this site is 80 acre-feet (98,700 m^3) or 3.8 acre-feet per square mile (1,810 m^3/km^2). This yield corrected to a long-term mean is 3.3 acre-feet per square mile (1,570 m^3/km^2).

2.--Using the linear regression (fig. 5) and the long-term mean precipitation at Post Headquarters, a mean-annual runoff of 38 acre-feet (47,000 m^3) or 1.8 acre-feet per square mile (860 m^3/km^2) was computed.

Using the above estimates and projecting the runoff estimates to the ungaged basins, on the basis of drainage area, gives the following estimated mean-annual runoff:

Site	Drainage area (mi^2)	Unit runoff (Ac-ft/mi^2)		Total annual runoff (Ac-ft)	
		Based on station record	Based on regression	Based on station record	Based on regression
1	1.9	3.4	1.1	6.5	2.1
2	.8	3.4	1.1	2.7	.9
3	7.8	3.4	1.1	26.	8.6
4	17.2	3.4	1.1	59.	18.9
5	21.0	3.3	1.8	69.	37.8
6	11.1	3.3	1.8	37	20.0
7	21.4	3.3	1.8	71	38.5
Totals	81.2			270	130

Because these estimates were computed by somewhat independent means, it was assumed that the best estimate of mean-annual runoff is the average value or 200 acre-feet (245,000 m^3).

It is impossible to quantify the magnitude of error associated with this estimate. The standard error of the linear regressions is about 60 percent. In addition, there is an unknown time-sampling error in assuming the 24-year average rainfall represents the true mean.

Also an undetermined error is introduced into the estimate of total runoff by assuming that the measured runoff at the two gaged sites represents the average conditions of runoff over the entire area and by using these runoff estimates to compute runoff from the ungaged sites. The gaged sites represent about 47 percent of the total drainage area.

Summary

Four methods of estimating long-term mean-annual runoff in the Post Headquarters area were initially attempted Two of these were considered unsuccessful--a daily rainfall-runoff relation, and a precipitation-altitude relation. Estimates of runoff using the two other methods were considered reliable--a graphical regression of annual runoff against annual precipitation and an average of the annual runoff measured at each gaging station. It was assumed that that the best estimate would be the average of the results from the two reliable methods.

Mean-annual runoff in the Post Headquarters area, a drainage area of about 81 square miles (210 km^2), is estimated to be about 200 acre-feet (247,000 m^3) per year.

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Appendix

The following tables summarize precipitation and runoff data collected by the Geological Survey at White Sands Missile Range from September 1965 through December 1974. Monthly and annual means are shown for those precipitation stations which have at least five complete years of record.

Beginning with 1968, the precipitation data were published in an annual series of open-file basic-data reports entitled "Annual water-resources review, White Sands Missile Range--a basic data report," and (Busch, 1969 and 1970; Basler, 1971, Cruz, 1972-1975).

