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14. ABSTRACT
The purpose of this report is to summarize briefly the history of the Surface Water Research project since its inception in 1952, the work accomplished, and the problems encountered. In general, each topic is discussed under two periods of time: 1952-1963, when projects were confined to the Helmand River Valley and was entitled "Helmand Surface Water Investigations (306-12-021, 306-M-12-AD and 306-AC-12-AD5)," and 1963-1969 when activities were expanded to cover most of Afghanistan and title was changed to "Surface Water Research (306-11-190-002)".

Prepared by the United States Geological Survey in cooperation with the Water and Soil Survey Department, Ministry of Agriculture and Irrigation, Royal Government of Afghanistan under the auspices of the United States Agency for International Development.

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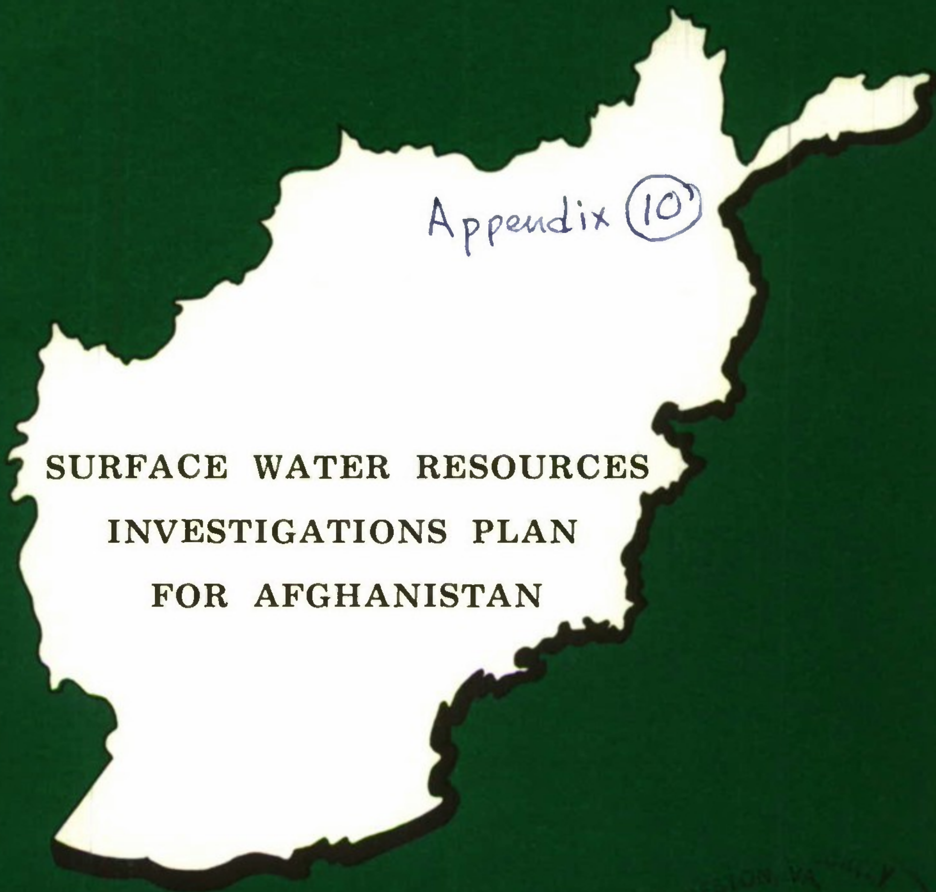

Appendix (10)

SURFACE WATER RESOURCES INVESTIGATIONS PLAN FOR AFGHANISTAN

Prepared cooperatively by
the United States Geological Survey and the Water and Soil Survey Department,
Ministry of Agriculture and Irrigation, Royal Government of Afghanistan
under the auspices of the
United States Agency for International Development

Surface Water Resources
Investigations Plan
for Afghanistan

by

A. O. Westfall and V. J. Latkovich

Water Resources Division

U.S. Geological Survey

Administrative Report

Kabul, Afghanistan

June 1966

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Abstract

Surface-water resources investigations in Afghanistan have been carried on since 1946 with the guidance of American engineers. Until 1963, these investigations were confined to streams of the Helmand River Basin. In 1964, however, the U.S. Agency for International development was requested to assist in the organization of a Water and Soil Survey Authority in the Government of Afghanistan, and to develop a plan for a nationwide network of stream-gaging stations that would supply the hydrologic data necessary for increasing agricultural production through irrigation.

This report evaluates the present surface-water data collection program and makes recommendations for the improvement of the central organization, for a gaging-station network to supply needed information, and for procedures and standards under which the organization could operate effectively.

Introduction

History.--Surface-water resources investigations in Afghanistan have been conducted by American engineers since 1946 when feasibility studies were undertaken by Morrison Knudsen Company and its affiliates in the Helmand Valley development. In 1952, Mr. L. J. Snell of the U.S. Geological Survey (USGS) arrived to set up a stream-gaging program under the auspices of a predecessor of the U.S. Agency for International Development (USAID) and in June 1954, Mr. I. A. Heckmiller arrived to assist Mr. Snell. Since that time work has continued under agreements between the USAID, with Mr. R. H. Brigham replacing Mr. Heckmiller in 1959, and Mr. V. J. Latkovich replacing Mr. Brigham in 1964. From 1952 until 1963, the project was titled, "Helmand Surface-Water Investigations", and activities were confined to the streams of the Helmand Basin.

In March 1963, the Royal Government of Afghanistan (RGA) organized an independent agency, the Water and Soil Survey Authority (WSSA), for the collection, interpretation, and publication of data on the water and soils of Afghanistan, and requested assistance of USAID in developing the Surface Water Hydrology Section of WSSA while at the same time continuing the advisory services provided by the former Helmand Surface Water Investigations. The project renamed "Surface Water Research" was made a part of the National Agricultural Development Project of USAID with headquarters in Kabul. With the expanded project, the senior author of this report, arrived in March 1964 to assume leadership. The project has functioned since that time under two full-time advisors. Early in 1966, the WSSA ceased to function as an independent authority and was taken into the Ministry of Agriculture as the Water and Soil Survey Department (WSSD) under the Natural Resources Division.

Another hydrologic mission, the "Deutsche Wasserwirtschafts Gruppe", West German Hydrological Mission (WGHM) of the Federal Republic of Germany, began water resources investigations in 1958, concentrating most of its activities on the surface-water resources of the Kabul River drainage basin. For a short time, the group also worked in the Kunduz River basin but later withdrew to concentrate on work in the Kabul River basin. In the last 2 years, the WGHM has expanded to the Paktia area where some work has been done on the Matun River.

Surface-water investigations have also been carred on by technical aid missions of other countries, notably the Union of Soviet Socialist Republics (USSR) and to some extent, by international organizations of the United Nations (UN) and the International Bank for Reconstruction and Development (IBRD). Most of this work has been directed toward obtaining data for specific projects.

Purpose and Authority.--The purpose of this report is twofold: first to evaluate the present gaging station network and to outline the scope of an expanded nationwide stream-gaging network; and second, to recommend procedures, standards, personnel, equipment, and publications needed for operation of the expanded network and dissemination of information to the user.

The Program Agreement (ProAg) between RGA and USAID states that the objective of the project is to advise the RGA, through the Ministry of Agriculture (MinAG), on procedures and practices in surface-water investigations that will permit the most rational use of the water resources of the country, and further, the ProAg requires the development of a water-resources investigation plan to coordinate the collection of data from drainage basins in all parts of the country.

Acknowledgments--We gratefully acknowledge the cooperation by members of the Afghan Water and Soil Survey Department (WSSD), His Excellency Mir Mohammad Akbar Reza, formerly President of the WSSA and now Minister of Agriculture and Irrigation; Mr. Ghulam Sham, Director General of Surface-Water Hydrology (WSSD); Mr. Abdul Khaliq of the Kandahar office of WSSD; other members of the department who have assisted in all phases of the project; the members of the WGHM with whom we have worked amicably in our mutual desire to help Afghanistan in the solution of its water problems; and the members of the UN Special Fund Groundwater Investigation Project who have been most helpful in sharing technical knowledge in the "gray" areas between surface-water and ground-water hydrology.

Afghanistan [1/]

General Description

Afghanistan (fig. 1) landlocked in central Asia lies within approximately 30 to 37 degrees north latitude and 61 to 72 degrees east longitude. It has an area of about 635,000 square kilometers, and extends about 1,300 kilometers from southwest to northeast, and about 600 kilometers from northwest to southeast. Afghanistan shares a 2,320 kilometer frontier with USSR on the north, is bordered by Iran on the west and Pakistan on the south. In the "panhandle" of the northeast, Afghanistan touches Communist China's Sinkiang Province.

The majestic Hindu Kush, a spur of the even loftier Himalaya, are the dominant topographical feature of the country. These mountains, which rise in places to more than 6,000 meters, divide the rich plains of the north from the central plateau and southern deserts. Much of the country is mountainous, with the central plateau having an average altitude of 1,800 meters.

Principal cities include the capital, Kabul, and the provincial cities of Herat, Kandahar, Mazar-i-Sharif, Jalalabad, Shibarghan, Maimana, and Kunduz. Although no nationwide census has ever been taken, the most reliable estimates place the population between 10 and 13 million. A 1965 census of Kabul placed the population of that city at 449,000.

1/ Some of the material in this section is taken from "Afghanistan, a Glimpse", prepared by the United States Information Service, Kabul, Afghanistan.

Climate

Temperature.--The climate of Afghanistan is continental, arid to semi-arid although a small area near Jalalabad affected by the monsoons of southern Asia is sometimes described as subtropical. The high central plateau has been compared to the Rocky Mountain area near Denver, Colorado in USA although less precipitation is recorded. At an average elevation 1,800 meters on this plateau the days are quite warm but the nights are cool, even in summer. Winters can be quite severe with subzero temperatures and much snowfall, but the average winter is relatively mild with only short periods of extreme cold and three or four significant snowfalls. The regions of lower altitude are steppes, or even true desert, with mild winters and hot summers. They are sparsely populated except for scattered cultivated areas where water is available for irrigation.

Throughout most of Afghanistan, the daily range in temperature is quite wide, both in summer and winter. In the desert areas temperatures sometimes reach 49°C during the day but may cool to 15°C at night. Temperatures during winter in the northern deserts occasionally drop to -24°C at night but a rise to 10°C under the clear skies and warm sun of the daylight hours. The mean temperatures at selected stations are given in table 1. Extremes of temperature and precipitation are shown in table 2.

Precipitation.--Precipitation usually occurs in the period extending from the middle of November through May, although in some areas convectional storms may cause precipitation during the summer months. In areas of scant rainfall, it is not unusual for all of the monthly precipitation to occur in a single storm.

