STREAMFLOW INVESTIGATIONS OF THE U. S. GEOLOGICAL SURVEY IN NEW MEXICO

By

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The water resources investigations conducted by the Geological Survey are made by authorization of the Congress under the organic act of 1879. Since 1894, Congress has annually appropriated funds for investigating the water resources, and since 1902 each appropriation bill has had in it the following:

".....for gaging streams and determining the water supply of the United States, investigating underground currents and artesian wells, and methods of utilizing the water resources".

Since 1929 the appropriation acts have provided that a part of the appropriation shall be made available for matching on a 50-50 basis the cooperation offered by States or municipalities for general water resources investigations.

The water resources investigations of the Survey are conducted by the Water Resources Division through its three operating branches -- Surface Water, Ground Water, and Quality of Water--and the Technical Coordination Branch, a staff branch.

The Surface Water Branch collects, compiles, analyzes, and evaluates basic data relating to the source, quantity, movement, availability for utilization, and hydraulic and hydrologic characteristics of the nation's streams and other surface water resources.

In New Mexico there are 178 gaging stations operated by the Geological Service located on streams, canals and reservoirs, These stations are operated for or in cooperation with the following agencies:

Soil Conservation Service	1
Bureau of Reclamation	23
Corps of Engineers	16
Fish and Wildlife Service	4
Bureau of Indian Affairs	7

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State Engineer of New Mexico and Interstate Streams Commission	104
Rio Grande Compact Commission	10
Costilla Creek Compact Commission	14
Pecos River Commission	15
U. S. Federal Base Stations	17
Total	211

The difference of 33, between 211 and 178, is accounted for by the fact that a number of gaging stations receive partial support from more than one agency.

In addition to the operation of these gaging stations the New Mexico Surface Water District is engaged in four other related projects.

1. Compilation and evaluation of records

This project involves reviewing, revising, filling in gaps, and summarizing and publishing all available streamflow records through the water year 1950 in one volume. It has been a tremendous project, in that early discharge records have been reviewed in the light of modern reporting standards. Records collected by other agencies but not previously published by the Survey have been included after having been reviewed. Part 9, Colorado River basin, was published in 1954; Part 7, Arkansas River basin, has recently been received from the printer. Part 8, Western Gulf of Mexico basins, of which the Rio Grande is a part, is being reviewed at this time. The review for the New Mexico portion will be completed about two years from now, but it is not known when the printed report will be available. These compilations will save a tremendous amount of time of those who use the data.

2. Flood-frequency analyses

This project involves the compilation of annual peak discharges and the computation of the probable frequency of occurrence of discharges of various magnitudes. These studies will provide flood-frequency data useful in the design of highways, bridges, dams, and levees, and in determining the feasibility of establishing residential, farming or industrial activities within a flood plain. By these studies it will be possible to predict losses from flooding as well as to provide data for adequate designs, and at the same time ensure that overdesigns may be avoided.

This district's part of the Colorado River basin report has been completed; our part of the Canadian River basin has been computed and is now being checked. The Rio Grande and Pecos River basin studies probably will not be started for two years, although some work will be done in connection with the compilation report.

3. Highway program

This project is operated in cooperation with the Bridge Design Section of the State Highway Department and consists of the operation of 75 crest-stage gages, indirect determination of peak discharges, reports on the magnitude and frequency of floods, and site reports on hydrologic and hydraulic characteristics of stream channels. The basic data collected and the studies made under this program will ensure sound planning and economical design of bridges and culverts. The cost of these studies is small when compared to the overall cost of the bridges and culverts; savings resulting from more economical designs based on the information obtained will more than pay for the program.

4. Drought Studies

The Surface Water Branch is engaged in a study of the drought that persists in the Southwest and is preparing a report on it. This work is being done in Tucson, Arizona, by a staff engineer.

The question often is asked, "Why continue operating gaging stations? Won't three, five, or ten years of record suffice?" A good answer is, "If you were a farmer or fruit grower in an area subject to killing frosts, would you say that five to ten years of weather records would be all you need?".