The discharge data were published in U.S. Geological Survey annual report "Water resources data for New Mexico, Part 1, Surface Water data" (U.S. Geological Survey, 1961-1973).

Appendix A.--Precipitation, in inches, for recording-precipitation gages operated by the U.S. Geological Survey at White Sands Missile Range, New Mexico

Gage No.	Location	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Total
5	T.19 S., R.5 E SW¼SW¼SW¼ sec 17	1967	-	.01	0	0	0	0.32	0.41	0.81	0.56	0	0	0	3.58*
		1968	0	.60	.38	0	0	.16	0	.90	0	T	.15	.05	2.24
		1969	0	0	.15	0	0	.11	1.25	0	1.85	1.72	0	1.00	5.86
		1970	0	0	.44	0	0	0	-4.12-		.48	0	0	.62	5.66
		1971	.30	0	0	.14	.08	0	.86	1.30	.85	.82	.52	.28	4.87
		1972	-	-	-	0	0	.28	0	4.00	.22	1.25	.60	.70	7.05*
		1973	1.02	.54	.12	-	.12	-	-	1.46	0*	.16	.30	.12	3.84*
		1974	.81*	.05	.14*	0	.07	0	1.70	.62	2.27	1.55	0	0*	6.40*
		Mean	0.26	0.17	0.18	0.02	0.03	0.12	0.70	1.30	0.89	0.79	0.20	0.40	-
4	T.21 S., R.5 E SE¼SE¼NW¼ sec 18	1967	-	0.01	0	0	0	0.51	0.78	0.86	1.81	0	0	1.36	5.32*
		1968	0	0	.96	.62	0	0	1.00	1.10	0	.27	1.00	0	4.95
		1969	0	0	.21	0	0	.07	1.38	1.16	2.25	1.70	0	1.07	7.84
		1970	0	0	.85	0	0	0	-4.04-		-	0	.06	.50	5.45*
		1971	.25	.27	0	.10	0	0	-	71	.44	.80	.66	.13	3.36*
		1972	.28	.26	.23	.11	.18	.13	2.65	3.20	.28	1.65	1.00	1.35	11.32
		1973	.42	.92	.09	.15	.13	.09	3.69*	1.28*	.17	0	.18	.32	7.44*
		1974	.99*	0*	0*	.62	0	.23	3.52	2.17	3.66	3.04	0	.06*	14.29*
		Mean	0.16	0.21	0.33	0.20	0.04	0.13	1.87	1.53	1.23	0.93	0.36	0.68	-
3	T.21 S., R.4 E NE¼NE¼SE¼ sec 22	1967	-	0	0	0	0	0.70	1.15	1.10	1.52	0	0	1.61	6.08*
		1968	0	0	.68	0	0	0	1.53	1.76	0	.20	.78	0	4.95
		1969	0	0	.21	0	0	.05	1.60	.73	4.30	1.05	0	1.04	8.98
		1970	0	0	.84	0	0	0	3.04	.19	.21	0	.02	.36	4.66
		1971	.27	.01	0	.34	0	0	3.31	1.89	1.28	1.80	1.16	.42	10.48
		1972	.34	.33	.30	.05	.35	.19	.76	2.85	.50	1.30	1.10	1.00	9.07
		1973	.56	.68	.05	.22	.15	.51	5.17	2.30	.16	.03	.22	.25	10.30
		1974	1.61	.02	.44	.15	0	.02	4.39	3.41	3.50	2.87	0	.15*	16.56*
		Mean	0.40	0.13	0.32	0.10	0.06	0.18	2.62	1.78	1.43	0.91	0.41	0.67	8.07
2	T.21 S., R.4 E NE¼NE¼SW¼ sec 9	1967	-	0	0	0	0	0.72	0.70	0.63	1.72	0	0	1.67	5.44*
		1968	0	.61	1.53	0	0	.40	1.15	1.10	0	1.25	.75	0	6.79
		1969	0	0	1.33	0	0	.06	1.75	1.07	3.89	1.38	0	1.09	10.57
		1970	0	0	.66	0	0	0	1.51	.88	.25	.74	.03	.61	4.68
		1971	.48	.01	0	.33	0	0	3.30	.59	1.13	.45	.21	1.83	8.33
		1972	.50	.48	.45	.16	.30	1.30	.42	3.45	.34	1.55	1.65	.90	11.50
		1973	.50	.88	.28	.44	.22	.17	5.09	1.70	.12	0	.14	0	9.54
		1974	2.14	.02	0*	.90	0	.02	3.51	2.92	3.23	2.15	0	.07*	14.96*
		Mean	0.52	0.25	0.61	0.23	0.07	0.33	2.18	1.54	1.34	0.94	0.35	0.92	8.57
1	T.22 S., R.4 E SE¼NW¼NW¼ sec 23	1967	-	0	0	0	0	0.63	0.09	0.45	1.47	0	0	1.65	3.85*
		1968	0	.40	1.10	0	0	0	1.27	1.15	0	1.00	.25	.02	5.19
		1969	0	0	.26	0	0	.07	1.48	.92	3.83	1.45	0	1.00	8.68
		1970	0	0	.82	0	0	0	.76	-	1.62	-	.02	.56	3.78*
		1971	.43	.07	0	.25	0	.08	3.73	.55	.51	1.66	1.26	1.92	10.46
		1972	.66	.86	.57	.06	.22	.54	.82	3.50	.32	1.80	1.20	-	10.55*
		1973	-	1.30	-	.12	.34	.05	5.47	1.29*	.13	.02	.35	0	9.07*
		1974	.82	.02	.60	0	.50	.11	1.16*	-	6.14	2.16	.02	-	11.53*
		Mean	0.32	0.33	0.48	0.05	0.13	0.19	1.95	1.31	1.75	1.16	0.39	0.86	-

