

IRRIGATION DATA
LONG RANGE PROGRAM

HOPI

Los Angeles, Calif.

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IRRIGATION DATA FOR LONG RANGE PROGRAM

HOPI RESERVATION
PART ONE - BASIC DATA

SECTION 1 - RESOURCES

Location, Date Established and Area of Reservation -

The Hopi Reservation, Navajo and Coconino Counties, Arizona, lies between 35°-30' and 36°-30' N. lat. and 110° and 111° W. long. It is north of Winslow and Holbrook on the A.T. & S.F.R.R. The Agency at Keams Canyon is 80 miles north of Holbrook.

The reservation was established by Executive Order of Dec. 16, 1882, for the use and occupancy of the Moqui and such other Indians as the Secretary of the Interior may see fit to settle thereon.

The area as established is 2,472,166 acres. Hopi Land Management, District No. 6, included 499,248 acres, and as revised includes 631,994 acres.

Elevation and Climate -

The elevation of the reservation varies from about 5000' in the SW corner to 7740' in the NE corner. The elevation at Keams Canyon is 6184'; Polacca, 5800'; Oraibi, 5700'; Hotevilla, 6363'. Elevation of the irrigable areas is approximately 6000'.

The climate is classed with that of the Rocky Mountain region, but is modified by the high, open plateau and proximity to the Southwest desert.

The winters are moderate, but with considerable hard freezing weather, some snow and light rains.

The summers are characterized by hot days and cool nights, with occasional rains of great intensity.

The temperatures at Kayenta,⁽¹⁾ elevation 5800' and about 12 miles north of the reservation, prior to 1928, follows:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Av.
Ext.Max.14 yrs.	70	70	82	90	93	102	103	100	100	89	82	61	-
Ext.Min.14 yrs.	-18	5	10	15	23	32	42	40	30	17	-4	-17	-
Mean 11 yrs.	27	40	43	51	62	70	76	73	65	53	41	30	52.6

The average length of the frost-free growing season at Kayenta during the 12 years of record prior to 1928⁽¹⁾ is 169 days, from April 27 to October 13, with the latest killing frost May 23 and the earliest September 21.

(1) From Bull. 130, U. of A., 4/1/30, Climate of Arizona.

The average precipitation at Kayenta⁽¹⁾ for 12 years of record prior to 1928 was as follows:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
.74"	.46"	.69"	.39"	.33"	.44"	1.44"	1.46"	.68"	.98"	.64"	.82"	9.07"

Kayenta is the nearest station with similar elevation.

Comparison with Tuba City,⁽¹⁾ elevation 4500', and a 22-year record, shows the extreme maximum temperature to be 1° higher; extreme minimum 3° higher; mean 2.1° higher; frost-free period (24-year record), 10 days longer; precipitation (26-year record), 2.13" less.

At Holbrook,⁽¹⁾ elevation 5069', and a 26-year record, the extreme maximum was 3° higher; extreme minimum 2° lower; mean 1.9° higher; frost-free period (38-year record), 3 days less; precipitation (37-year record), 0.36" more.

Erosion is a serious factor, many large washes having developed in modern times. Formerly the outwash from the plateau areas fanned out on the slopes and in the valleys. Being of a sandy nature and holding moisture well, these fans were used for farming. Many large washes, such as Moencopi, Dinnebite, Oraibi, Polacca and Jedito, have become deeply entrenched in the principal valleys to the ruination of many of the farming areas. These washes are of such proportions that serious efforts to control them seem puny and ineffectual.

Topography - (2)

The northeastern portion of the reservation, for the most part, is situated on Black Mesa, which rises sharply out of Chinle Valley to the east and northeast to elevations of about 8000'. From this high, timbered rim the surface of the plateau descends gradually to the south and southwest until its average elevation is 6500'. The southwestern and southern margins are made extremely sinuous by the development of long, scalloped mesas which project like withered fingers into the Tusayan washes which make up the southwestern portion. Upon the extremities of these fingers are situated the principal Hopi villages.

Between the mesas are broad, alluvial valleys out by deep washes, sloping to the Little Colorado River. The moencopi area in the northwest is distinguished by being entrenched several hundred feet, with tributaries only slightly less prominent.

In the southeast corner is an area of lava-capped mesas, igneous dikes and volcanic necks on a platform of sedimentary rocks and bad land topography.

Geology and Soils - (2)

The cretaceous strata forming the Black Mesa are arranged as a flat syncline, dipping southwest. The surface formation is largely mesa verde, extending down to the ends of the mesas. Next below is the Mancos shale, exposed by erosion in the valleys. Underlying are lenses of Dakota sandstone, McElmo and the La Plata group. Water horizons, indicated by springs, are found between Mesa Verde and Mancos

(2) From W.S.P. 380, The Navajo Country, by Herbert E. Gregory, 1916.

formations and at the base of the Dakota sandstone. Artesian water is likely to be struck in the Mesa Verde over the less broken portions of the plateau at depths of 400' to 800'.