Water is our most important natural resource. It is a unique resource - and fortunately so - in that it is a renewable resource. But replenishment varies from time to time and from place to place. In some areas the supply received in any one year may be insufficient to meet the demands, while in others too much is received.

Because of the variations in streamflow, the value of a program depends to a large extent on the continuity and adequate areal coverage of basic field observation. Because of time variations in streamflow, a gaging-station record becomes progressively more valuable as it increases in length. When a long record is interrupted, even for only a few years, it loses a great deal of its value, for during that period floods or droughts might occur that would pass unmeasured. Records of extreme occurrences are of great importance to engineers designing or operating water-works facilities. Because of areal variations in streamflow, proper distribution of stream-gaging stations is necessary. Runoff is influenced by factors such as topography and geology. They are basin characteristics and do not vary with time, but may vary greatly from one basin to another.

Flood-frequency studies show very clearly that records of 50 or 60 years cover too short a period of time to be used with certainty to predict the recurrence interval for 100 or more years. Often in such studies a peak discharge will plot high in discharge, indicating that the recurrence interval is much greater than the period of record. A streamflow record 10 years long may contain a 50-year, a 100-year, or even a greater flood. When gaging-station records are analyzed on an areal basis, results will allow prediction of the 50-year flood with acceptable accuracy.

Residents of the Mesilla Valley are vitally interested and concerned with the flow of the Rio Grande. Figure 1 (refer to hydrographs) shows the annual runoff in thousands of acre-feet of three stations on the Rio Grande for the period 1931 to 1955. The lower one (Black) is for Lobatos, which shows the inflow to New Mexico; the upper (blue) is for Otowi, which is the inflow station for the Middle Valley and the index for scheduled deliveries to Elephant Butte; the third, or center (red), is for San Marcial, The difference between the hydrographs for Otowi and San Marcial reflects the use of water between those two points. The runoff at Otowi was greater than downstream at San Marcial in all years shown on the graph except the two high years 1941 and 1942.

The 5-year moving average for each station is superimposed on the hydrograph. This moving average smooths out extreme annual variations and indicates trends more clearly than the conventional hydrograph. The second chart (fig. 2) shows the ratio of the 5-year moving average to the average or mean for the same period, 1931-55. It emphasizes the fact that lower flows have prevailed since 1943 than during the 12-year period 1931-1942.