* Partial Record

Appendix B.--Precipitation, in inches, for storage-type precipitation gages operated by the U.S. Geological Survey at White Sands Missile Range, New Mexico

Gage No.	Location	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Total
17	T.21 S., R.4 E	1967	-	-	-	-	-	1.20	0.50	0.65	1.50	0	0	0.91	4.76*
	SE¼NE¼SE¼ sec 10	1968	0	0.76	0.94	0	0	.16	.92	1.10	0	.40	.58	3.16	5.16
		1969	0	0	.32	0	0	.10	2.25	1.10	3.55	1.85	0	.91	10.08
		1970	0	0	.84	0	0	.10	2.00	.35	.31	0	0	.34	3.94
		1971	0	.01	0	.09	0	0	.89	.45	.84	1.45	1.25	.44	5.42
		1972	.25	0	0	.23	.40	.31	1.20	3.40	.38	1.60	.65	.50	8.92
		1973	.56	.92	.06	.25	.22	-	1.00	-	0	0	.07	.80	3.88*
		1974	.20	0	.40	.06	0	3.05	-	-	-	-	-	-	3.71*
		Mean	0.14	0.24	0.37	0.09	0.09	0.70	1.25	1.18	0.94	0.76	0.36	1.01	6.70
19	NE¼SW¼SW¼ sec 12	1967	-	-	-	-	-	0.76	-	-	1.00	-	-	-	1.76*
		1968	-	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW¼NW¼SW¼ sec 12	1971	-	-	0	0	0	0	0.72	0.73	0.50	1.15	1.18	0.21	4.49*
		1972	0.13	0	0	.02	.17	.32	1.95	2.80	.30	1.55	1.00	-	8.24*
		1973	.44	.92	.15	.20	.20	2.50	1.26	1.30	0	0	.16	.90	8.03
		1974	.15	0	.40	.44	0	3.26	-	-	-	-	-	-	4.29*
18	NE¼NW¼SE¼ sec 14	1967	-	-	-	-	-	0.97	0.50	0.63	1.25	0	0	1.40	4.75*
		1968	0	0.66	0.80	0	0	.20	.80	.80	0	.40	.60	.60	4.86
		1969	0	0	.15	0	0	.11	1.75	1.24	2.75	1.95	0	.72	8.67
		1970	0	0	.70	0	0	0	1.80	.22	.24	.20	0	.40	3.56
		1971	0	.03	0	.09	0	0	3.06	.86	1.00	1.43	1.17	.42	8.06
		1972	.26	0	0	.02	.30	.05	1.05	3.10	.44	1.67	1.25	1.30	9.44
		1973	.56	.86	.12	.23	.28	3.15	1.05	2.15	0	0	.05	1.05	9.50
		1974	.01	0	.35	.20	0	-	-	-	-	-	-	-	.56*
		Mean	0.12	0.22	0.30	0.08	0.08	0.64	1.43	1.29	0.81	0.81	0.44	0.84	7.35
15	SW¼SW¼NE¼ sec 21	1967	-	-	-	-	-	0.35	0.74	0.64	0	0	0	0	1.73*
		1968	0	0.90	0.70	0	0	.68	1.00	.90	0	.25	.45	.30	5.18
		1969	0	0	.18	0	0	.10	1.24	.50	3.35	1.90	0	.63	7.90
		1970	0	0	.90	0	0	0	1.80	.46	.36	.24	-	-	3.76*
		1971	0	.03	0	-	0	0	2.47	1.10	.90	2.20	1.45	.28	8.43*
		1972	.17	0	0	.04	.44	.10	.44	3.50	.40	.82	1.45	1.55	8.91
		1973	.68	1.40	.11	.44	.22	3.40	.66	2.65	0	0	.13	1.35	11.26
		1974	.14	.38	0	0	0	2.85	-	-	-	-	-	-	3.37*
		Mean	0.14	0.39	0.27	0.08	0.09	0.94	1.22	1.39	0.72	0.77	0.58	0.69	-
16	NE¼NE¼NE¼ sec 22	1967	-	-	-	-	-	1.05	.96	1.10	1.65	0	0	1.05	5.81*
		1968	0	0.60	1.10	0	0	.14	.38	.50	0	.52	.48	.50	4.22
		1969	0	0	.21	0	0	.11	2.00	.80	3.55	1.95	0	.80	9.42
		1970	0	0	.80	0	0	0	2.00	.40	.05	.21	0	.15	3.61
		1971	0	0	0	.03	0	0	3.12	.94	.64	1.03	.84	1.10	7.70
		1972	.21	0	0	.02	.30	0	1.46	3.05	.26	1.30	.84	.80	8.24
		1973	.40	.50	.02	.15	.15	3.60	.56	1.85	0	0	.02	-	7.25*
		1974	.16	0	.34	.14	0	2.25	-	-	-	-	-	-	3.37*
		Mean	0.11	0.16	0.35	0.05	0.06	0.89	1.50	1.23	0.88	0.72	0.31	0.73	6.64
14	NE¼NE¼SE¼ sec 25	1967	-	-	-	-	-	1.21	1.15	0.40	1.15	0	0	1.20	5.11*
		1968	0	0.42	0.44	0	0	.14	.90	.90	0	.30	.40	.60	4.10
		1969	0	0	0	0	0	.20	1.55	.18	3.50	1.05	0	.83	7.31
		1970	0	0	.48	0	0	0	2.80	.30	.19	.20	0	.36	4.33
		1971	0	.05	0	0	0	0	2.13	1.15	.48	.97	1.05	.34	6.17
		1972	.32	0	0	.20	.23	.07	1.05	2.60	.28	1.52	.88	1.05	8.70
		1973	.33	.80	.10	.20	.15	3.25	1.55	1.00	0	0	.22	.60	8.20
		1974	.10	0	.33	.82	0	2.35	-	-	-	-	-	-	3.60*
		Mean	0.11	0.18	0.19	0.17	0.05	0.90	1.59	0.93	0.80	0.58	0.36	0.71	6.47
13	NE¼NE¼SW¼ sec 27	1967	-	-	-	-	-	0.26	1.15	0.76	1.60	0	0	1.05	4.82*
		1968	0	0.76	0.90	0	0	.19	.72	.90	0	-	-	-	3.47*
		1969	0	0	.15	0	0	.11	1.30	.50	4.25	1.65	0	.80	8.76
		1970	0	0	.70	0	0	0	2.00	0	.22	.13	-	.22	3.27*
		1971	0	.05	0	-	0	0	3.43	.84	.75	1.45	1.10	.94	8.56*
		1972	.15	0	0	.10	.48	.02	.10	2.75	.50	1.55	1.30	1.25	8.70
		1973	.56	.82	.12	.36	.18	3.00	1.50	2.15	0	0	0	1.20	9.89
		1974	.12	.37	0	0	0	2.30	-	-	-	-	-	-	2.79*
		Mean	0.12	0.29	0.27	0.08	0.09	0.74	1.46	1.13	1.05	0.80	0.48	0.91	-
11	NW¼NW¼NW¼ sec 32	1967	-	-	-	-	-	0.42	0.55	1.04	2.00	0	0	1.15	5.14*
		1968	0	1.00	1.10	0	0	.28	.92	.87	0	.20	-	-	4.37*
		1968	0	0	.20	0	0	-	-	-	-	-	-	-	.20*
		1970	0	0	-	-	-	-	-	-	-	-	-	-	-