Table 1.--Monthly Mean Temperature, in Degrees Celsius (Centigrade), at Selected Stations

Station and Altitude (meters)	Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Kabul	1960	2.1	4.1	5.4	9.7	17.0	22.4	25.7	24.7	19.5	12.2	4.7	-
1,763	1961	-0.6	-1.0	6.2	11.1	19.0	23.3	25.7	24.7	21.8	12.3	4.1	0.0
	1962	-1.1	2.7	7.8	12.3	17.5	22.0	25.3	23.9	18.4	12.2	4.8	-1.8
	1963	-1.2	5.9	7.4	12.4	16.1	24.5	25.1	24.1	19.5	14.3	5.6	0.9
	1964	-11.2	-4.0	5.9	11.6	16.8	22.2	24.5	24.3	19.1	11.2	4.0	-1.2
	Ave	-2.4	1.5	6.6	11.4	17.3	22.8	25.2	24.3	19.6	12.4	4.6	-
Herat	1960	2.9	7.7	6.5	13.2	19.7	27.1	28.9	27.9	22.4	20.7	7.7	-
975	1961	3.3	3.4	10.8	14.1	23.3	26.7	30.3	27.5	23.8	14.8	8.7	6.7
	1962	2.9	8.7	12.1	15.8	22.0	25.6	30.1	26.4	20.3	14.7	6.5	5.0
	1963	6.4	9.5	10.7	18.2	20.8	27.7	29.2	27.1	22.7	17.5	8.9	2.3
	1964	-6.7	4.9	12.8	15.4	21.6	26.7	29.5	28.1	22.1	11.5	7.9	-0.3
	Ave	1.8	6.8	10.6	15.3	21.5	26.8	29.6	27.4	22.2	15.8	7.9	-
Mazar-i-Sharif	1960	3.9	8.3	6.6	14.4	20.7	28.4	30.3	28.7	21.1	17.4	7.5	-
325	1961	3.1	3.7	11.5	15.9	25.3	28.2	31.8	28.5	23.4	13.9	8.3	5.7
	1962	2.6	7.7	13.2	17.1	24.1	28.7	34.0	30.5	22.9	15.6	6.6	3.6
	1963	4.3	9.6	11.1	20.1	23.5	30.8	32.5	29.8	24.3	18.9	9.2	3.0
	1964	-3.7	6.1	12.2	16.1	23.9	30.1	32.6	30.6	24.8	13.8	9.1	0.1
	Ave	2.0	7.1	10.9	16.7	23.5	29.2	26.2	29.6	23.3	15.9	8.1	-
Maimana	1960	4.2	8.4	4.4	12.1	17.1	24.8	26.0	24.9	17.9	16.8	7.0	-
900	1961	3.1	1.9	8.9	13.1	21.3	24.1	27.0	24.7	19.7	11.3	8.5	6.8
	1962	1.7	7.9	11.1	13.2	18.2	22.9	27.2	23.7	18.1	12.6	5.4	4.3
	1963	7.1	8.9	8.7	16.4	19.6	26.5	28.0	24.6	19.8	15.1	8.6	2.7
	1964	-3.3	4.7	10.6	13.2	18.7	24.2	27.1	25.2	19.7	10.1	9.1	-0.5
	Ave	3.1	6.3	8.7	13.6	18.9	24.5	27.0	24.6	19.0	13.2	7.7	-
Kandahar	1960	5.6	11.4	11.8	17.4	23.7	30.6	31.2	28.8	-	15.6	9.8	-
1,007	1961	4.5	6.1	14.5	17.0	26.5	31.1	31.8	29.0	25.2	15.2	10.9	6.5
	1962	4.2	10.6	14.1	20.3	25.5	27.5	31.4	28.4	21.1	16.2	7.3	4.6
	1963	5.9	11.6	14.3	20.4	24.7	30.9	31.1	29.4	25.9	21.7	14.5	8.8
	1964	1.4	8.5	17.1	20.1	24.8	28.4	31.3	30.0	23.8	14.1	9.5	3.7
	Ave	4.3	9.8	12.3	19.0	25.0	29.7	31.3	29.1	-	16.5	10.4	-
Jalalabad	1960	-	14.6	14.4	18.6	27.2	-	33.4	33.8	26.5	-	-	-
550	1961	7.7	-	-	19.1	28.8	33.6	34.4	-	30.9	21.4	12.0	8.4
	1962	7.1	11.9	16.5	21.5	27.8	32.2	33.4	31.6	26.8	21.5	13.9	7.9
	1963	7.5	13.8	15.4	20.7	24.6	34.6	34.4	32.5	28.8	22.2	14.7	9.1
	1964	5.6	10.0	17.4	21.4	28.1	32.4	32.5	32.9	28.2	20.9	12.3	8.6
	Ave	-	-	-	20.2	27.3	-	33.6	-	28.2	-	-	-
Farah	1960	-	-	-	18.4	24.8	32.1	-	31.7	26.5	19.4	11.3	-
750	1961	6.7	7.6	15.8	18.3	27.6	31.3	34.9	31.4	27.3	18.0	11.9	9.7
	1962	6.8	12.8	17.0	23.2	26.2	30.0	34.2	30.2	23.6	18.9	9.8	9.9
	1963	7.9	12.8	15.3	21.9	23.8	32.2	34.2	31.6	26.9	21.6	13.1	8.2
	1964	2.4	9.4	16.1	20.3	26.5	31.3	33.2	31.1	24.0	14.8	11.6	3.5
	Ave	-	-	-	20.4	25.8	31.4	-	31.2	25.6	18.5	11.5	-

Table 2.--Instantaneous Maximum and Minimum Temperatures, and Maximum Precipitation for 24 hours, for Selected Stations during 1960-64.

Station	Instantaneous temperature in Degrees Celsius (centigrade)		Maximum 24-hour Precipitation (millimeters)
	Maximum	Minimum	
Kabul	36.9 in 1961	-25.5 in 1964	35.2 in 1960
Herat	44.4 in 1960	-26.7 in 1964	35.2 in 1960
Mazar-i-Sharif	45.2 in 1964	-16.0 in 1964	36.0 in 1961
Maimana	42.5 in 1960	-18.1 in 1964	69.9 in 1960
Kandahar	43.9 in 1964	-12.3 in 1964	46.3 in 1962
Jalalabad	48.4 in 1964	- 4.4 in 1962 1/	67.2 in 1963
Farah	47.0 in 1964	-11.9 in 1962	35.9 in 1961

1/ A period in 1960-62 only

During the winter, relatively large amounts of precipitation fall as snow in the Hindu Kush and across the central plateau. This water is released from storage as snowmelt runoff in the spring and summer months. Snowmelt runoff is more important to the farmer than rainfall runoff for irrigating crops and for determining cropping practices. Average precipitation at selected stations is given in table 3.

Table 3.--Monthly and Annual Precipitation, in Millimeters, at Selected Stations

Station and Altitude (meters)	Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Kabul 1,763	1960	11.2	32.3	54.4	176.9	12.0	0.2	T	0	T	T	40.1	-	-
	1961	22.7	42.4	101.2	127.6	11.6	4.3	1.0	0	0	0	32.1	7.6	350.4
	1962	6.8	45.6	44.3	60.4	6.5	3.7	T	T	T	5.2	T	24.3	196.8
	1963	T	45.3	55.4	108.0	104.8	T	0	6.4	0.6	0.8	37.6	5.3	364.2
	1964	67.5	106.9	74.1	118.3	13.6	T	6.3	0	T	0	16.2	15.2	418.1
	Ave	21.6	54.5	65.9	118.2	29.7	1.64	1.46	1.28	0.12	1.2	25.2	-	-
Herat 975	1960	16.0	64.6	59.1	66.1	6.8	0	0	0	0	0	0.4	-	-
	1961	20.9	3.2	88.4	75.7	4.4	0	0	0	0	0	39.4	51.7	283.7
	1962	9.9	20.7	39.9	32.7	5.0	0	0	0	0	T	7.2	15.8	131.2
	1963	6.0	14.1	20.7	40.5	91.2	0	0	0	T	T	13.7	30.1	216.3
	1964	23.3	95.7	62.5	37.5	0.4	0	0	0	0	0	14.4	3.2	237.0
	Ave	15.2	39.7	54.1	50.5	21.6	0	0	0	0	0	15.0	-	-
Mazar-i-Sharif 325	1960	22.2	16.7	48.5	88.3	24.7	0	0	0	0.2	T	26.9	-	-
	1961	41.6	11.4	54.8	35.3	2.6	0	0	T	0	0	28.5	23.2	197.4
	1962	16.3	47.3	21.5	45.6	5.7	0	0	0	0	9.4	22.9	40.5	209.2
	1963	6.0	22.3	46.0	67.5	33.4	1.7	T	0	T	T	18.9	26.8	222.6
	1964	26.0	45.6	39.0	33.2	15.9	0	T	0	0	0	16.6	2.5	178.8
	Ave	22.4	28.7	42.0	54.0	16.5	0.3	0	0	T	1.9	22.8	-	-
Maimana 900	1960	39.5	22.4	82.1	130.1	105.6	0	0	0	0	4.8	42.3	-	-
	1961	68.0	59.4	124.8	92.0	14.7	0	0	0	0	0	65.0	46.9	470.8
	1962	32.5	72.2	57.8	-	46.2	24.0	0	T	0.8	35.0	22.5	31.4	-
	1963	10.6	32.0	77.3	94.8	140.7	0	0	0	T	1.1	29.9	39.1	425.5
	1964	28.7	70.0	132.0	74.8	14.9	0	0.8	0	0	0	23.3	250.0	594.5
	Ave	35.8	51.2	94.8	-	64.6	4.8	0.2	0	0.2	8.2	44.6	-	-
Kandahar 1,007	1960	6.0	3.6	40.5	56.6	0.3	0	0	0	-	0	0	-	-
	1961	6.1	10.6	44.8	111.0	10.7	T	0	0	0	0	30.4	43.5	257.1
	1962	1.0	5.4	119.6	10.2	T	0	0	0	0	T	0	69.7	205.9
	1963	3.1	5.4	90.1	59.0	68.7	0	0	0	0	0	8.1	6.1	240.5
	1964	50.8	34.7	43.4	0	0	0	0	0	0	0	0.1	19.4	148.4
	Ave	13.4	11.9	67.7	47.4	15.9	0	0	0	0	0	7.7	-	-
Jalalabad 550	1960		4.7	-	46.9	8.2	-	0	0	-	-	-	-	-
	1961	26.4	-	-	44.0	-	-	-	-	0	5.0	14.8	2.1	-
	1962	20.5	17.6	19.9	19.6	8.2	1.3	29.2	8.5	T	8.6	17.6	16.4	167.4
	1963	0	3.3	65.5	32.0	121.0	0.2	0	1.0	T	0.8	5.1	48.0	276.9
	1964	21.4	19.2	6.1	37.2	0.6	T	T	2.0	0	0	8.0	29.4	123.9
	Ave	-	-	-	35.9	-	-	-	-	-	-	-	-	-
Farah 750	1960	-	-	-	33.8	2.4	0	0	0	0	0	0.5	-	-
	1961	5.0	5.9	27.7	13.6	9.5	0	0	0	0	0	T	38.9	91.1
	1962	0	6.2	14.1	1.1	T	0	0	0	0	0	0	4.0	25.4
	1963	1.8	14.5	29.7	23.0	25.4	T	0	0	0	0	6.1	1.4	101.9
	1964	12.7	44.7	29.8	7.2	0	0	0	0.5	0	0	0	0	95.1
	Ave	-	-	-	15.7	7.5	0	0	0.1	0	0	1.3	-	-

River Systems

There are about 10 river systems or major subsystems (fig. 1) in Afghanistan of which the Oxus (or Amu Darya), Helmand, Kabul, and Hari Rivers are the most important. Large irrigation and hydropower developments are now under construction or are planned for these basins. It is quite difficult to classify some of the rivers of Afghanistan into systems, because under normal conditions many of them disappear into desert wastes or swampy areas. Of the rivers rising on the northern slope of the Hindu Kush, the Shirin Tagao, Sarepul, Balkh, and Tashkurgan (Kholem) Rivers all disappear in the desert region south of the Oxus River. On the west, the Hari River flows north after leaving Afghanistan and is lost in the desert areas of USSR. The Helmand and Farah Rivers both flow into the Hamun or swampy area of the Sistan Basin on the southeastern border.

Oxus River--The Oxus River rises in the high mountain area of the Wakhan Corridor in the northeast where it is known as the Pamir River. It flows westward forming much of the border with USSR. Many large tributaries enter the Oxus from the north. The major tributaries from Afghanistan are the Kokcha and Kunduz Rivers. Also, during extreme floods, the Shirin Tagao, Serepul, Balkh, and Tashkurgan (Kholem) Rivers at times may contribute to the flow to the Oxus. The Oxus River ultimately empties into the Aral Sea in USSR.

Helmand River--The Helmand River rises on the southern slopes of the Hindu Kush not far from Kabul. It flows in a southwestward direction until it terminates in the Hamun of the Sistan Basin on the Iranian border where it is lost to evaporation. The major tributary to the Helmand River is the Arghandab River that drains a large part of southeastern Afghanistan. The only other major tributary from the east is the Tirin River. Major tributaries from the west are the Musa Qala, Kaj, and Panjao Rivers, and an unnamed tributary that enters the mainstem in the vicinity of Ghizao. Most of the flow originates from snowmelt in the high central plateau, and most of the tributaries (except the Musa Qala River and probably the Kaj River) have a relatively high sustained flow throughout the year.