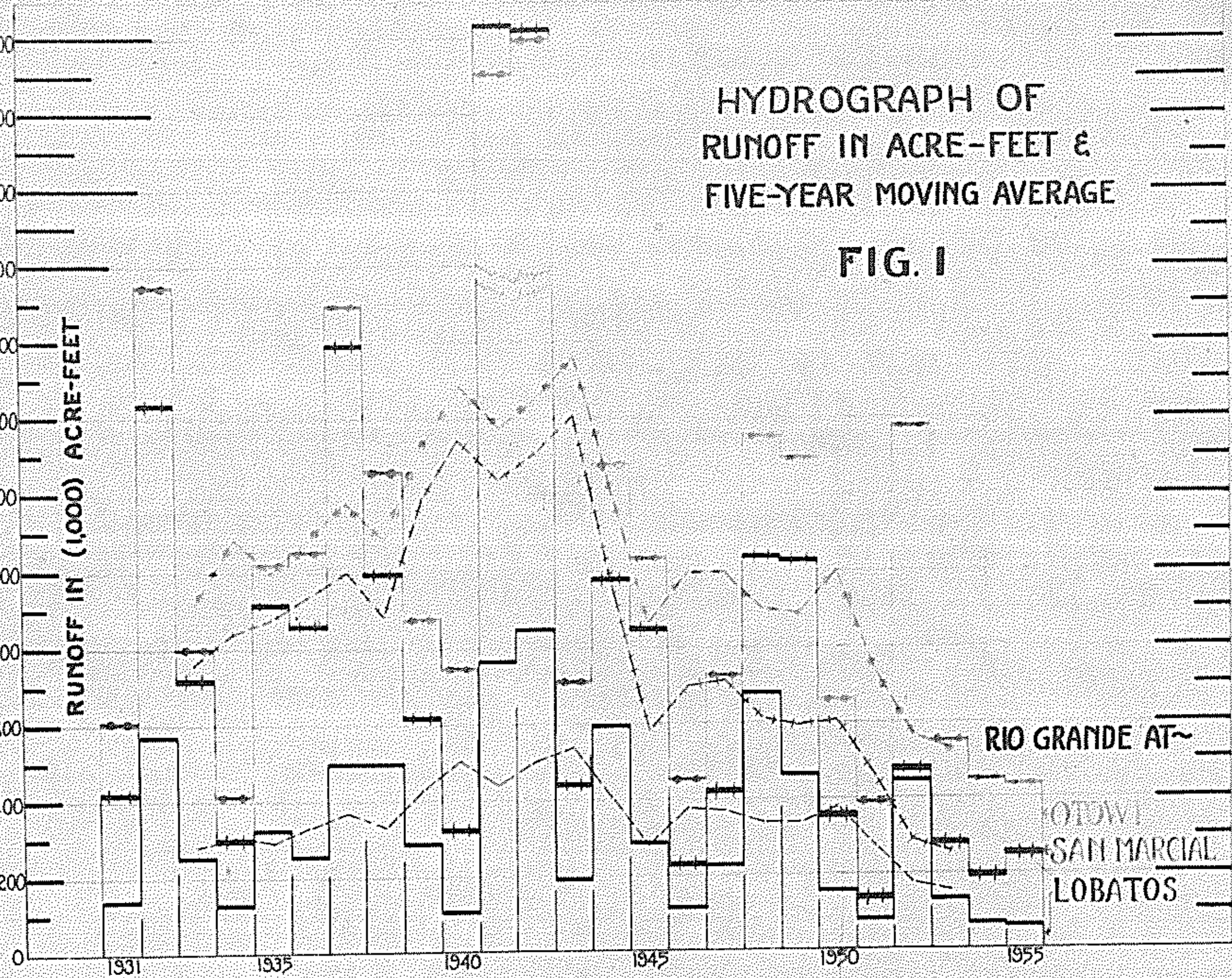

HYDROGRAPH OF
RUNOFF IN ACRE-FEET &
FIVE-YEAR MOVING AVERAGE
RUNOFF IN (1,000) ACRE-FEET
RIO GRANDE AT~
OTOWI
SAN MARCIAL
LOBATOS
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1931
1935
1940
1945
1950
1955