* Partial Record

Appendix B.--Precipitation, in inches, for storage-type precipitation gages operated by the U.S. Geological Survey at White Sands Missile Range, New Mexico - Continued

Gage No.	Location	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Total
12	T.21 S., R.4 E NW¼NW¼SW¼ sec 32	1967	-	-	-	-	-	0.41	0.50	0.66	1.50	0	0	1.15	4.22*
		1968	0	0.54	0.35	0	0	.28	.93	.90	0	.10	.35	.25	3.70
		1969	0	0	.16	0	0	.14	1.70	.50	2.82	1.70	0	.72	7.74
		1970	0	0	.75	0	0	0	1.65	.31	.34	.22	0	.16	3.43
		1971	0	.03	0	.10	0	0	3.30	.63	.81	1.70	1.00	1.02	8.59
		1972	.16	0	0	.03	.46	.10	.20	2.45	.44	1.75	1.25	1.40	8.24
		1973	.68	1.25	.21	.48	.22	3.85	1.05	2.70	0	0	-	-	10.44*
		1974	-	.22	-	-	0	2.20	-	-	-	-	-	-	2.42*
		Mean	0.14	0.29	0.25	0.10	0.10	0.87	1.33	1.16	0.84	0.78	0.43	0.78	6.34
10	SE¼SE¼SW¼ sec 32	1967	-	-	-	-	-	0.81	0.34	0.74	1.75	0	0	1.03	4.67*
		1968	0	0.60	0.70	0	0	.46	1.10	-	T	.10	.15	-	3.11*
		1969	0	0	.10	0	0	.12	1.45	1.00	-	-	-	1.00	3.67*
		1970	0	0	-	-	-	0	-	-	-	-	-	-	-
		1971	-	-	0	.15	.01	0	3.27	.23	.93	1.30	1.20	1.10	8.79*
		1972	.14	0	0	.07	.49	.56	.33	2.30	.42	1.35	1.25	1.10	8.01
		1973	.80	.82	.18	.46	.32	3.90	1.35	2.05	0	0	.08	1.55	11.51
		1974	.10	.28	.02	.42	0	2.80	-	-	-	-	-	-	3.62
		Mean	0.17	0.28	0.17	0.18	0.14	1.08	1.41	1.26	0.62	0.55	0.54	1.16	-
9	NE¼NE¼SW¼ sec 33	1967	-	-	-	-	-	0.60	0.70	0.50	1.80	0	0	0.45	4.05*
		1968	0	1.00	1.10	0	0	.28	.92	.87	0	.20	-	-	4.37*
		1969	0	0	.17	0	0	.12	1.40	48	2.87	1.55	0	.63	7.22
		1970	0	0	0	0	0	0	-	-	.17	0	0	.31	.48*
		1971	0	0	0	.20	0	0	3.83	.44	.82	1.40	1.19	.70	8.58
		1972	.24	0	0	.07	.27	.48	.78	2.40	.38	1.55	1.45	1.30	8.92
		1973	.60	.90	.15	.38	.30	2.75	1.00	2.00	0	0	.09	1.50	9.67
		1974	.17	.18	.08	.60	0	2.50	-	-	-	-	-	-	3.53*
		Mean	0.14	0.30	0.21	0.18	0.08	0.84	1.44	1.12	0.86	0.67	0.46	0.82	-
21	T.21 S., R.5 E SE¼SE¼NE¼ sec 17	1967	-	-	-	-	-	0.33	0.18	0.68	0.74	0	0	1.00	2.93*
		1968	-	-	-	-	-	.27	.72	.90	0	.20	.40	.30	2.76*
		1969	0	0	.03	0	0	.10	1.60	.50	2.30	.80	0	.70	6.03
		1970	-	-	-	-	-	-	-	-	0	-	-	-	-
		1971	-	-	0	.05	.01	0	.60	.13	.26	.90	1.15	.15	3.25*
		1972	.28	0	0	.15	.04	.28	.40	2.35	.18	1.15	.68	1.00	6.51
		1973	.53	.46	.10	.13	.13	3.30	.40	1.20	0	0	.15	.46	6.86
		1974	.09	0	.21	.58	0	1.85	-	-	-	-	-	-	2.73*
		Mean	-	-	0.13	0.18	0.04	0.88	0.65	0.96	0.50	0.51	0.40	0.60	-
8	T.22 S., R.4 E SE¼NW¼NW¼ sec 2	1967	-	-	-	-	-	0.43	1.00	0.15	0.94	0	0	1.05	3.57*
		1968	0	0.60	0	0	0	.12	1.20	1.22	-	-	.30	.20	2.64*
		1969	0	0	.16	0	0	.22	1.55	.48	2.92	.75	0	.70	6.78
		1970	0	0	0	0	0	0	-	-	-	-	0	.26	.26*
		1971	0	.02	0	.20	0	0	3.83	.44	.82	1.40	1.19	.70	8.60
		1972	-	-	-	.22	.24,	.38	.68	3.18	.28	1.55	1.45	.50	8.48*
		1973	.38	.80	.14	.29	.15	3.20	1.50	1.45	0	0	.22	-	8.13*
		1974	0	.40	.02	.58	0	-	-	-	-	-	-	-	1.00*
		Mean	0.06	0.30	0.05	0.18	0.06	0.62	1.63	1.15	0.99	0.93	0.45	0.57	-
5	SW¼SW¼SE¼ sec 8	1967	-	-	-	-	-	0.96	0.41	0.66	1.73	0	0	1.25	3.79*
		1968	-	-	-	-	-	-	-	-	-	-	-	-	-
		1969	-	-	-	-	-	-	-	-	-	-	-	-	-
		1970	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW¼NW¼SW¼ sec 17	1971	-	-	0	0	0	0	2.95	0	.10	.75	1.30	.80	5.90*
		1972	0.30	0	0	0	.29	1.16	.51	2.95	-	-	2.00	1.15	8.36*
		1973	.64	1.50	.24	.42	.17	2.80	3.90	1.95	0	0	.21	1.95	13.78
		1974	.11	0	.56	0	0	-	-	-	-	-	-	-	.67*
7	NE¼NE¼NW¼ sec 10	1967	-	-	-	-	-	0.61	0.70	0.19	1.65	0	0	1.15	4.30*
		1968	0	0.50	0.62	0	0	.06	1.49	1.62	T	.40	.30	0	4.99
		1969	0	0	.19	0	0	.20	1.35	.32	-	-	-	-	2.06*
		1970	-	-	-	-	0	.15	3.05	.38	0	.17	0	.20	3.95*
		1971	0	.08	0	.07	0	0	2.73	.27	.40	1.10	1.03	.52	6.20
		1972	.36	0	0	.06	.34	1.05	1.50	2.45	.46	1.30	1.25	-	8.77*
		1973	.28	.90	.24	.42	.13	2.55	1.05	1.40	0	0	.28	1.20	8.45
		1974	.10	.38	.11	1.10	0	1.80	-	-	-	-	-	-	3.49*
		Mean	0.12	0.31	0.19	0.28	0.07	0.80	1.70	0.95	0.42	0.50	0.48	0.61	-

* Partial Record

Appendix B.--Precipitation, in inches, for storage-type precipitation gages operated by the U.S. Geological Survey at White Sands Missile Range, New Mexico - Concluded