Kabul River--The Kabul River flows from the vicinity of Kabul eastward into Pakistan where it enters the Indus River. The major tributary from the south is the Logar River. The bulk of the flow in the lower reaches of the Kabul River comes from the Panshir River that enters the Kabul near Sarobi. The Panshir River originates in the high mountains and has a large sustained flow from snowmelt. Another major tributary, the Kunar River, comes from the mountains of Pakistan and enters the Kabul near Jalalabad. The Laghman River is a minor tributary entering from the north between the Panshir and Kunar Rivers.

Hari River--The Hari River rises in the high central plateau and flows westward to the Iranian border where it turns northward to form the border between Iran and Afghanistan. North of Afghanistan it forms the Iranian-USSR border and finally disappears in the desert wastes of Turkmen, USSR. The Kowgon River is the only major tributary to the Hari. This river rises to the south of the Hari River and flows almost parallel to it before joining the Hari near Marwa.

Minor systems--The minor river systems of Afghanistan are the Murghab River in the northwest, of which the Kushka River is a tributary that rises in Afghanistan but joins the Murghab in Turkmen, USSR; the Adraskand and Farah Rivers on the west which flow parallel to each other and enter the Hamun area of the Sistan Basin from the north and opposite to the Helmand River; the Khash River on the south which rises between the Farah and Helmand Rivers and normally disappears into the desert but occasionally reaches the Hamun; and the many tributaries to the Indus River along the eastern border of which the Matun River is probably the most important except for the Kabul River.

Most of the rivers of Afghanistan have two things in common: fairly steep gradients in all but the lower reaches, and transport of large silt loads during heavy runoff from rain and snowmelt.

Transportation and Communication

Roads--At the present time Afghanistan has a paved road that runs from the port city of Qizil Qala on the Oxus River south through Kunduz, over Salang Pass to Kabul, then southwest to Kandahar, northwest to Herat, then north to Torghondi on the USSR border. Some sections of this road have not been completed but are scheduled for completion by the end of the summer of 1966. A paved road runs east from Kabul through Jalalabad to the Pakistan border near Peshawar, and another paved road runs southeast from Kandahar to the Pakistan border near Spin Baldak-Chaman. The rest of Afghanistan is covered by a network of rough gravel or dirt roads that connect all the provincial capitals. Some of these roads appear on maps, others do not. Plans are underway to improve some of these roads.

Waterways--As mentioned previously, the only navigable river is the Oxus on the USSR border, but at present only the USSR is using this river for water transport.

Airways--Domestic air service in Afghanistan is provided by the government-controlled Ariana Airlines. Airports are available at Kabul, Kandahar, Herat, Maimana, Mazar-i-Sharif, Kunduz, and Bost. Almost daily service is maintained between Kabul and Kandahar, but not more than twice weekly service exists to the other airports. An airport exists at Jalalabad but no commerical service is now (1966) offered to that city. A study is underway to determine if all provincial capitals can be connected by air using Short Takeoff and Landing (STOL) type aircraft. Some tourist spots may be included in this network. International service is supplied by many airlines to and from Kabul. Ariana Airlines also offers international service at Kandahar as well as at Kabul.

Communication--Limited domestic telephone service exists in the larger cities, between all provincial capitals, and many intermediate points. International telephone service is also available. US AID maintains a radio service between headquarters in Kabul and the facilities at Kandahar and Bost. Afghan Highway Constructors maintains radio communication between its facilities and to mobile equipment. The Air Authority maintains a large radio communication network for operation of the air lanes.

Need for Water Data

Hydrology

Hydrology is the study of water. The hydrologic cycle is the circulation of water from the sea to the atmosphere, then back to the sea directly, or by falling on land and flowing to the sea over or under the land surface. Surface-water hydrology is the study of that part of the hydrologic cycle pertaining to the movement of water over the land surface. Knowledge of the hydrology of a country is important, if the full potential of the water resources is to be developed. Logical planning and development cannot take place without first studying the quantity of the water and its occurrence in space and time. The following paragraphs will describe the categories of water knowledge that are important to Afghanistan at present, and give a short description of activities in each category.

Hydroelectric Power

The importance of electrical power in the modern economy cannot be overemphasized. While hydropower cannot always be depended on for firm power supply, it does offer an economical means of supplying power needed for industries. If Afghanistan is to develop industrially it must develop its hydropower potential. Because of differences in altitude and sustained flow of rivers from snowmelt, the mountainous areas of the Hindu Kush that form the backbone of Afghanistan have large potential for hydropower development.

The United Nations (United Nations, 1961) reports that as of 1961 only 1.5 percent of the estimated power potential of Afghanistan had been developed. With the completion of hydropower installations now under construction, there will be an additional 4 percent of the total potential hydropower placed in operation. The following table lists the estimated hydropower potential in kilowatts (kw):

Watershed		Estimated Potential
Hari		150,000
Helmand		700,000
Kabul		750,000
Kokcha		300,000
Kunduz		500,000
Miscellaneous		100,000
	Total	2,500,000

There are several major hydropower installations in operation at the present time. The following table 1/ lists the hydropower installations of over 1,000 kw installed capacity:

Map No.	Name	Date of Installation	Area Served	Installed Capacity (kw)
1	Jabulus Seraj	1920	Bagram	1,500
2	Wardak	1941	Kabul	3,360
3	Pul-i-Khumri	1943	Pul-i-Khumri	4,800
4	Sarobi	1957	Kabul	22,000
5	Girishk	1958	Helmand Valley	2,400
6	Khanabad	1960	Khanabad, Kunduz	1,400
7	Pul-i-Khumir II	1962	Pul-i-Khumri, Baghlan	9,900
8	Darunta	1964	Kabul	11,000

Also, there are several small hydropower plants serving special needs. The combined capacity of these plants is about 1,000 kw. Two hydropower plants under construction at present, Mahipur and Nahglu on the Kabul River with a combined installed capacity of 111,500 kw, will serve the Kabul area. Many potential hydropower sites are being considered for future development. Among the more important are a 120,000 kw station at Kajakai Reservoir on the Helmand River; a 13,000 kw station on the Hari River 80 miles east of Herat; a 4,500 kw station on the Kokcha River near Kowajoghan; and possibly six additional stations on the Kunduz River near Baghlan.

1/ Extracted from a report entitled,"Coordinating the Development of Afghanistan's Energy Resources", by Enar Eskilsson, 1965, United Nations.

Irrigation

Currently, about 85 percent of the people in Afghanistan derive their living from agriculture. Because of the scant rainfall during the growing season most irrigated crops are dependent on water in streams released from storage in the snow pack of the Hundu Kush. Irrigation from streams has been practiced for many centuries in a primitive but effective manner, and the remains of ancient irrigation works can be seen in many parts of the country.

The RGA is taking rapid steps forward in the development of irrigation in new areas and in the improvement of existing systems. The following table (United Nations, 1961) shows the major projects that will bring newly developed lands under irrigation:

Project	Province	River Source	Hectares Irrigated
Helmand Valley	Helmand	Helmand	60,000
Nangarhar	Naghahar	Arghandab	31,500
Alchin	Ghazni	Ghazni	15,000
Shibarghan and Andkoi	Fariab and Jozan	Shirin Tagao & Sarepul	20,000
Zardsung	- -	- -	3,000
Gowgan	Herat	Hari	4,000

Many of the present canals do not carry sufficient water for full irrigation of all land served by the canals. The following table (United Nations, 1961) shows the major canals on which improvements are being made or are scheduled to be made in the near future:

Canal	River Source	Hectares Irrigated
Ajmir	Kunduz	12,000
Archi	Kokcha	14,000
Gouhargan	- -	3,000
Charhardarah	Kunduz	32,000
Nagir	- -	12,000
Aliabad	Kunduz	8,000
Sharawan	Oxus	28,000
Badak	Kabul	5,200
Kohestan	Panshir	3,200

It has been estimated (United Nations, 1961) that there are about 50,000 million cubic meters of runoff each year of which about 30,000 million cubic meters could be impounded. There are about 5.5 million hectares of land under irrigation out of a total of 14 million hectares classified as arable. Only about half of the irrigated land is cropped each year because of poor soil conditions caused by farming practices of the past. Furthermore, some canal systems are unable to carry sufficient water during critical periods of low streamflow. The construction of diversion dams or barrages to impound water would prevent damage to canal intakes during floods and maintain water levels above canal intakes.

Flood Control

Although Afghanistan is mostly semi-arid to arid, some areas are flooded from intense rains almost every year. Most damage up to the present has been confined to the flooding of low-lying agricultural lands and villages. As the population grows, however, with increasing intensity of settlement more and more damage to industry, irrigation works and urban areas is likely to follow unless control measures are developed.

A flood can be defined as any river discharge in excess of the normal channel capacity. In Afghanistan, minor spring floods that inundate crop lands are accepted as a way of life, and in many places are considered beneficial because of the moisture and rich river silt that is added to the land. Occasionally, however, there are major floods that cause great damage. In the spring of 1965, the lower Helmand River Valley was seriously flooded because above-normal rainfall caused loss of control at Kajakai Reservoir, and many villages suffered great losses of crops, livestock and homes. Gaging station records show that 1939, 1949, 1956, and 1957 were years of major floods in the Helmand River Basin. A British river survey (1903-05) indicates that 1885 and 1903 were years of major floods also. None of the major existing reservoirs have been designed with provision for flood storage. On the Arghandab River, the annual runoff is often not much greater than the storage capacity of Arghandab Reservoir, and therefore when the reservoir is filled in the spring, little capacity is left to store heavy runoff late in the season. At Kajakai Reservoir, moreover, the average yearly discharge is several times greater than the storage capacity of the reservoir. Through proper operation, downstream flooding could be prevented during most years, especially if gates were installed on the spillway. Gaging station records from which a study of flood magnitudes and frequencies could be made are not available for most of the country. On the Helmand River where the longest periods of record are, records are not long enough nor is station density great enough to define flood frequencies.

Water Supply

The municipal water supplies for most towns and villages come from open ditches (jueys) and shallow wells. The city of Kabul has the only municipal water-supply system and this comes from deep wells. Only part of Kabul is served by this system, and the remainder of the city depends on shallow wells, both public and private, and on jueys that divert water from the Kabul River. In some parts of Aghanistan where topographic and geologic features are favorable, water is obtained from the "kharez" or infiltration gallery. This water is usually of good quality and uncontaminated. The amount of water available per kharez is limited in quantity and usually is considerably less than 1 cubic foot per second. Most shallow wells cannot be considered safe, because of contamination from septic tanks or from raw wastes on the land surface. Many surface-water supplies are contaminated from these same sources. Aside from chemical treatment, the best sources of uncontaminated water are from the high mountain streams for cities close to those areas, and from deep wells for those in the lowlands.

Adequate gaging-station records are needed for the development of municipal supplies from rivers, not only for service to the people of municipalities, but also for supporting industries. Muncipal supplies are also used for abatement of pollution, for sanitary systems, and for municipal services such as fire-fighting, beautification and recreation.

International Rivers

Almost all major rivers that rise in Afghanistan flow across a border into an adjacent country. One river, the Kunar, rises in Pakistan and flows into Afghanistan where it joins the Kabul River. The Oxus River, where it forms the border with the USSR, has inflow from both the USSR and Afghanistan. With this complex of flow between countries, water records are needed as a basis for international water agreements. At present (1966), both Afghanistan and Pakistan are building large irrigation projects on the Kabul River. Afghanistan and the USSR are developing irrigation projects that will develop water from the Oxus River or its tributaries. Without data to establish the historic flow of these rivers and to measure water use in projects, future equitable allocation may be difficult or impossible.

Water Law

According to Hirsch (1959) Afghanistan legal matters pertaining to water utilization are handled on the local level, informally by customary law and, in most of the country, formally according to the Hanefite school of Sunni Islam. Mr. Hirsch, a student of water law, was one of the USAID Mission Program Officers at the time of this writing. Neither Mr. Hirsch nor the authors have knowledge of any change since Hirsch's findings of 1959, although there has been an effort undertaken by the RGA, through the UN Economic Commission for Asia and the Far East (ECAFE), to establish a modern water code and water law.

Regardless of whether water is apportioned under tribal law or by modern laws and regulations, the governing agencies cannot make just and equitable distribution without basic data. Such data become increasingly important as water use passes from the relatively simple village irrigation and livestock watering use of the past to the allocation of water for large developments in power, irrigation, and industry.