FIG. 1

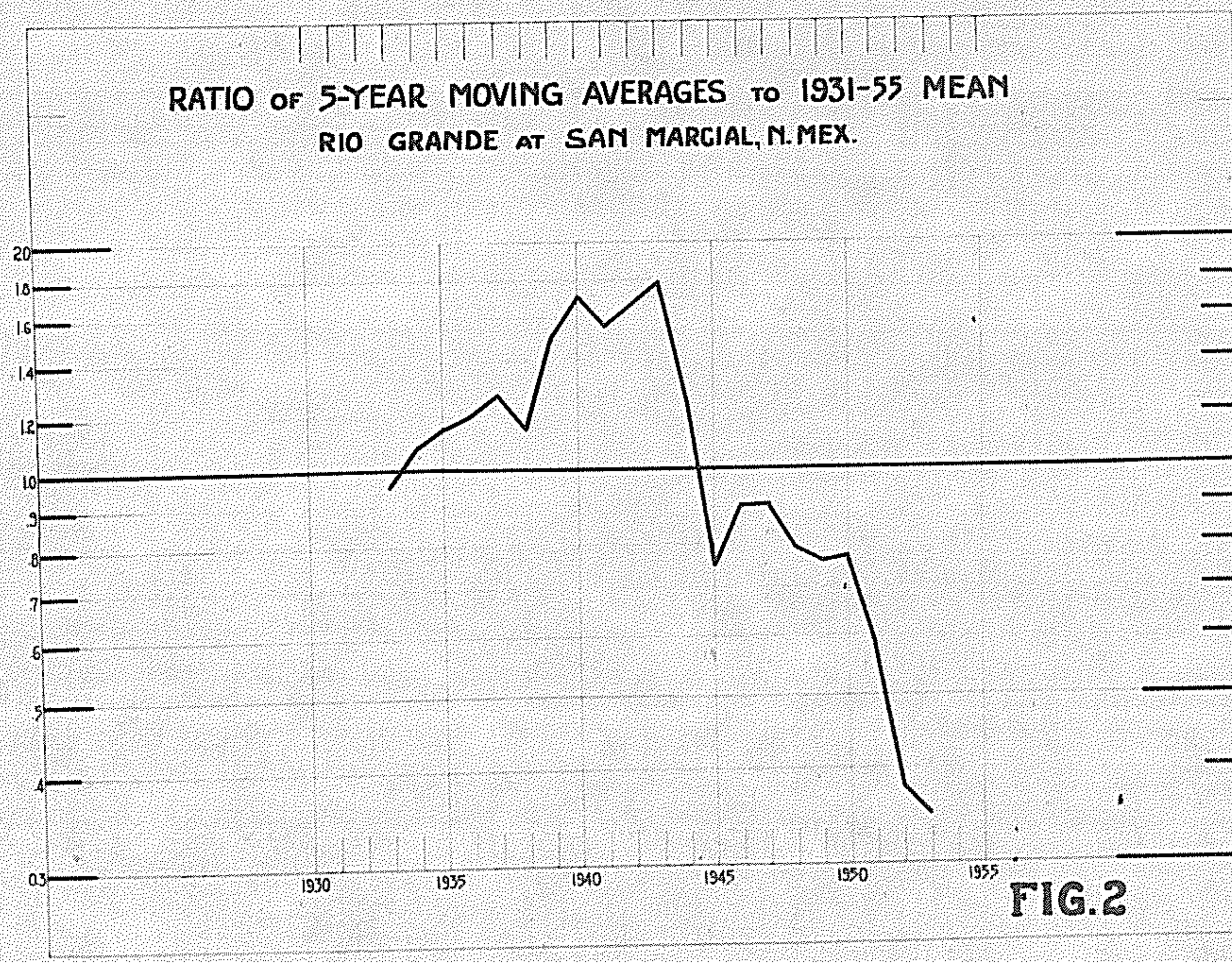