Gage No.	Location	Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Annual Total
6	T.22 S., R.4 E NW¼NW¼SW¼ sec 11	1967	-	-	-	-	-	0.59	0.44	0.16	1.35	0	0	1.25	3.79*
		1968	0	0.52	0.52	0	0	.05	1.25	1.50	0	.20	.30	.36	4.70
		1969	0	0	.08	0	0	.20	1.48	.32	3.65	.92	0	.60	7.25
		1970	0	0	.40	0	0	.15	3.00	.41	0	0	0	.35	4.31
		1971	0	.08	0	.05	0	0	2.47	.07	.30	.94	1.31	.36	5.58
		1972	.34	0	0	.08	.48	.64	.47	2.45	.40	1.25	.55	1.55	8.21
		1973	.35	.78	.11	.28	.12	2.35	1.25	1.33	0	0	.27	.84	7.68
		1974	.09	.32	.09	.84	0	2.45	-	-	-	-	-	-	3.79*
		Mean	0.11	0.24	0.17	0.18	0.09	0.80	1.48	0.89	0.81	0.47	0.35	0.76	6.29
22	SE¼NE¼SE¼ sec 20	1973	-	-	-	-	0.22	2.10	2.00	2.50	0	0	0.18	2.10	9.10*
		1974	0.12	0	0.74	1.05	0	-	-	-	-	-	-	-	1.91*
23	SE¼SW¼SE¼ sec 20	1973	-	-	-	-	0.28	4.55	2.00	-	0	0	0.19	1.95	8.97*
		1974	0.09	0	0.72	3.00	0	2.65	-	-	-	-	-	-	6.46*
4	NE¼NE¼NE¼ sec 22	1967	-	-	-	-	-	0.81	0.09	0.32	1.55	0	0	2.00	4.77*
		1968	0	0.70	1.15	0	0	.05	1.25	1.25	.10	1.00	.17	.67	6.34
		1969	0	0	.20	0	0	.18	1.55	1.00	3.65	1.40	0	1.00	8.98
		1970	0	0	.65	0	0	0	3.40	.15	0	.10	0	.34	4.64
		1971	0	.05	0	.10	0	0	3.32	0	.36	1.43	1.50	.57	7.33
		1972	.38	0	0	.08	.23	.41	.78	3.70	.34	2.05	1.20	2.10	11.27
		1973	.57	1.25	.15	.52	.19	3.50	3.30	1.60	0	0	.24	1.45	12.[illegible]
		1974	.10	.58	.37	.70	0	1.90	-	-	-	-	-	-	3.60*
		Mean	0.15	0.37	0.36	0.20	0.06	0.86	1.96	1.15	0.86	0.85	0.44	1.16	8.56
24	SW¼NE¼SW¼ sec 29	1973	-	-	-	-	0.21	4.45	2.00	2.50	0	0	.18	2.35	11.69*
		1974	0.09	0	0.62	1.55	0	2.05	-	-	-	-	-	-	4.31*
3	T.22 S., R.5 E NE¼SW¼SW¼ sec 25	1967	-	-	-	-	-	0.31	0.08	0.52	2.25	0	0	2.25	5.41*
		1968	0	0.58	0.64	0	0	.20	.93	1.10	0	.65	.35	.55	5.00
		1969	0	0	.08	0	0	.10	2.25	1.00	3.95	1.00	0	1.00	9.38
		1970	0	0	.66	0	0	0	2.95	.11	0	0	0	.50	4.22
		1971	0	.20	0	.08	.05	0	2.30	0	.30	1.22	1.15	.48	5.78
		1972	.13	0	0	0	.23	.56	.42	3.05	.25	1.66	.90	1.60	9.15
		1973	.53	.88	.15	.50	.07	4.25	2.65	1.10	0	0	.18	1.15	11.46
		1974	.10	.44	.07	.54	0	2.40	-	-	-	-	-	-	3.55*
		Mean	0.11	0.30	0.23	0.16	0.05	0.98	1.65	0.98	0.96	0.65	0.37	1.08	7.50
1	T.23 S., R.5 E NW¼NW¼SE¼ sec 15	1967	-	-	-	-	-	0.05	0.04	0	0.45	0	0	0.66	1.20*
	T.22 S., R.4 E SE¼SE¼SE¼ sec 11	1968	0	0	0.72	0	0	0.45	2.20	1.85	0.10	0.20	0.20	0.56	6.24
		1969	0	0	.10	0	0	.20	1.25	.20	3.95	.90	0	.70	7.30
		1970	0	0	.50	0	0	0	2.90	.56	0	.04	0	.36	4.36
		1971	0	.05	0	.04	0	0	2.35	.17	.28	1.02	1.15	.35	5.41
		1972	.28	0	0	.09	.35	.82	.46	2.40	.32	1.25	1.00	1.65	8.62
		1973	.32	.72	.09	.24	.20	2.80	1.35	1.38	0	0	.27	.88	8.25
		1974	.09	.32	0	1.00	0	2.40	-	-	-	-	-	-	3.81*
		Mean	0.10	0.16	0.20	0.20	0.08	0.95	1.75	1.09	0.78	0.57	0.44	0.75	6.70
2	T.23 S., R.5 E SE¼SE¼NE¼ sec 6	1967	-	-	-	-	-	0.05	0.70	0.30	1.55	0	0	1.35	3.95*
		1968	0	0.58	0.60	0	0	.17	1.10	1.15	0	.50	.22	.30	4.62
	NW¼NW¼SW¼ sec 5	1969	0	0	0	0	0	0	2.25	.32	3.82	1.00	0	0	7.39
		1970	0	0	.86	0	0	0	4.65	.70	.37	.30	0	.58	7.29
		1971	0	.12	0	.05	.03	-	2.73	.03	.08	.90	.03	.12	4.09*
		1972	.28	0	0	0	.08	1.20	1.50	3.10	-	1.55	.36	1.30	9.35*
		1973	.44	.64	.05	.60	.10	3.65	1.95	.94	0	0	.22	.76	9.35
		1974	.04	.54	.08	.40	0	-	-	-	-	-	-	-	1.06*
		Mean	0.11	0.27	0.23	0.15	0.03	0.85	2.13	0.93	0.97	0.61	0.12	0.63	-

* Partial Record

Appendix C.--Runoff, in acre-feet, for gaging station 08486250 Tularosa Valley tributary (North Gate) near White Sands, N. Mex.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1965	-	-	-	-	-	-	-	-	-	0	0	13	-
1966	0	0.11	0	0	0	92	0	18	30	0	0	0	140.11
1967	0	0	0	0	0	0	3.0	.2	5.8	0	0	0	9.0
1968	0	0	0	0	0	.5	20	6.5	0	0	0	0	27.0
1969	0	0	0	0	0	0	5.0	133	2.2	2.2	0	0	142.4
1970	0	0	0	0	0	0	12	0	0	0	0	0	12
1971	0	0	0	0	0	.2	5.9	0	0	.4	0	.1	6.6
1972	0	0	0	0	0	0	16	149	2.5	24	0	0	191.5
1973	0	0	0	0	0	0	17	0	0	0	0	0	17
1974	0	0	0	0	0	0	-	-	-	-	-	-	-

Appendix D.--Runoff, in acre-feet, for gaging station 08486260 Tularosa Valley tributary (Texas Canyon) at White Sands, N. Mex.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
1965	-	-	-	-	-	-	-	-	5	0	0	0.8	-
1966	0	0	0	0.3	0	152	23	5.6	16	0	0	0	196.9
1967	0	0	0	0	0	0	0	0	22	0	0	0	22
1968	0	0	0	0	0	0	17	8.8	0	0	0	0	25.8
1969	0	0	0	0	0	3.2	5.0	86	0	.7	0	0	94.9
1970	0	0	0	0	0	.5	30	30	0	0	0	0	60.5
1971	0	0	0	0	0	0	12	0	0	.02	0	0	12.02
1972	0	0	0	0	0	.04	20	92	36	22	0	6.1	176.14
1973	0	0	0	0	0	0	51	0	0	0	0	0	51
1974	0	0	0	0	0	0	-	-	-	-	-	-	-