Investigations of Surface-Water Supplies

Surface-water investigations in Afghanistan at present (1966) are chiefly directed to collecting data for specific projects. Until 1963, the activities of USAID advisors were aimed at gathering hydrologic data for the Helmand River basin, and after that time, the work was extended to include the Hari and Adraskand River basins where land, water and hydropower feasibility studies were begun under UN sponsorship in 1960.

The WGHM began studies of the Kabul River in 1958 for hydropower and irrigation development. By 1962 they had extended their activities to the Matun River basin in the east, and for a short while, to the Kunduz River in the north. Both of these rivers have irrigation projects planned or under construction.

The WSSD established several stations on the Oxus River and its tributaries under the technical guidance of USSR technicians. A part of this work hydropower and irrigation studies are being made in the Amu-Pandj area of the Oxus River and irrigation studies are being made on all the Oxus River tributaries, with the exception of the Kokcha River.

All the data collected by the WSSD under the guidance of USAID and WGHM technical assistance have been analyzed and tabulated through the 1964 water year. A compilation of data for the Helmand River basin through water year 1960 has been published (Brigham, 1964) by the U.S. Geological Survey. Hydrologic year books have been prepared by the WGHM team for each year from 1960 to 1963. Data collected on the Hari, Adraskand, and Farah Rivers by UN Technicians have been published in a report by the UN and some of the data have been recomputed by the WSSD to USGS standards. Data collected by other technical aid missions has not been made available to the WSSD at the present time.

With but few exceptions, all gaging stations that have been established by the WSSD under the guidance of the various technical aid missions are still in operation (see table 3).

Evaluation of Surface Water Data Collection Program

Organization

Central Agency--Prior to early 1963, the collection of surface-water data was divided among various Ministries concerned with water projects. In March 1963, the WSSA was organized to assume responsibility for water and soil resources under the leadership of President Mir Mohammad Akbar Reza (who was also Deputy Minister of Agriculture) until March 1966. At that time, the WSSA was made a department (WSSD) of the reorganized Ministry of Agriculture and Irrigation. Mr. Reza was appointed Minister of Agriculture late in 1965. The WSSD is presently (1966) headed by Vice-President Juma Mohammad Mohammadi. The Surface Water Hydrology Section of the department is headed by Director General Ghulam Sham, now (1966) on military leave.

The Surface Water Hydrology Section has its headquarters in Kabul with field offices in Kandahar and Kunduz. The Kabul office is divided into two groups, one group receiving technical assistance from US AID and the other group receiving technical assistance from WGHM. The Kandahar field office receives technical assistance from US AID. The Kunduz field office is considered by the Military to be a direct branch of the Kabul office and is operating in a region of the country where the prime technical assistance comes from the USSR.

Hydrologic Teams--A description of the hydrologic teams working in Afghanistan has been given the section on "History". As concerns the collection of basic water data, the teams operate primarily in the manner in which they were trained by their parent organization. In the case of the US AID technicians, the work is performed much along the lines of U.S. Geological Survey methods. In the case of WGHM technicians, the work is performed to standards of the Federal Republic of Germany. This has not created major problems between the teams, because both are composed of individuals who understand basic hydrologic principles, but it has led to non-standarization in teaching and training of Afghan counterparts.

In 1964, a committee composed of representatives from each technical mission and the WSSA was formed to meet regularly and set policy on standards and methods to be used in Afghanistan. The committee recognized that the basic methods of all teams had merit and agreed that Afghanistan should adopt the best elements from each method. It was also decided to adopt the metric system for all expressions of measurement, and the English language for the preparation of reports.

Present Gaging Station Network

The present (1966) gaging-station network consists of the following number of stations grouped according to the office and technical assistance group under which they are operated:

Kabul (US AID)		13
Kabul (WGHM)		18
Kandahar (US AID)		14
Kunduz		20
	Total	65

Existing gaging stations are shown on the map (fig. 1) and are described in more detail in table 4. In addition, there are several canal and reservoir stations, some of which are operated by the WSSD and some by the operation and maintenance departments of the irrigation projects.

Because all the gaging stations now extant were installed to obtain information related to specific projects, no attempt has yet been made to establish a system of primary and secondary gaging stations that would give an overall picture of the general hydrology of Afghanistan, and that could be used for future planning of projects not yet foreseen. Because of the small number of gaging stations in operation and their specialized nature, the present network is not capable of supplying the data needed for future development.

Table 4.--Existing Stream-Gaging Stations

Number on Figure 1	Location of Gaging Station	Location lat. E. ° '	long. N. ° '	Drainage Area (square kilometers)	Altitude (meters above mean sea level)	Records Available	Present Installation Type of Gage 1	Measuring Structure 2	Sediment Data	Proposed Installation Type of Gage	Measuring Structure	Sediment Data	Station Classification 3
1200.90	Kokcha River at Kokcha	37 08	69 25				R	C	-	R	C	-	E MP
1300.20	Kunduz River near Doab	35 15	67 59				RP	B	-	R	C	-	E AP
1300.40	Kunduz River near Doshi	35 35	68 35				RP	B	-	R	C	-	E AP
1300.80	Kunduz River near Chardarra	36 43	68 48				R	BT	-	R	C	-	E AP
1320.80	Jaozari River near Doab	35 17	67 56				RP	B	-	R	C	-	E AP
1350.90	Anderab River at Doshi	35 37	68 48				R	B	-	R	C	-	E AP
1390.40	Khanabad River at Farkhar	36 35	69 45				S	-	-	R	C	-	E AS
1390.70	Khanabad River near Chogha	36 43	69 10	Data unavailable	Data unavailable	Data unavailable	R	B	-	R	C	-	E AP
1390.90	Khanabad River at Alchine Bridge	36 50	68 45				R	B	-	R	C	-	E AP
1397.90	Bangi River near Sakow	36 42	69 12				R	B	-	R	C	-	E AS
1400.70	Kholem River near Siad	36 34	67 47				S	C	-	R	C	-	E AP
1500.70	Balkh River at Chasmashafa	36 20	66 55				S	-	-	R	C	-	E AP
1600.50	Sarepul River near Sarepul	36 15	65 55				S	C	-	R	C	Yes	E AP
1700.70	Shirin Tagao River near Daulatabad	36 35	64 50				S	C	-	R	C	-	E AP
3000.20	Hari River at Chekcheran	34 32	65 16	5,960	2,430	1961-66	R	C	-				E AP
3000.50	Hari River at Tagaw Gaza	34 21	63 38	11,510	1,220	1961-66	R	C	Yes				E MP
3000.80	Hari River at Puli Pushtun	34 17	62 10	-	762	1963-66	S	B	-	R	B	-	E MP
3500.20	Kowgon River at Tangi Azo	34 09	64 10	-	2,320	1963-66	R	C	-				E AP
3500.80	Kowgon River at Langar	34 10	62 59	6,150	1,370	1962-66	R	C	Yes				E MP
4000.60	Adraskand River at Adraskand	33 37	62 17	-	1,430	1963-66	S	B	-				E AP
4500.90	Gaz River near Adraskand	33 43	62 17	-	1,380	1963-66	S	B	-	R	B	-	E AP
5000.30	Farah River at Petchi Tangi	32 52	62 52	19,190	1,400	1961-66	S	-	-	R	C	Yes	E AP
5000.60	Farah River at Daulatabad	32 48	62 40	21,800	854	1963-66	S	B	-	R	C	-	E MP
5000.80	Farah River near Farah	32 20	62 00	26,900	760	1953-66	R	B	-				E MP
5500.90	Malman River near Shawalat	32 51	63 19	1,380	1,370	1961-66	R	-	-	R	C	Yes	E AP
6000.20	Khash River at Dileram	32 10	63 25	5,380	1,210	1952-66	R	B	-	R	C	-	E AP
7000.10	Helmand River near Ghizao	33 25	66 20	-	2,000	1966	S	F	-	R	C	-	E AP
7000.20	Helmand River near Dehraout	32 41	65 30	35,500	1,100	1951-66	R	C	-	R	C	Yes	E MP
7000.30	Helmand River below Kajakai Dam	32 19	65 06	42,200	820	1947-66	R,T	C	-				E WW
7000.40	Helmand River at Bost	31 33	64 19	57,800	764	1954-57	S	B	-	R	B	-	MP
7000.50	Helmand River at Darweshan	31 01	64 05	147,500	588	1956-66	R,T	C	-				E MP
7000.70	Helmand River at Chahar Burjak	30 15	62 00	187,000	500	1946-66	R	C	-				E MP
7000.90	Helmand River at Shela Charkh	31 02	61 52	-	480	1953-66	R	C	-				E MP

Table 4.--Existing Stream-Gaging Stations (cont'd)

Number on Figure 1	Location of Gaging Station	Location lat. E. ° '	long. N. ° '	Drainage Area (square kilometers)	Altitude (meters above mean sea level)	Records Available	Present Installation Type of Gage 1	Measuring Structure 2	Sediment Data	Proposed Installation Type of Gage	Measuring Structure	Sediment Data	Station Classification 3
7600.90	Tirin River at Dehraout	32 40	65 30	5,590	1,100	1952-66	R	-	-	R	-	-	E AP
7700.90	Musa Qala River near Musa Qala	32 20	64 46	3,750	970	1952-66	R	-	-	R	C	-	E AP
7800.50	Arghandab River above Arghandab Res.	32 01	66 10	16,950	1,140	1951-66	R	C	-	R	C	Yes	E AP
7800.60	Arghandab River below Arghandab Dam	31 51	65 51	17,800	1,050	1947-66	R,T	C	-				E WM
7800.90	Arghandab River near Qala Bist	31 30	64 20	81,900	720	1947-66	R	C	-				MP
7887.90	Arghastan River near Kandahar	31 26	65 54	33,200	1,220	1952-66	R	B	-				E AP
8000.20	Kabul River at Maydan	34 20	68 55	1,520	2,096	1961-66	R	B	-				AP
8000.50	Kabul River at Tangi Saydan	34 25	69 10	1,900	1,850	1960-66	S,R	B	-				MP
8000.60	Kabul River at Tangi Gharu	34 33	69 26	14,370	1,770	1959-66	R	C	-				MP
8000.70	Kabul River at Naghlu	34 34	69 45	29,920	1,110	1960-66	R	-	-				MP
8000.80	Kabul River near Jalalabad	34 33	70 17	40,770	590	1959-63	R	-	-				MP
8100.80	Paghman River at Puli Sokhta	34 33	69 02	510	1,805	1963-66	S	-	-				AP
8200.30	Qargha River above Qargha Res.	-	-	-	-	1963-66	R	-	-				AP
8200.70	Qargha River below Qargha Dam	-	-	-	-	1965-66	R	-	-				WM
8300.30	Loghar River at Sekhabad	34 04	68 40	6,020	2,025	1961-66	R	B	-				AP
8300.80	Loghar River at Sang-i-Nawesta	34 26	69 16	11,160	1,805	1961-66	S,R	-	-				MP
8400.60	Ghazi River below Ghazi Dam	-	-	-	-	1965-66	S	-	-	R	-	-	WM
8500.30	Panshir River at Omars	-	-	3,780	2,020	1961-66	S	-	-				AP
8500.80	Panshir River at Gulbahar	35 05	69 10	5,585	1,560	1959-66	S	-	-				MP
8550.80	Ghorband River near Ashauwa	35 07	69 10	4,390	1,580	1959-66	R	B	-				E AP
8558.80	Salang River near Jebel Seraj	35 08	69 13	660	1,590	1961-66	R	-	-				E AP
8600.80	Laghman River at Puli Qarghari	34 32	70 14	8,800	625	1960-66	R	B	-				AP
8800.60	Kunar River near Sherghaserai	34 55	71 13	22,820	850	1960-66	R	BT	-	R	C		E AP
8800.80	Kunar River near Kunari	34 37	70 40	28,900	630	1959-66	S	-	-				E MP
8870.90	Pesh River at Sherghaserai	34 55	71 08	5,200	800	1960-66	R	B	-	R	C		E AP
9300.20	Khoram River at Cakamani	33 52	69 38	-	1,830	-	R	-	-				AP
9300.80	Khoram River at Puli Bangakh	33 50	69 47	-	1,670	-	R	B	-				MP
9400.30	Kaitu River at Domandi	33 18	69 40	-	1,220	1963-66	R	-	-				AP
9400.80	Kaitu River at Tora Tiga	-	-	-	(1,100)	-	-	-	-				MP
9410.90	Matun River near Khost	33 22	69 57	-	1,340	1962-66	R	-	-	R	C	-	E AP

1 S-staff gage; RP-reference point; R-recorder; T-thermograph; ST-stage station.
2 C-cableway; B-bridge; BT-boat; F-ferry.
3 AP-areal primary; AS-areal secondary; MP-mainstem primary; WM-water management; E-evaluation report written.