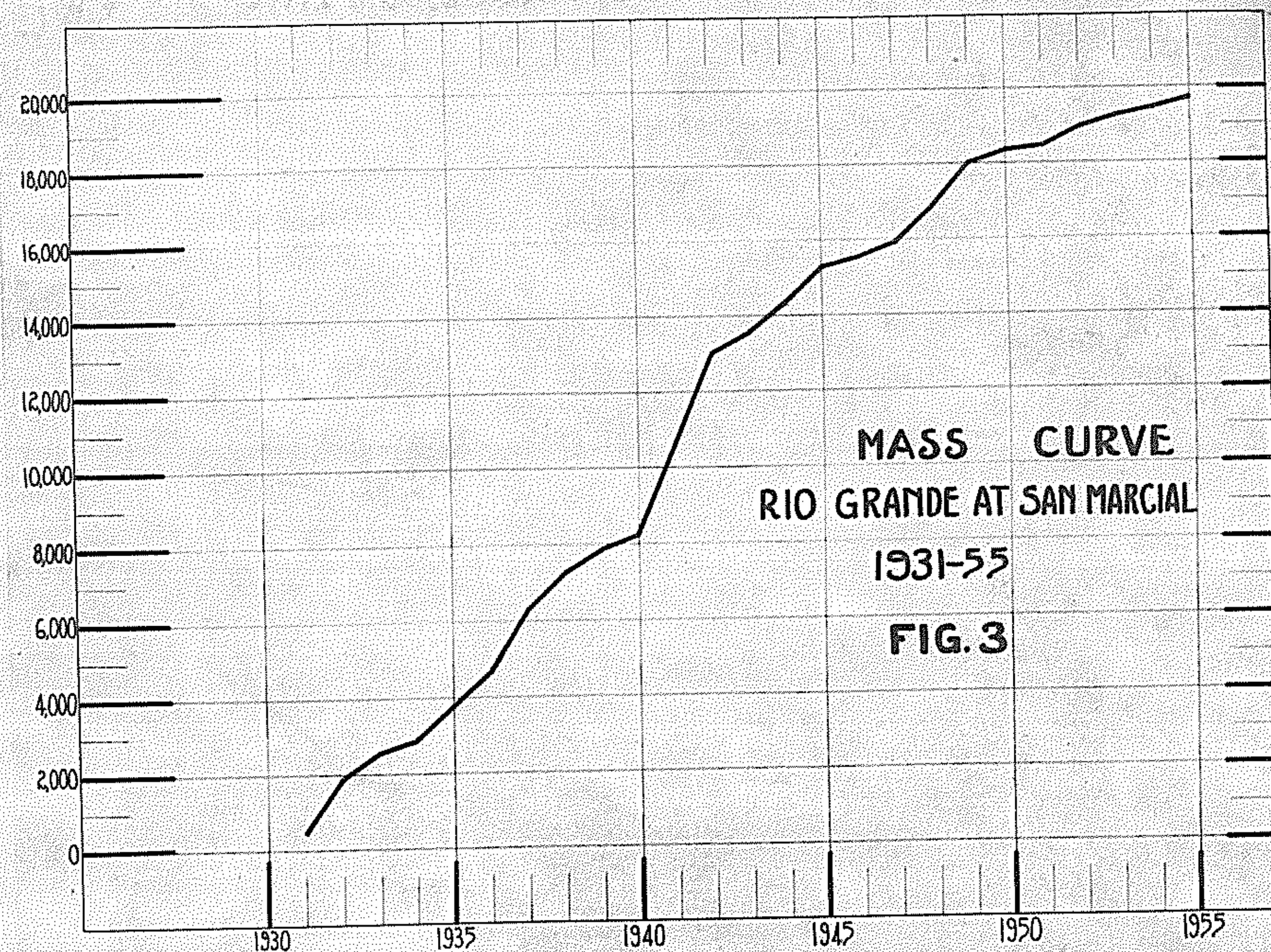
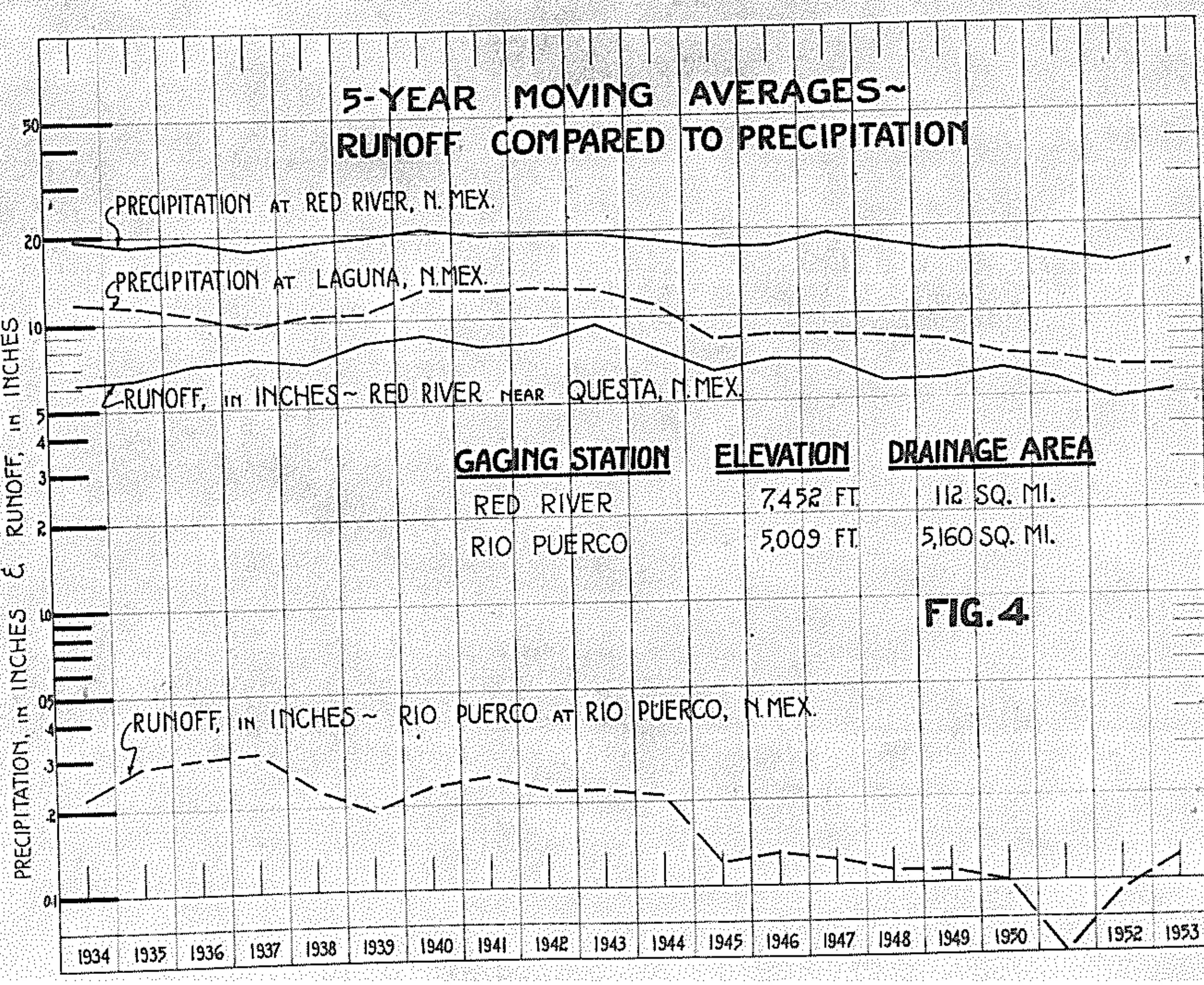