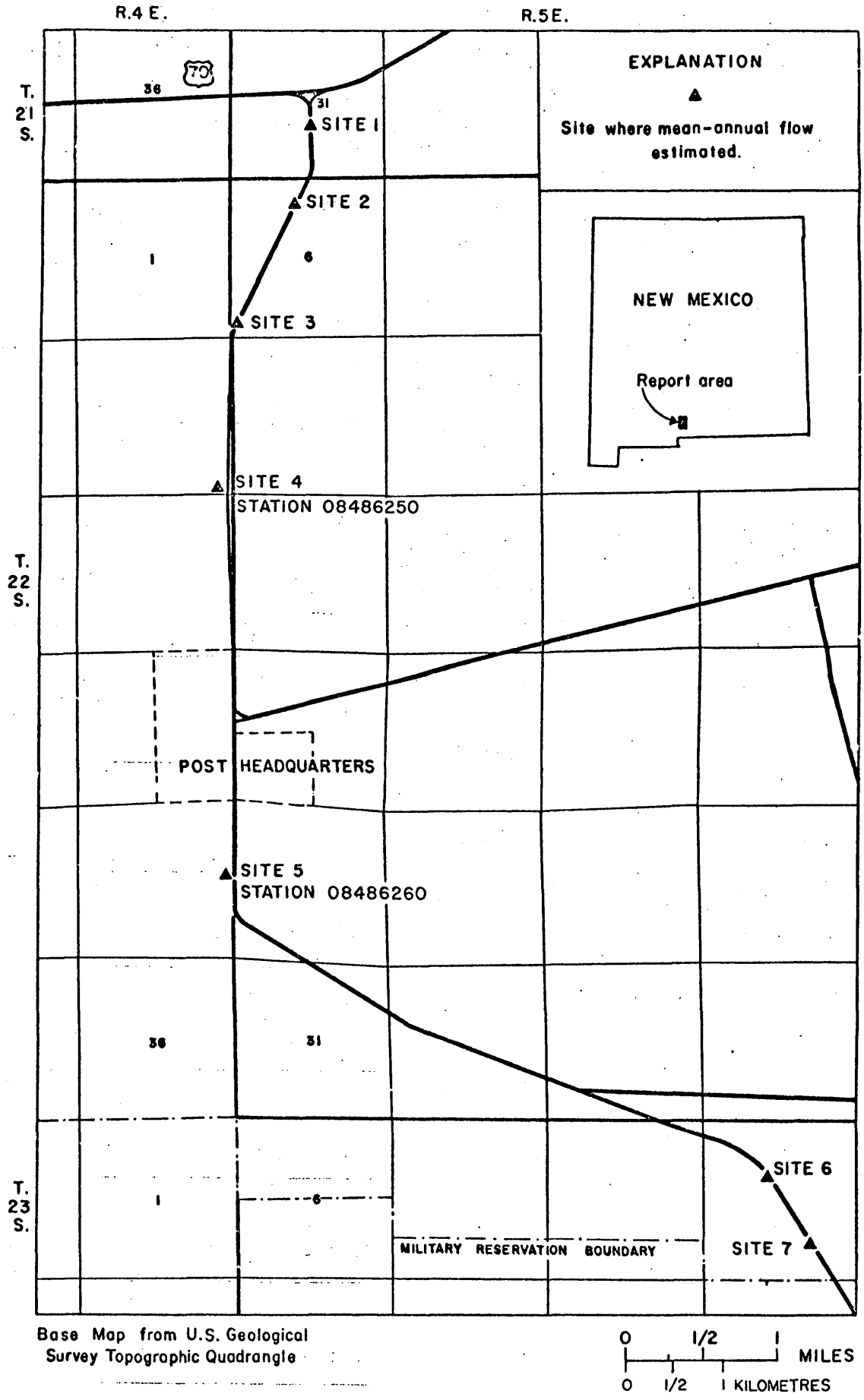

Figure 1.--Map of Post Headquarters area, White Sands, N. Mex. showing sites where mean-annual runoff was estimated.

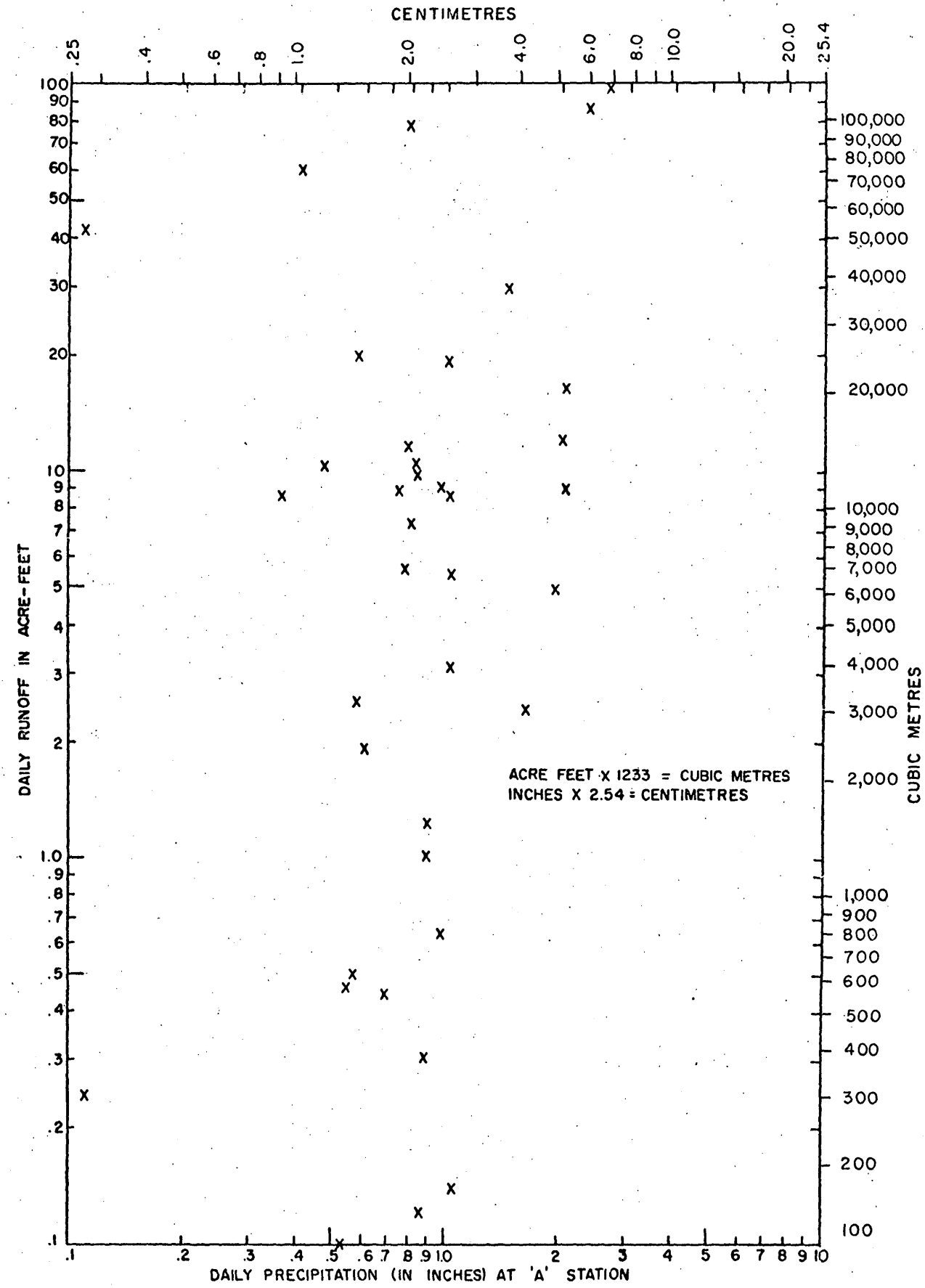

Figure 2.--Relation of daily runoff to daily precipitation ('A' Station) for gaging station 08486260 Tularosa Valley tributary at White Sands, N. Mex.