Field Work

Because of the dispersal of hydrologic work among various offices operating under different technical assistance programs, it is difficult to evaluate the overall effectiveness of the field work.

In the US AID-supported office at Kandahar, there has been a good record of field work accomplished, both in frequency of trips to obtain necessary data and in the quality of the data obtained by Afghan technicians - all a reflection of the many years of effective logistic support and of training of technicians at this office. The US AID-supported office established in 1964 at Kabul, has not yet operated effectively owing to rapid turnover in trained Afghan personnel and limitations in logistic support.

Office Work

An overall evaluation of the work is difficult to make because of the dispersal of offices. In Kandahar, work has progressed fairly well, but much training is still needed beyond the point of simple computation of gage-heights and discharge measurements. The evaluation of stage-discharge relations is beyond the capabilities of most Afghan technicians at present, but some U. S. educated Afghan engineers are making good progress along these lines. In the Kabul office, 2 years of training has not yet produced technicians capable of elementary computation of gage-heights. The only straight-forward computations of discharge measurements can be handled at present.

Recommendations

Organization

For the development and management of Afghanistan's water resources it is important that all information and data be available to those in need of it. Only through an autonomous organization can this be done. In November 1961, Mr. George C. Taylor, Jr., Chief of the Foreign Hydrology Section, U.S. Geological Survey, visited Afghanistan and prepared a basic proposal for such an organization. On the basis of his recommendations, a start was made in the proper direction in March 1963 with the organization of the Water and Soil Survey Authority. This organization was discontinued as an autonomous body in early 1966 and absorbed as a department in the Ministry of Agriculture and Irrigation. The basic reasoning of Mr. Taylor's recommendations is still valid, however, and as qualified personnel become available to staff a national organization, his recommendations should be given serious consideration. In the five years that have passed since Mr. Taylor wrote this paper, the value of his recommendations has been emphasized by the problems associated with the multitude of agencies offering technical assistance. Real progress will not be possible until all activities are brought under one head, and a standard system of procedure is adopted. Mr. Taylor's paper, outlining the general structure of a body for coordinating and policy making; an institute responsible for hydrologic research, surveys, and data collection; and a control agency for apportioning water resources, adjudicating water disputes, and issuing licenses and permits, is presented in its entirety in the Appendix to this report.

Proposed Gaging Station Network

The present (1966) gaging station network consists of 65 streamgaging stations. According to a system of determining gaging station density by population and climatic conditions presented by Langbein (1959) a network of 0.2 station per 1,000 square kilometers should be considered as a minimum program. On this basis, Afghanistan should have a network of no less than 127 stations. Under this minimum program, nearly all stations would be primary stations. No provision is made for temporary (5 to 8 years) stations to obtain information for specific purposes such as development of irrigation or hydropower, determination of heavy sediment loads, or analysis of saline water. With Afghanistan rapidly developing its agriculture and hydropower, the minimum requirement should be raised to about 0.3 station per (1,000) square kilometers. At this density level, Afghanistan would require 190 streamgaging stations.

Primary gaging stations--A primary gaging station is one located where the discharge of a river cannot be obtained in any manner other than by direct measurement. No other gages in the same or nearby basins will give satisfactory results either by the summation of two or more stations or by a correlation of discharges. According to Langbein's minimum program classification, about 120 gaging stations will have to be primary stations.

Secondary gaging stations--Secondary gaging stations are those located in areas of short-term interest, or whose records correlate within acceptable limits with those of a primary station after a relatively short period of operation, usually about 5 years. When the purpose for which a secondary gage was installed is accomplished or an acceptable correlation is defined, the station is moved to a new site.

There is no formula to determine the number of secondary gaging stations. The desired density, the number of sites of short-term interest, the climatic, topographic, and geologic factors that determine the correlation between sites, are all items that influcence the number of secondary gaging stations. When the minimum requirements for primary, water-management, reservoir, and benchmark stations have been met, the secondary network can be planned on the basis of need balanced against economic resources.

Water Management Stations--Water management stations are those used to obtain discharge information for operation of reservoirs, irrigation systems, hydropower plants, municipal water systems, and other hydraulic installations. Generally speaking, each such installation will require an inflow and an outflow station. On large complex systems more than one gage may be needed to record inflow.

Partial-Record Stations--Partial-record stations are those used to determine the discharge during critically high- or low-flow periods. For example, an irrigation system is more dependent on minimum flows than on average or high flows; a flood-control project would require information pertaining to flows large enough to cause flooding; an industry might operate only during the part of the year when raw products are available. The number of stations required would be determined by the project needs.

Reservoir and Stage Stations--Reservoir stations are used to determine the reservoir contents at any elevation of the reservoir surface. For planning and operating, it is important to know the volume of water impounded because of its effect on cropping practices, power generation, and flood-control releases.

Stage stations are used to determine the elevation of a river above a reference point for forecasting flood crests and for navigation. The number of each type of reservoir or stage station required depends on the number of reservoirs and the need for flood warning and navigation information.

Benchmark Station--Benchmark stations are used to determine the amount of influence man's activities may have on a river basin. In the normal course of operation of a gaging station network, a long-term change in a river's flow can be readily detected, but the cause of the change is not always evident. Many of man's activities will have the same effect on a river basin as will a change in climatic conditions. Quite often a change in planning will result if it is shown that previous development activities have had a deleterious effect on the river flow.

Benchmark stations are located on small drainage basins of 1 to 10 square miles and in wilderness areas where the likelihood of future influence by main is nil. Such stations are generally operated on a non-routine basis and with a minimum of equipment. A complete inventory of all basin and river characteristics is made including geology, topography, ground cover, soil types, river cross sections, meander patterns, streambed gradients, and many others. Periodically, the initial inventory is checked against current conditions to see if any changes are apparent.

Three benchmark stations probably would suffice for Afghanistan: one in the northern section, one in the central plateau, and one in the southern desert area. Because of the qualifying conditions it may not be possible to find suitable drainage basins in all these regions.

The proposed stream-gaging stations are shown in table 5. Approximately 40 of these sites have been visited and reconnaissance reports have been written. Another 20 sites have been selected by map reconnaissance and will be visited in the near future.

Table 5.--Proposed Stream-Gaging Stations

Number	Name and Location of Proposed Gaging Station	Location		Proposed Installation			Classification
		Latitude ° '	Longitude ° '	Type of Gage	Measuring Structure	Sediment Data	
1100.90	Wakhan River near Wakhan (approx.)	37 00	72 45	R	C	-	AP
1200.50	Kokcha River at Khardars	36 08	70 51	R	C	-	AP
1200.60	+ Kokcha River near Barak	36 48	70 48	RT	C	Yes	MP
1230.90	Unnamed Tributary at Khardars	36 06	70 50	R	C	-	AP
1250.80	+ Warduch River near Barak	36 54	70 53	R	C	-	AS
1259.80	+ Zardew River at Barak	36 56	70 50	R	C	-	AS
1280.90	+ Mashad River near Mashad	36 48	69 53	R	C	-	AS
1350.40	+ Andarab River at Banu	35 37	69 15	R	C	-	AS
1500.20	Balkh River at Naiak	34 45	66 57	R	C	-	AP
1500.30	Balkh River near Dahan-i-Kashan	35 13	66 16	R	C	-	MS
1550.90	Darra Yusuf River near Chasmashafa	36 12	66 55	R	C	-	AP
1620.90	Jui Buri River near Sarepul	36 12	66 03	R	C	-	AP
1700.20	Shirin Tagao River near Belchiragh	35 50	65 11	R	C	-	AP
1740.90	Unnamed Tributary at Belchiragh	35 49	65 13	R	C	-	AS
1760.90	Shor Nurish River near Daulatabad	36 32	64 54	R	C	Yes	AP
2000.40	Murghab River near Qal'eh Niaz Khan	35 02	63 58	R	C	Yes	AP
2000.80	+ Murghab River at Murghab	35 36	63 18	RT	C	Yes	MP
2500.90	Chichaktu Shor River near Murghab	35 42	63 17	R	C	-	AP
2700.90	Unnamed Tributary near Qal'eh Nau	35 20	62 56	R	C	-	AP
2800.90	+ Kushk River at Torghondi	35 07	62 17	R	C	-	AP
2900.90	Shorao River at Ab-i-Rahuk	35 22	61 59	R	C	-	AS
3000.60	Hari River at Marwa	34 16	62 56	R	C	-	MP
3000.90	+ Hari River at Tirpul	34 35	61 17	R	C	-	MP
3500.30	+ Kowgon River near Tangi Azo	34 08	64 11	R	C	-	MP
3510.90	+ Dahuk River near Tangi Azo	34 12	64 11	R	C	-	AS
3520.90	+ Gauarah River near Tangi Azo	34 10	64 13	R	C	-	AS
3600.90	+ Shir Khaj River near Chisht	34 18	63 55	R	C	-	AS
4000.70	+ Adraskand River near Adraskand	33 38	62 14	R	C	-	MP
4000.80	Adraskand River near Anardarra	32 42	61 40	R	C	-	MP
4000.90	Adraskand River at Harut Rud	31 47	61 16	R	C	-	MP
5000.90	Farah River near Juwain	31 43	61 35	R	C	-	MP
5400.90	Ghor River near Shawalat	33 06	63 22	R	C	Yes	AP
6000.80	+ Khash River near Lukhi	31 26	62 35	R	C	-	MP
6000.90	Khash River at Kharan	32 15	61 17	R	C	-	MP
7000.05	Helmand River near Behsood	34 24	67 44	R	C	-	AP
7000.40	+ Helmand River at Bost (former station)	31 33	64 19	R	B	-	MP
7000.60	+ Helmand River near Mala Khan	30 27	63 23	R	C	-	MP
7000.80	Helmand River at Khuabgah	30 47	61 46	R	C	-	MP
7200.90	Panjao River near Panjao	34 12	66 54	R	C	-	AP
7500.20	+ Tirin River at Orozgan	33 00	66 40	R	C	-	AP
7500.80	+ Tirin River at Anar-joie	32 38	65 35	R	C	Yes	MP
7540.80	Chora River at Chora	32 41	65 55	R	C	-	AP
7550.90	+ Morcha River near Tirin	32 35	65 40	R	C	-	AS
7700.90	Sangin Wash at Sangin	32 04	64 52	R	B	-	AP
7800.20	+ Arghandab River near Sang-i-Masha	33 17	66 10	R	C	-	AP
7800.30	Arghandab River at Maisan	32 27	66 42	R	C	-	MP
7800.70	+ Arghandab River near Kandahar	31 37	65 35	R	B	-	MP
7810.90	+ Wayan Wash at Wayan	31 58	66 00	R	C	Yes	AP
7820.90	+ Almish Wash near Almish	31 53	65 54	R	C	Yes	AP
7880.20	Dori River at Chaghori Post	31 22	65 53	R	C	-	AP