The soils on Black Mesa are thin, with high porosity resulting from local disintegration of sandstone. Soils in the valley areas are often of considerable depth. The relatively small amounts of limestone and shale contributed by decomposing ledges give to these alluvial deposits a composition almost wholly of sand and gravels of great absorbtive powers and poor holding capacity. They are easily eroded by both wind and water.

In spite of the unfavorable natural conditions, the Hopis have a large number of farms, where advantage is taken of the best soils on the deltas, or fans of the washes, to produce rather limited crops.

Agronomy -

Dry-farming, as commonly understood, is not practicable on this reservation due to the low rainfall, sandy soil, low humidity and high evaporation. However, the Hopis have some 1500 farms with a fenced area of 10,400 acres, of which 4524 acres are in cultivation. (Report S.C.S. and Indian Service, 10/13/38). These are widely scattered, mostly located on the sandy fans of the larger washes, and may be classed as flood-water farms.

Irrigation possibilities, other than the above, are extremely limited in both number and size. There are no permanent streams, except for a few seeps in the bottoms of deep washes and a few small springs. The diversion of flash floods from the large, deep sand-washes is an expensive and precarious undertaking. Only four small projects have been constructed, and three small ones are proposed. These have a total irrigable area of 727 acres, including Reservoir Canyon, farmed by Hopis off the reservation near Tuba City. This is the largest well established project. Hardrocks, of equal irrigable area, has only recently been taken over by the Hopis.

It is apparent that at best only a small part of the Hopi subsistence can be obtained by irrigation farming.

The crop report for the calendar year 1942 shows the following data as to acreage, yield and value of the principal crops:

<u>All Units</u>	<u>Irrigated</u>	<u>Yield</u>		<u>Market Value</u>		<u>No. Indians</u>
<u>Crop</u>	<u>Acres</u>	<u>Per Acre</u>	<u>Total</u>	<u>Per Acre</u>	<u>Total</u>	<u>Farming</u>
All	102			\$19.60	\$2000	24

Not including Reservoir Canyon.

SECTION 2 - PRESENT DEVELOPMENT & USE

Irrigation -

It is probable that the Hopis did some farming under irrigation from very early times, although there is no record. Certainly they have been long accustomed to doing flood-water farming on the fans and in the valleys.

In 1903 certain lands near the mouth of Reservoir Canyon near Tuba City, about 13 miles west of the Hopi Reservation, were purchased from Mormon settlers who had constructed three dams in the canyon to store the small but permanent flows from springs. The lands have been farmed by Hopis ever since. In 1908 two of the dams were raised, capacity 350 ac.ft. Drifting sand threatened to choke the channel, and a stone culvert was built and later extended with corrugated pipe. A new feeder canal was built in 1937. About 300 acres are irrigable.

The Hardrocks Project, about 12 miles northeast of Oraibi, was constructed by the Navajo Service on Oraibi wash with P.W.A. funds in 1933-5, under the name of Lower Oraibi Wash. The project works consist of a masonry diversion dam, 104' long by 4-1/2' high, and headworks, on sandstone, silt trap, main canal and flume. About 300 acres are irrigable. Seventy acres were rough leveled and fenced in 1936. No use was made of it, and in 1942 it was turned over to the Hopis. The project is dependent on flood flows, which are fairly reliable.

The Jeddito Project, 50 miles north of Winslow, was constructed by the Navajo Service on Jeddito wash in 1939 for Navajos--left side, and Hopis--right side. The diversion dam is of concrete 95' long, 7-1/2' high, on shale, with radial sluice gate and turnout gate at each end. The Hopi main canal is one-half mile long, with two main branches 5/8 mile each. The land has been subjugated, bordered, fenced and divided into 28 lots. A 3/4 mile flood protection dike was built in 1941. There are 57 acres irrigable. The project is dependent on floods, as the minimum flow is only about 0.5 sec. ft. from springs.

Phillips Farms is 2 1/4 miles southwest of Polacca on Polacca wash, which is 60' deep. It was built in 1940. It consists of a masonry check dam and spillway 145' long by 4' high, with three 4' x 16' radial gates. A 900 g.p.m. gasoline engine-driven pump lifts the water 58' through 220' of 8" steel pipe to a concrete discharge basin on the left bank. The low flow is about 138 gpm. when it takes 72 hours to fill the sump and 12 hours to empty it. The irrigable area is 50 acres. The main canal is 2200' long, with two laterals, each 1100' long. Forty-three acres were subjugated in 1939 and 1941..

Hoteville Gardens is an old Indian project of three acres under a spring which flows about 10 g.p.m. There is no storage. With storage, the area could be increased to six acres.

Talchogan Gardens is an old Indian project of three acres under a spring which flows about 15 g.p.m. There is no storage. With storage, the area could be increased to six acres.

Wepo Gardens is an old Indian project of four acres under a spring which flows about 20 g.p.m. There are two small masonry reservoirs with a capacity of 15,000 gals. With additional storage, the area could be increased to eight acres.