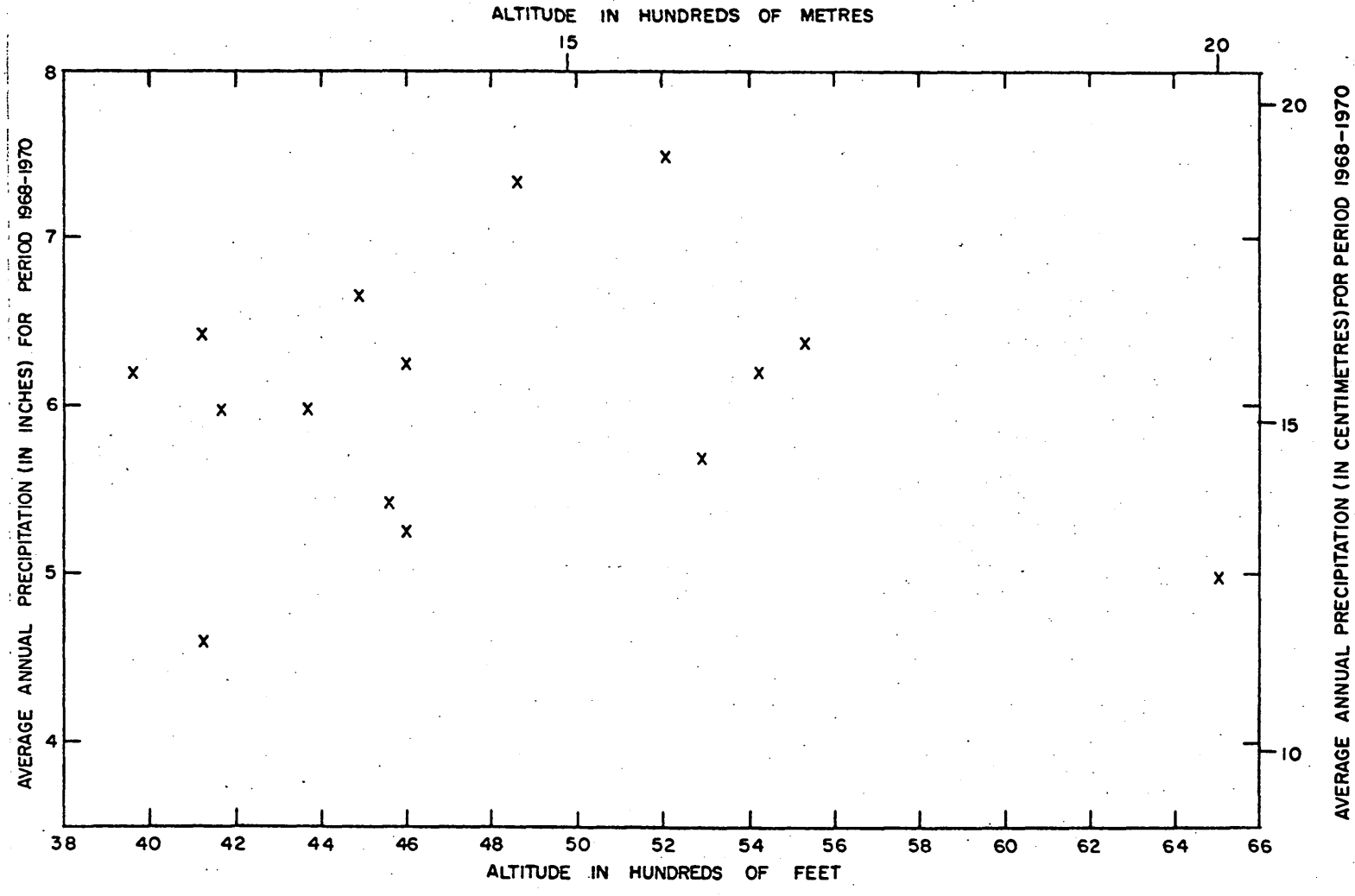

Figure 3.--Relation of precipitation to altitude in the Post Headquarters area at White Sands, N. Mex.