Table 5.--Proposed Stream-Gaging Stations cont'd

Number	Name and Location of Proposed Gaging Station	Location		Proposed Installation			Classification
		Latitude ° '	Longitude ° '	Type of Gage	Measuring Structure	Sediment Data	
7880.90	Dori River near Kandahar	31 27	65 17	R	C	-	MP
7887.30	Arghastan River near Maruf	31 33	66 42	R	C	-	AP
7888.20	Tarnak River at Shah-joie	32 32	67 27	R	C	-	AP
7888.90	Tarnak River near Kandahar	31 37	66 00	R	C	-	MP
7888.15	Ali Zar River at Ghazi Khel	32 40	67 34	R	C	-	AP
7889.90	+ Kushk-i-Nakhud River at Kushk-i-Nakhud	31 39	65 04	R	B	-	AP
8300.40	Loghar River near Surkha Khan	34 02	69 02	R	C	-	MP
8550.50	+ Ghorband River near Ghorband	35 01	68 47	R	C	-	AP
8680.90	Alisang River near Kalatusseraj	34 40	70 11	R	C	-	AP
8800.50	+ Kunar River at Arandu	35 18	71 32	RT	C	Yes	AP
8800.90	+ Kunar River near Jalalabad	34 27	70 33	R	B	-	MP
8850.90	+ Landai River near Komdish	35 20	71 34	R	C	-	AP
9400.20	+ Kaitu River near Waza	33 21	69 34	R	C	-	AP
9400.40	+ Kaitu River at Nadi Shakot	33 18	69 45	R	C	-	MP
9400.70	+ Kaitu River at Lakharn	33 18	69 59	R	C	-	MP
9420.90	+ Tongi River at Eespah	33 15	69 34	R	C	-	AP
9500.10	+ Big Gumal River near Gumal	32 33	68 53	R	C	-	AP
9500.20	+ Little Gumal River at Gumal	32 30	68 55	R	C	-	AP
9500.80	+ Gumal River near Marana	32 19	69 02	R	C	-	MP
10000.20	Ghazni River at Ghazni	33 33	68 36	R	B	-	MP
10000.80	Ghazni River near Mukur	33 03	68 08	R	C	-	MP
10300.20	+ Jilga River at Gardez	33 38	69 07	R	C	-	AP
10300.70	Jilga River above Band-i-Sardi	33 20	68 43	R	C	Yes	MP
10300.80	Jilga River below Band-i-Sardi	33 18	68 40	R	C	-	WM
11000.80	+ Nahar River near Zarghun Shahr	32 45	68 28	R	C	-	AP

Type of Gage: R-water-stage recorder; T-recording thermograph
Measuring Structure: C-cableway; B-bridge
Classification: AP-areal primary; MP-mainstem primary; WM-water management
+-reconnaissance reports written

Procedures and Standards

Field--A comprehensive "Hydrology Training Manual" that describes procedures and standards for basic stream gaging has been compiled by the author and used in the WSSD since 1964. The training manual, adapted from the U.S. Geological Survey Stream Gaging Manual, was modified to fit conditions in Afghanistan and was rewritten in 1966 to include sections previously omitted. This manual has been duplicated by US AID/Kabul for use in Afghanistan. The procedures and standards described in the manual are recommended for adoption by the WSSD. The information contained in the manual covers all phases of basic stream-gaging work except for sedimentology and surveying. These subjects are more complex than basic stream-gaging and the reader is referred to the approporiate reference listed at the end of this report for recommended procedures and standards in these subjects.

There are several technical aid missions in Afghanistan and each mission uses the procedures and standards of its parent organization insofar as possible. People have a natural tendency to use the methods they are most familiar with, but these methods may not always be the best under different sets of conditions. For example, the European system of computing river discharge by the graphical method is very good in an area, where the utilization of the water has been developed to a high degree and there is an abundance of well-trained technicians. However, in an arid country in the early stages water-resources development, the time and expense devoted to such complex computations could be better spent in gaining broader coverage of field data, rather than attempting to refine the available data to a degree unwarranted by a limited number of trained technicians.

There is also a tendency among some of the technical aid missions to measure one hydraulic parameter more accurately than others. For example, the relation of the river stage to the river discharge is basic to computing the mean daily discharge. Some missions measure the mean daily river stage very accurately by means of an automatic water stage recorder. On the other hand, they may measure the river discharge at flows higher than wading stage, by unproved indirect methods. Again they may attempt to relate the discharge measured at a low stage to that of a high stage by adjusting the area and velocity readings through a curve of relation. This procedure can lead to erroneous results because of unknown factors both in the measurement at the low stage and in the channel conditions at the high stage.

One of the major reasons for failure to measure the river discharge at higher stages is the lack of the necessary cableways to make high-discharge measurements. It is false economy to assume that it is not necessary to spend money for cableways, if the discharge can be computed indirectly, because indirect measurements are often erroneous. If later project design is based on incorrect data, then the resulting works will be either too large or too small for the available water supplies. Either over-or under-design is economically unsound. Also, the cost of a cableway is but a small fraction of the cost of even.a small irrigation or hydropower installation. Because it will provide the means to obtain adequate data for properly design hydraulic works, a cableway will pay for itself many times over.

Office--The procedures and standards used for office work and training of Afghan personnel are contained in a manual compiled by the project engineers over a period of years. This manual was originally written by Mr. L. F. Snell, revised by Mr. I. A. Heckmiller, and is being completely rewritten, updated, and expanded by Mr. V. J. Latkovich at the present time. This manual is recommended as the standard text for office computations.

Special investigations--Special investigations of river hydrology are essential to a well-rounded water-resources plan for appraisal and development. Such investigations can be divided into two classes: (1) those for a specific purpose or project, and (2) those that contribute to the overall knowledge of the hydrology of a basin or region. In Afghanistan, all special investigations up to the present time have been carried on for specific purposes or projects.

Special investigations can be made either by contract specialists hired for the purpose, or by the agency responsible for the operation of a national hydrology program. In Afghanistan, there have been in the past a large number of contract specialists or teams from international organizations carrying out these investigations, often overlapping or duplicating one other to a considerable extent. Also, many special investigations have been based on too little factual data, because of the lack of an adequate stream-gaging networks and records, and the subsequent reports have been in error in certain respects. Too often, there has been a tendency among these groups to base interpretations on very skimpy data, and to assume unverified hydrologic and meterologic relations.

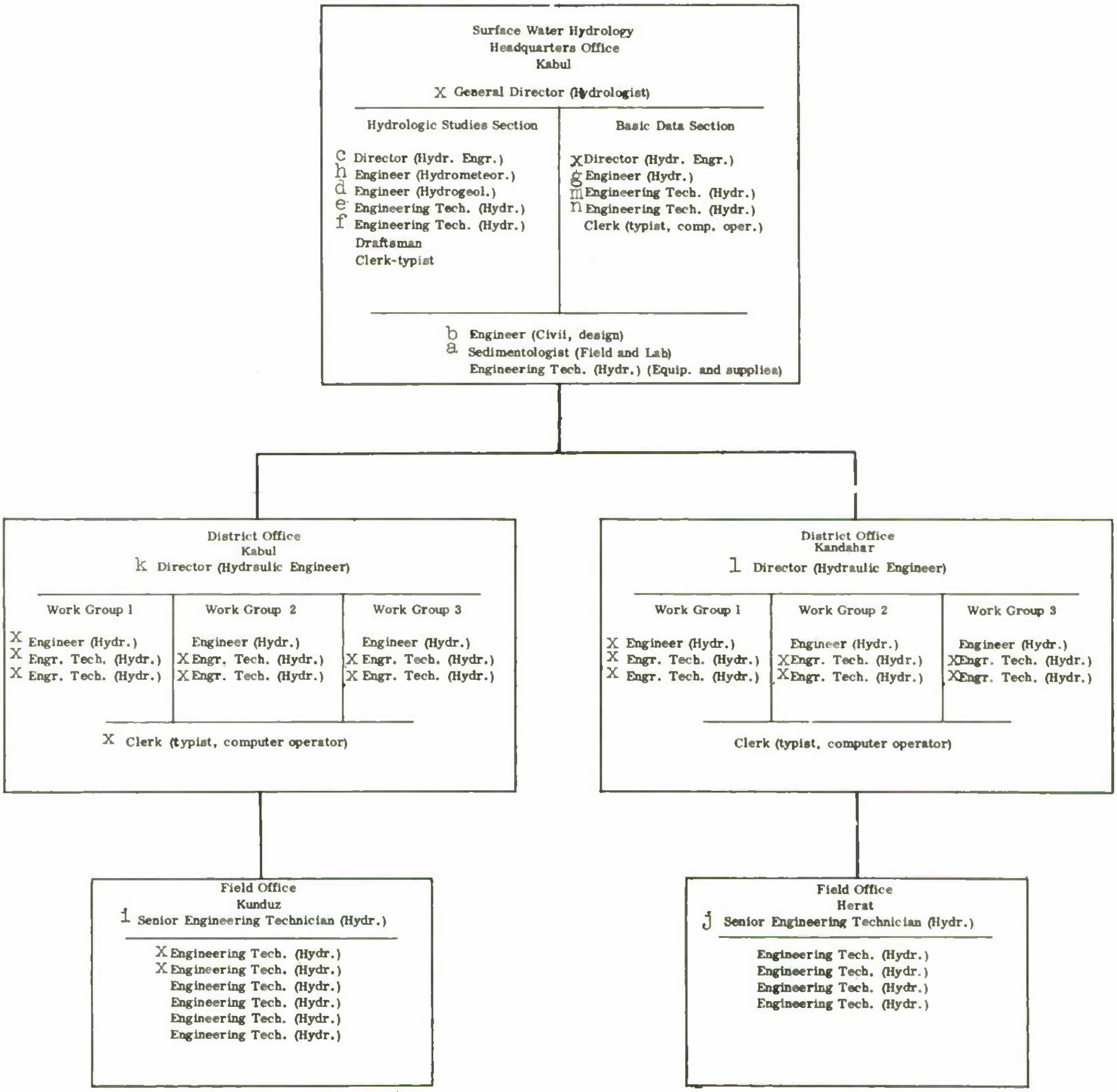
The staffing pattern presented in the next section of this report, includes a hydrologic studies section in the headquarters office. It is recommended that this section be organized and trained as rapidly as qualified personnel become available. Only through the use of such a section can the special investigations be carried on with direction and purpose. This will result in substantial savings in trained manpower and in foreign exchange both of which are critical in Afghanistan.

Personnel

The present Surface Water Hydrology Section, divided as it is among offices receiving guidance from different technical assistance missions, can only continue in its present fragmented operational pattern, unless some adjustments are made. If it is not feasible to operate under direction of one technical assistance mission, then it is recommended that the RGA either hire an expert foreign hydrologist to coordinate the activities of the various technical assistance missions or that it select the methods and procedures considered most appropriate to nationwide needs and incorporate them in program agreements with the various technical assistance missions. The following staffing pattern and organization chart is suggested to provide the necessary leadership and to define areas of responsibility.

Size of staff--Assuming that optimum development of a gaging station network will result in 190 gaging stations, it will take a staff of about 50 professional, subprofessional, and clerical workers to operate the network. This represents about one worker for every four gaging stations and includes about one professional to two subprofessional workers.

Disciplines--Figure 2 shows the recommended organization of the Surface Water Hydrology Section of the WSSD.



x-Position filled (for other letter designations see table 6).

Figure 2.--Recommended staffing pattern

The following is a summary of the recommended positions:

Professional		
Hydrologist		1
Hydraulic Engineers		11
Hydrometeorologist		1
Hydrogeologist		1
Sedimentologist		1
Civil Engineer		1
	Total	16
Subprofessional		
Senior Engineering Technicians (Hydraulic)		2
Engineering Technicians (Hydraulic)		27
Draftsman		1
	Total	30
Clerical		
Clerk-typist		1
Clerk (typist-computer operator)		3
	Total	4

Present staff--The present staff consists of about 25 people of which only five have had college training. Of the college-trained men, one has received a degree from an American university, and the others have received degrees from Kabul University. Two men have received additional schooling in the United States but did not qualify for the B.S. degree. The work experience of the college-trained men ranges from zero to 5 years.

The subprofessional workers vary considerably in education and experience. Some are technical school graduates, others have only a sixth-grade general education. The work experience ranges from zero to about 17 years, but in general the most educated are the least work-experienced.

Participant training--To fill the positions recommended in the staffing pattern, it will be necessary to provide academic training at graduate level or special course work at appropriate universities, or a practical course of in-service training at U.S. Geological Survey field offices in the United States. Table 6 shows the recommended participant training program. The letter keys in the left-hand column of table 6 are entered in the staffing pattern (fig. 2) to show where these participants will fit.

In-service training--Training programs of an in-service type must be organized and given to all employees at all levels. The first such course entitled, "Hydrology Training Manual No. 1, Basic Streamgaging," was prepared by the author in 1964 and revised, updated, and duplicated by US AID/Kabul in 1966. This manual covers all phases of basic streamgaging including methods, procedures, equipment, operation, safety, and basic office procedures.