Some work was done on Polacca Wepo wash, but the project has been abandoned. Investigations and tentative plans were made for a diversion dam for this project but it is not considered feasible.

Some work has also been done on Miscellaneous Gardens.

Work done under P.W.A. at Chimopovy, Keams Canyon, Oraibi and Torava Schools, for water, sewer and power, amounting to \$52,406.36, is carried under Irrigation Costs.

SUMMARY OF PRESENT IRRIGATION DEVELOPMENT

<u>Unit</u>	<u>Area Irrigable</u>	<u>Area Under Const. Works</u>	<u>Area Irrigated</u>	<u>Indian Farmed</u>	<u>Leased</u>
Reservoir Canyon	300	300	274	274	0
Hardrocks	300	250	0	0	0
Jeddito	57	57	57	57	0
Phillips Farms	50	43	43	43	0
Hotevilla Gardens	6	3	3	3	0
Talehogan "	6	3	3	3	0
Wepo "	8	4	4	4	0
Polacca-Wepo	0	0	0	0	0
Miscellaneous Gdns.)					
Total	727	660	384	384	0

<u>Unit</u>	<u>Av. Return per Acre Indian</u>	<u>Leased</u>	<u>Total Const. Cost</u>	<u>Est. Cost to Complete</u>	<u>Av. O. & M. Cost per Acre</u>
Reservoir Canyon		0	\$ 2,788.30 (3)	0	
Hardrocks		0	16,019.56 (3)	\$11,850	
Jeddito		0	9,915.90		
Phillips Farms		0	15,998.66	300	
Hotevilla Gardens		0	0	3,500	
Talehogan "		0	0	3,000	
Wepo "		0	0	3,500	
Polacca-Wepo "		0	960.39		
Miscellaneous Gardens			2,213.09		
Trans. from Navajo Service		-	6,323.29 (4)	-	-
Total Irrigation			\$54,219.18	\$22,150	
Chimopovy School			\$ 1,715.22		
Keams Canyon "			34,131.15		
Oraibi "			13,962.64		
Toreva "			2,138.52		
Total Schools			\$51,947.53		
Grand Total			106,166.71		
Less Reservoir Canyon			\$ 2,788.30		
Hardrocks			16,019.56		
Total as shown on 1943 Cost Report			\$87,358.85		

- (3) Carried on Navajo Service Cost sheet.
- (4) Project not shown, possibly Hardrocks or Jeddito.

SECTION 4 - SERVICES PROVIDED BY GOVERNMENT

Irrigation -

The present irrigation systems, for the most part, have been built by the Government and are being maintained and partly operated by the Government. An irrigation supervisor is employed to assist the Indians in making repairs and improvements and in operating the systems. An appropriation of \$1500 is made for this purpose.

PART TWO - OVERALL PLAN

SECTION 1 - GENERAL

General -

The Hopi Indians are poor in natural resources. Agriculture is limited to a little more than 700 acres of irrigable land and approximately 6430 acres of semi-dry farm land on the sandy fans of the principal washes. Their range land is limited to 621,064 acres in Hopi Land Management District No. 6, which has a carrying capacity of 23,627 sheep units, presently stocked with about 16,000 sheep and 3500 horses, cattle and burros, equivalent to 32,000 sheep units. Some income is derived from their baskets, pottery and jewelry and some from local and outside labor.

SECTION 2 - DEVELOPMENT BY FEATURES

Irrigation -

Most of the feasible irrigation projects have been completed or partly developed. Completion of construction and subjugation on existing units is about all that can be accomplished to improve the agricultural situation.

The proposed work is summarized as follows:

<u>Unit</u>	<u>Description of Work</u>	<u>Est. Cost</u>
Hardrocks	Extension of canals and laterals to increase the area from 250 to 300 acres and subjugation of 300 acres, 70 acres of which have been rough-leveled	\$11,850
Hotevilla Gardens	100,000-gal. masonry storage reservoir and 2" pipe distribution system to increase the area from 3 to 6 acres, and subjugation	3,500
Phillips Farms	Complete subjugation, 7 acres	300
Talehogan Gardens	100,000-gal. masonry storage reservoir and 2" pipe distribution system to increase the area from 3 to 6 acres, and subjugation	3,000
Wepo Gardens	100,000-gal. masonry storage reservoir and 2" pipe distribution system to increase the area from 4 to 8 acres	3,500
Total		<u>\$22,150</u>

SECTION 4 - ESTIMATED COSTS BY YEARS & FEATURES

<u>Feature</u>	<u>Total</u>	<u>1945</u>	<u>1946</u>	<u>1947</u>	<u>1948</u>	<u>1949</u>	<u>1950</u>
Hardrocks	\$11,850	5,000	6,850				
Hotevilla Gardens	3,500			3,500			
Phillips Farms	300	300					
Talehogan Gardens	3,000				3,000		
Wepo Gardens	3,500					3,500	
Total	\$22,150	5,300	6,850	3,500	3,000	3,500	