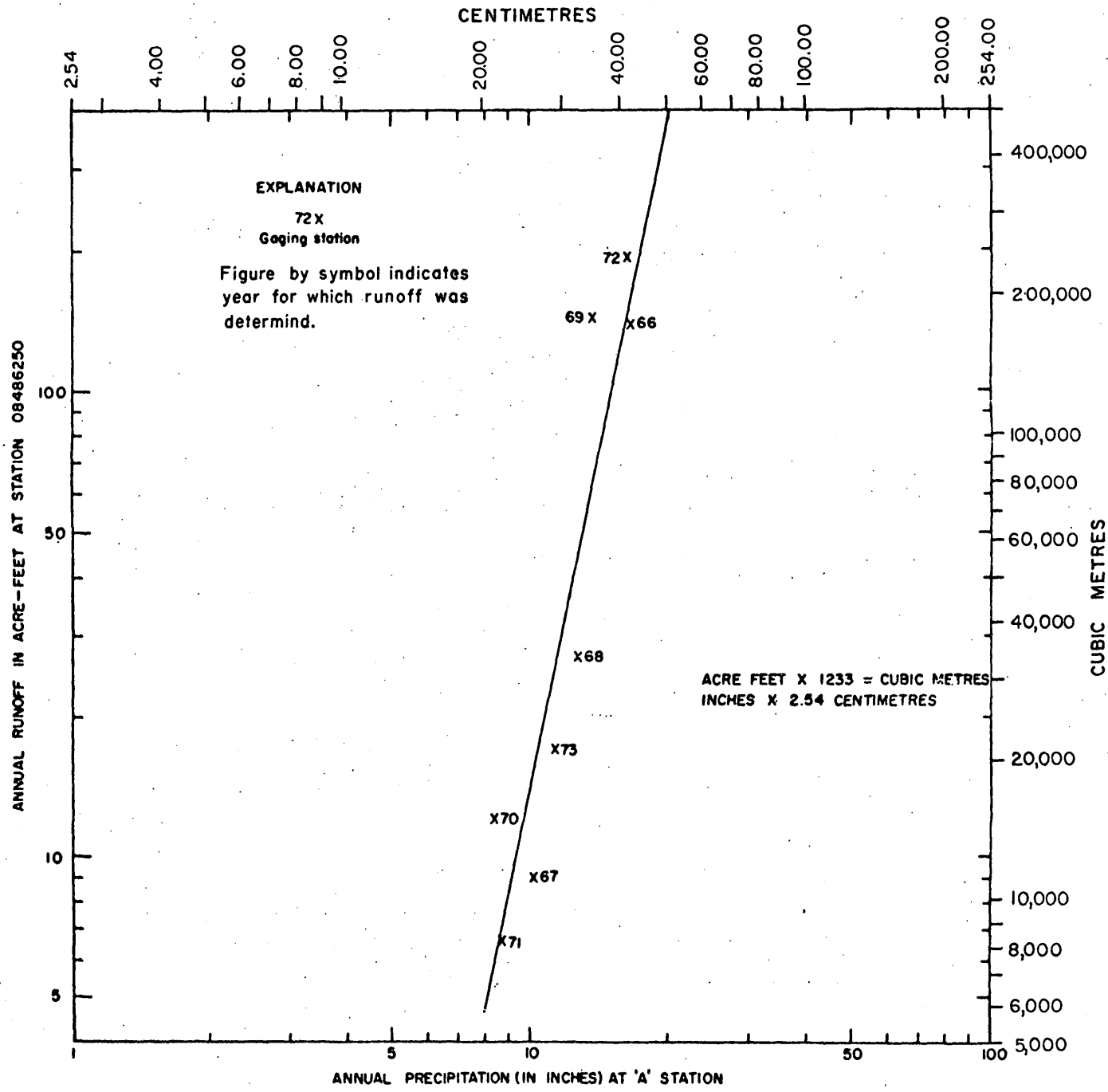

Figure 4.--Relation of annual runoff to annual precipitation ('A' Station) for gaging station 08486250 Tularosa Valley tributary near White Sands, N. Mex.

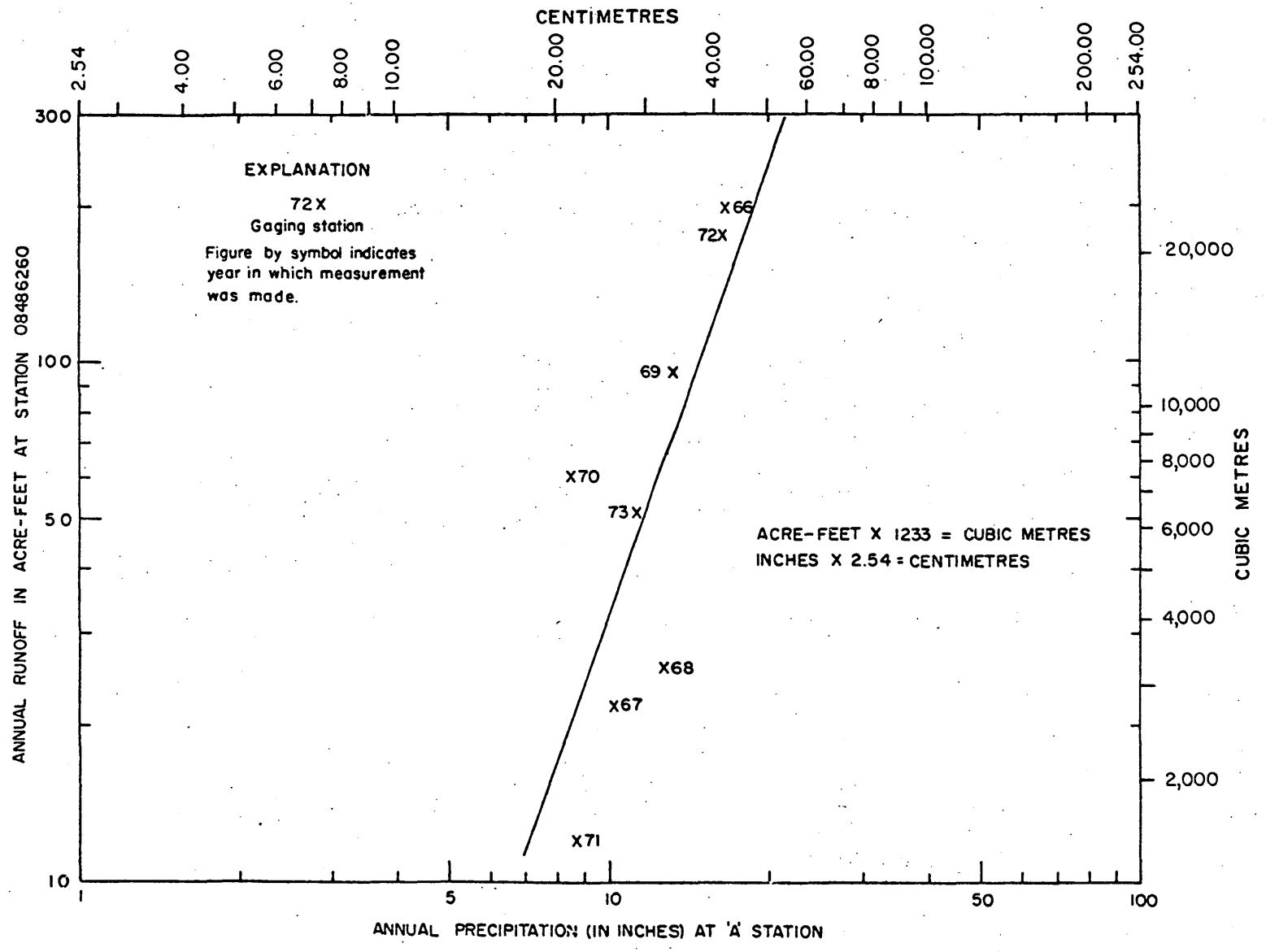

Figure 5.--Relation of annual runoff to annual precipitation ('A' Station) for gaging station 08486260 Tularosa Valley tributary near White Sands, N. Mex.