A second training manual covering more advanced office procedures is in preparation and must be put into use as fast as the capabilities of the Afghan employees allow. Most training manuals available through the U.S. Geological Survey, United Nations, and other groups have to be modified to fit the conditions of Afghanistan and the background of the Afghan technican. Because of language difficulties, standard English tests on hydrology are generally not suitable. For this reason, it is recommended that the training manuals be translated into Farsi. This would greatly enhance their value in training the subprofessional employee.

Table 6.--Recommended participant training program

```
            FY
            1966   /  1967   /  1968  /   1969   /  1970   /

a           XXXXXX (under training)   (6)

b           XXXXXXXXXXXXXXXXXXXXXXXX (under training)  (24)

c                 XXXXXXXXXXXXXXXXXX (nominated)       (18)
d                 XXXXXXXXXXXXXXXXXX                   (18)

e                 XXXXXXXXXX               (10)
f                 XXXXXXXXXX               (10)

g                           XXXXXXXXXXXXXXXXXX      (18)
h                           XXXXXXXXXXXXXXXXXX      (18)

i                           XXXXXXXXX               ( 9)
j                           XXXXXXXXX               ( 9)

k                                    XXXXXXXXXXXXXXXXXX       (18)
l                                    XXXXXXXXXXXXXXXXXX       (18)

m                                    XXXXXXXX                 ( 8)
n                                    XXXXXXXX                 ( 8)
```

a Soils Classification
b Civil Engineering (Hydraulic)
c Special Academic (Hydrology)
d Special Academic (Hydrogeology)
e USGS In-service Program
f USGS In-service Program
g Special Academic (Hydrology)
h Special Academic (Hydrometeorology)
i USGS In-service Program
j USGS In-service Program
k Special Academic (Hydrology)
l Special Academic (Hydrology)
m USGS In-service Program
n USGS In-service Program

Each letter indicates a participant

Equipment and Supplies

Hydrologic--The hydrologic equipment and supplies needed to operate a gaging station network are described in Hydrology Training Manual No 1. The project equipment and supplies currently (1966) on hand or on order are sufficient to operate the recommended network.

The biggest problem with equipment in the past has been the lack of maintenance. Attempts have been made to assign responsible personnel to a maintenance program but this had little success because of the frequent transfer of trained individuals who understand the workings of the equipment. The staffing pattern calls for one engineering technician who will have charge of all equipment. This man should be thoroughly trained in the maintenance of all hydrologic equipment and be responsible for its upkeep and repair.

Transportation--Suitable vehicles for transportation of field personnel to gaging station sites for the timely collection of data have not always been available when needed. Rough travel over all kinds of terrain demands that vehicles be in first-class condition and that an adequate supply of spare parts be available for immediate repairs. Often valuable data are missed because of lack of transportation due to breakdown or insufficient fuel.

All vehicles assigned to the Surface Water Hydrology Section should be for its exclusive use. Experience has shown that lack of authority over vehicles has led to a lack of maintenance. In surface-water hydrology, it is often necessary to make emergency trips to repair on-site stream-gaging equipment or obtain data available only during periods of stormy weather. Without control over the vehicles, these data can be lost forever.

Maintenance--An adequate supply of hand tools and equipment for effecting repairs at gaging stations should be maintained in the warehouse at all times for emergency use, and each field man should be supplied with a tool kit for making on-the-spot repairs. The great distances involved and the difficulties of travel can make even minor repairs costly if the field man has to return a second time.

Routine maintenance of water-stage recording devices can be accomplished with a few simple hand tools. To clean stilling wells and correct cable sag, however, may require tools not ordinarily carried by the field man. Therefore, for complete maintenance, a regular system of inspection should be established whereby the field man notes on special forms what maintenance is required. The maintenance crew can then take the necessary equipment to do a proper job.

Office--Although there is a good supply of office and drafting equipment available on the local market, the WSSD is currently (1966) lacking in the most basic implements needed for routine drafting and office work, including operable typewriters and calculators. There are two Ozalid machines in the WSSD. One is a large-capacity production machine and the other is a 16-inch table model. Neither machine can be used because of the need for a variable voltage transformer. Such simple but necessary items as pens and drawing ink, scales, triangles, and T-squares also have been in short supply. Good quality rag-base paper with a long storage life is not available through government supply sources although it can be purchased on the local market. If the data are to be computed accurately and recorded in an acceptable manner, the office machine must be maintained in an operative condition and necessary supplies furnished to do the job. Much valuable data will be lost over the years by use of short-lived inferior inks and paper.

Publications and Library

Basic data--At the present time, the basic data are not being published or distributed on a periodic basis. The daily gage-heights, daily discharges, monthly means, maximums and minimums, and the instantaneous yearly maximums and minimums are being entered on data sheets for each station from which prints are made as requests are received. For a few years, the West German Hydrologic Mission (WGHM) was printing a hydrologic year book containing essentially the above types of information plus a duration curve for each gaging stating under their purview. The data collected in the Helmand Basin up through 1960 were compiled and published in a duplicated report (Brigham, 1964) by the U.S. Geological Survey.

The data collected by technical aid groups, other than the US AID and WGHM groups, are not being reported to the central office. These data are being taken out of the country and presumably will be available in report form at some future date.

The recommended form of publication is a hydrologic year book similar to that formerly published by the WGHM and should include data from all gaging and meteorological stations in Afghanistan. The duration curves as presented by the WGHM should be modified to have one curve show the percentage of total time that a specific discharge has been equaled or exceeded rather than single-year curves that show the number of days during the year a specific discharge has been equaled or exceeded. This modification would make the data more useful for long-term analyses.

Library--The library should contain a section where all hydrologic and meteorologic data collected in Afghanistan (and adjoining regions if available) will be in a central file and accessible for use by interested parties. The library should contain all the raw data as well as any analyses, maps, tables, graphs, reports, and statistical compilations that have been made. The library should also contain a section of selected text books, periodicals, and publications of hydrological organizations. The science of hydrology and the development of new techniques are advancing rapidly; constant study is necessary to keep abreast of current activities.

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Appendix

A National Water Resources Commission

by

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U.S. Geological Survey
Kabul, Afghanistan
November 1961

Recognizing the great importance of water resources in many facets of Afghanistan's economy and the need for judicious development and management of available water supplies for the general benefit, it is proposed to establish ultimately an autonomous National Water Resources Commission. This body would be composed of a Coordinating Board, for policy making, and a Directorate-General, for implementation of policy. The Coordinating Board would be composed of the Ministers or their designated representatives from the following Ministries: Planning, Public Health, Mines and Industry, Agriculture, Finance, Public Works. The Minister of Planning or his designated representative would be permanent Chairman of the Board. Implementation and execution of policies promulgated by the Board would be the responsibility of the Director-General of the Commission who would be assisted by three Assistant Directors, one for Water Resources Investigations and Planning, one for Water Resources Development, and one for Water Resources Conservation and Management. The Assistant Directors would have responsibility for guidance and coordination of water resources activities and functions within their respective purviews.

Appendix (cont'd)

It is not conceived that the Water Resources Commission would be an operational agency but rather a coordinating and policy-making group to review and approve all major water resources projects and programs before operating funds are made available. Operational functions in water resources development and management would continue to be among the "line" ministries as is the current situation. However, it is proposed to establish an autonomous National Hydrologic Institute which could be attached either directly to the Water Resources Commission under the appropriate Assistant Director or to the Ministry of Planning. The Institute would be an operational organization responsible for hydrologic research, surveys and data collection and for making such information readily available to agencies concerned with water development and management.

In addition an autonomous and operational National Water Resources Control Agency is proposed. The agency would be responsible for overseeing the apportionment of all water in "declared" ground-water basins, the allocation of surface-water supplies, the adjudication of water disputes, the licensing of well drillers and issuance of permits for well construction, and other conservation and management functions as deemed desirable by the Coordinating Board. The Agency would be attached directly to the Water Resources Commission through the appropriate Asst. Director.

Appendix (cont'd)

Functional responsibilities of governmental agencies working in National Water Resources Commission

An autonomous National Hydrologic Institute under the surveillance of the Assistant Director for Water Resources Investigations and Planning, would be composed of qualified hydraulic engineers, hydrogeologists, chemists, mathematicians and supporting personnel. The institute would be headed by a Chief Hydrologist and would be responsible for maintaining an adequate network of stream-gaging stations on all major river systems in the nation and for compiling, analyzing, and publishing continuing stream-flow data; for undertaking hydrologic and geologic investigations of important ground-water basins and for preparing analytical reports on the quantity, quality and availability of ground-water supplies; for the establishment and maintenance of an adequate network of observation wells to evaluate seasonal and long-term changes in ground-water storage; for systematic inventories of wells, springs and infiltration tunnels (kharezes) and compilation of hydrologic data on suitable forms and maps; for the establishment and maintenance of a hydrologic and water quality laboratory; for the establishment and maintenance of files of hydrologic data and reports for the entire country. Exploratory drilling required for groundwater investigations would be undertaken by private contract or departmentally by the drilling section of the Afghan Geological Survey (Ministry of Mines and Industry) or designated drilling sections in other governmental agencies.

Appendix (cont'd)

A. The Meteorological Institute would have responsibility for maintaining an adequate network of weather stations for continuing collection of precipitation, temperature, evaporation and other meteorological data essential to proper evaluation of the nation's water resources.

B. Hydrologists of the National Hydrologic Institute in collaboration with soil scientists and land classification experts from the Ministry of Agriculture and irrigation engineers and engineering geologists from the Ministry of Public Works would have responsibility for undertaking land and water surveys of large river basins prior to major development.

C. The Ministry of Agriculture would have responsibility for supervising the construction of small irrigation systems including (1) dams and canals and (2) the drilling and equipping of production irrigation wells and provision of power sources for pumping in established ground-water irrigation development projects.

D. The Ministry of Public Health would have responsibility for supervising the construction of public-water supplies including those derived from surface-water diversions and for drilling and equipping public-supply wells and provision of power sources for pumping and water distribution.

E. The Ministry of Public Works would have responsibility for supervising the construction of major dams both single and multi-purpose for irrigation, hydropower and flood control and for major canals and flood-control structures. Construction of hydropower generation and distribution systems would be the responsibility of the Ministry of Mines and Industry.

F. An autonomous National Water Resources Control Agency reporting to the Assistant Director for Water Resources Management and Conservation would be headed up by a Chief Conservationist and would have responsibility for licensing well drillers and issuing permits for production wells in "declared" (that is, heavily developed) ground-water basins; for maintaining files of well logs and related hydrologic data; and for the apportionment of water and allocation of water rights to diversions from streams and for issuance of permits and licenses for same.

G. The operation and maintenance of the canals and diversion works of small surface-water irrigation systems and of wells, pumps and power sources in ground-water development projects would be the responsibility of the Ministry of Agriculture.

H. The Ministry of Public Works would have responsibility for the operation and maintenance of major dams and canals for irrigation and flood control. The Ministry of Mines and Industry would oversee operation and maintenance of hydropower stations and power distribution systems.

I. Operation and maintenance of public water supplies and sewage disposal systems and the enforcement of sanitary codes would be under the surveillance of the Ministry of Public Health.

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appendices

Appendixes
1-18

Copies of the listed appendixes are on file in the Office of International Activities, Water Resources Division, U. S. Geological Survey, Washington, D. C. 20242, and in the library of the National Agricultural Development Division, U. S. Agency for International Development, American Embassy, Kabul, Afghanistan.

Appendix 1. Termination of assignment report, Leonard J. Snell, 1957.

2. Termination of assignment report, I. A. Heckmiller, 1959.

3. Two year tour report, Robert H. Brigham, 1961

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5. End of tour report, Arthur O. Westfall, 1966

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7. Activities of the senior field engineer, Surface Water Research Project, Afghanistan, Vito J. Latkovich, 1969

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9. Summary report of project: Helmand Surface Water Investigations, Robert H. Brigham, 1963

10. Surface-water resources investigation plan for Afghanistan, A. O. Westfall and V. J. Latkovich, 1966

11. Reconnaissance sediment survey of Kajakai and Arghandab Reservoirs, George Porterfield and A. O. Westfall, 1967

12. A proposed sediment data collection program for Afghanistan, George Porterfield, 1967

13. Hydrographic and sedimentation survey of Kajakai Reservoir, Don Perkins and James K. Culbertson, 1968

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Appendix 15. Hydrology training manual No. 2,
Computation of basic streamflow records
A. O. Westfall, 1967.

16. Hydrology training manual No. 3,
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17. Streamflow records,
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18. Compilation of hydrologic data,
Helmand River Valley, Afghanistan,
through September 1960,
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appendix 10

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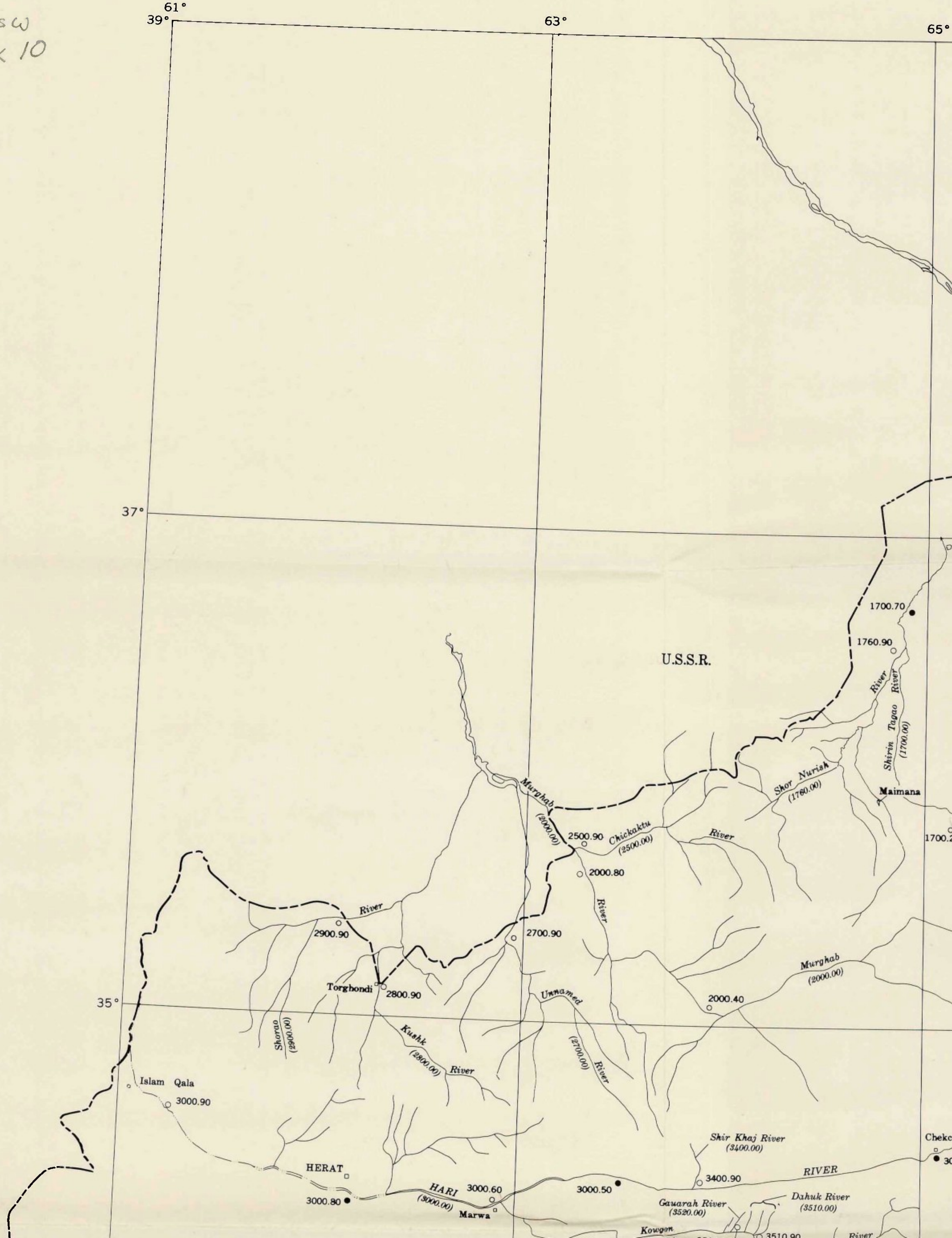

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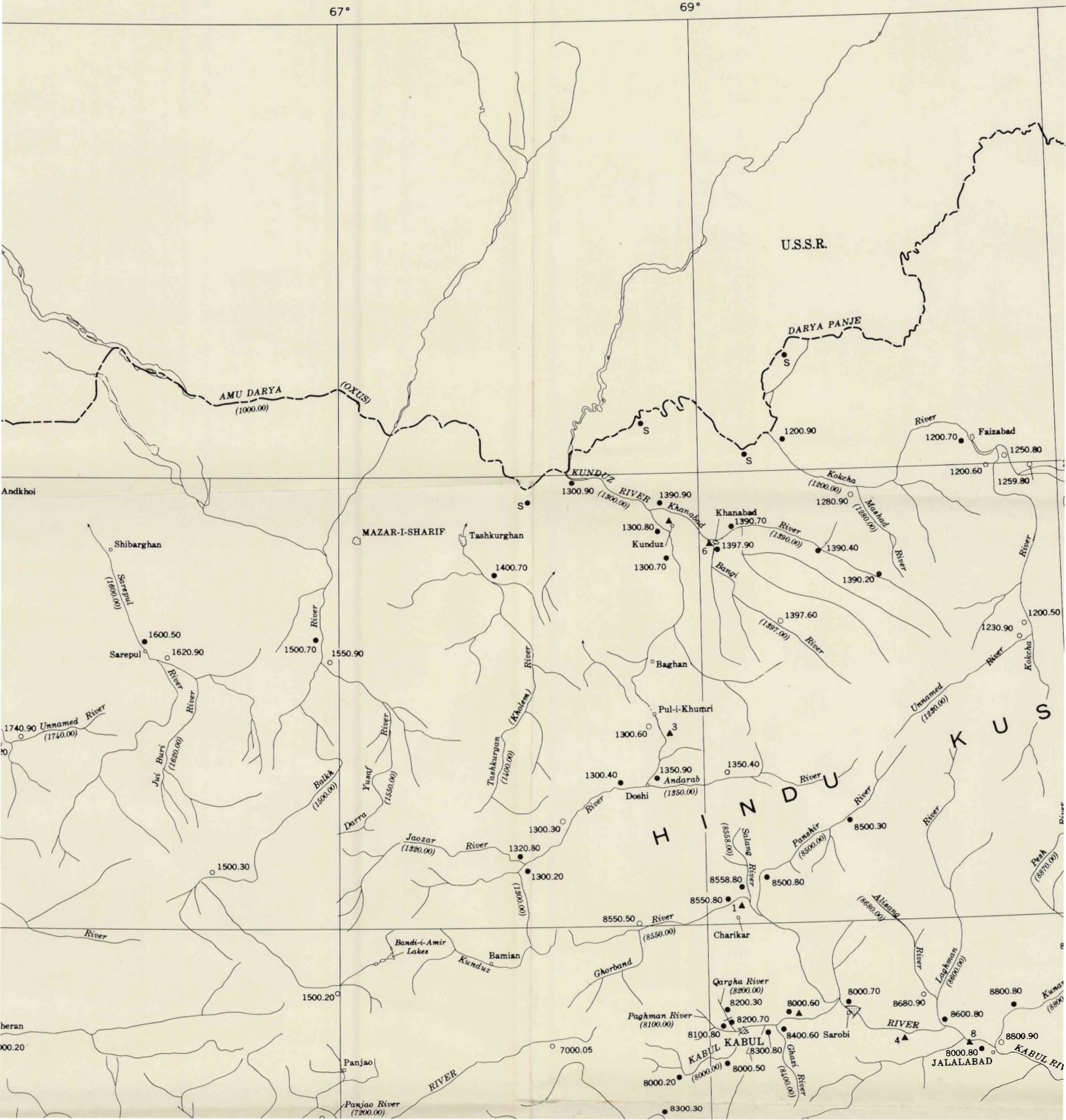
YAL GOVERNMENT OF AFGHANISTAN, UNDER THE AUSPICES OF THE UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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Base from World Aeronautical Chart, Scale 1:1 000 000, 1959

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appendix 10

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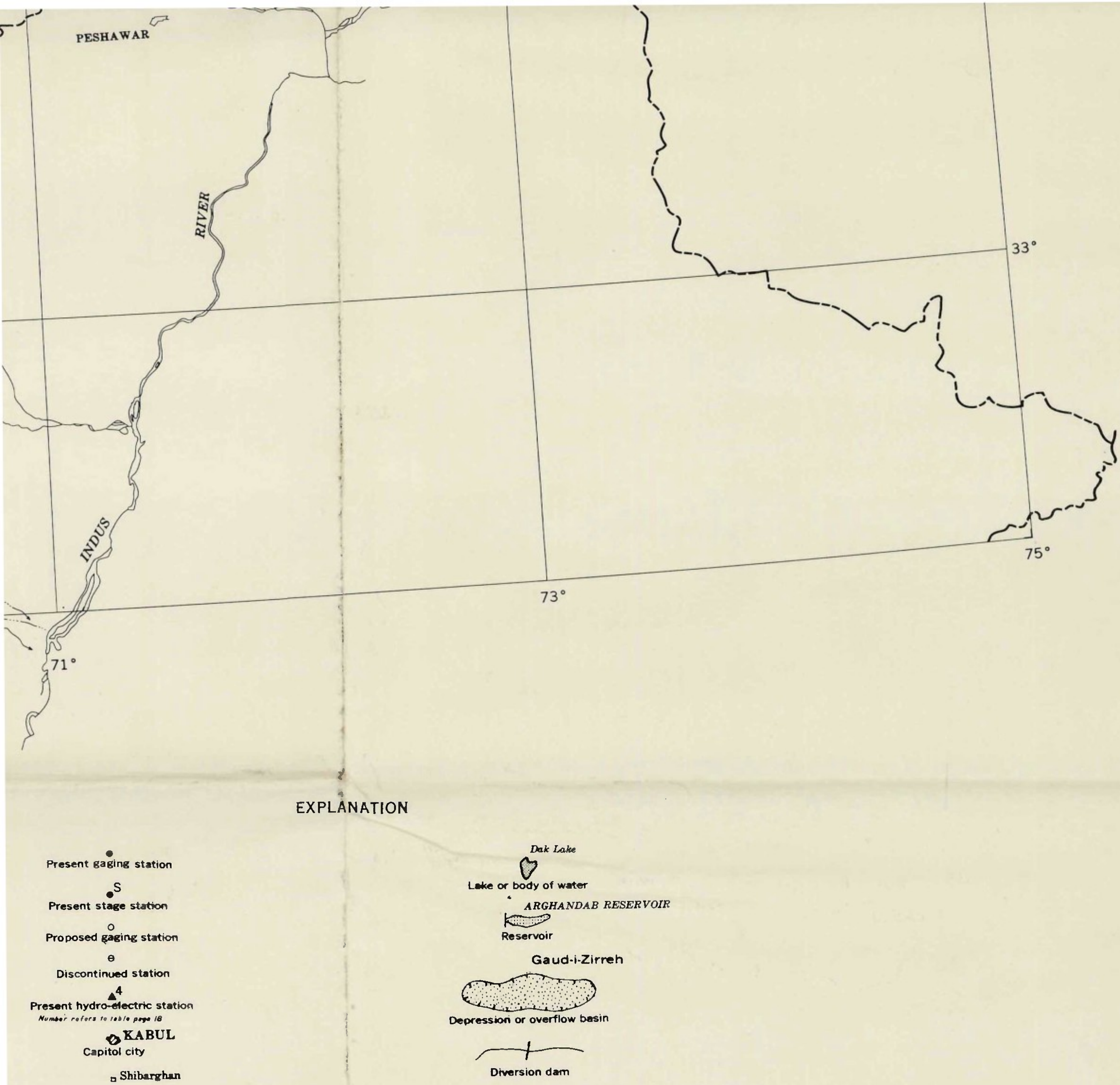

RE 1. MAP OF AFGHANISTAN SHOWING 1966 STREAMGAGING NETWORK.

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