RATIO OF 5-YEAR MOVING AVERAGES TO 1931-55 MEAN
RIO GRANDE AT SAN MARCIAL, N. MEX.
2.0
1.8
1.6
1.4
1.2
1.0
.9
.8
.7
.6
.5
.4
0.3
1930
1935
1940
1945
1950
1955

FIG. 2


MASS CURVE
RIO GRANDE AT SAN MARCIAL
1931-55
FIG. 3
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1930
1935
1940
1945
1950
1955


5-YEAR MOVING AVERAGES~
RUNOFF COMPARED TO PRECIPITATION
PRECIPITATION AT RED RIVER, N. MEX.
PRECIPITATION AT LAGUNA, N. MEX.
RUNOFF, IN INCHES~ RED RIVER NEAR QUESTA, N. MEX.
GAGING STATION
ELEVATION
DRAINAGE AREA
RED RIVER
7,452 FT.
112 SQ. MI.
RIO PUERCO
5,009 FT.
5,160 SQ. MI.
FIG. 4
RUNOFF, IN INCHES~ RIO PUERCO AT RIO PUERCO, N. MEX.
PRECIPITATION, IN INCHES & RUNOFF, IN INCHES
50
20
10
5
4
3
2
1.0
0.5
.4
.3
.2
0.1
1934
1935
1936
1937
1938
1939
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1952
1953

The third chart (fig. 3) is a mass diagram, or mass curve, of the annual runoff at San Marcial for the same period. You will note the effect of the high years of 1941 and 1942, and that since 1946, except for a respite in 1948 and 1949, the runoff has been below average, being particularly noticeable since 1950.

The fourth chart (fig. 4) shows the difference between precipitation and runoff on a high, rugged wooded drainage area and one at a lower elevation with less vegetation and much less rugged terrain. All factors have not been considered but the chart does show that the unit runoff per unit of rainfall is much higher from a mountainous area.

We all agree that the demand for water is increasing. The best estimates available are that 200,000 m.g.d. are being used in the United States. This is an average of about 1,200 gallons per day for each man, woman and child. It is estimated that the total use will amount to about 350,000 m.g.d. in 1975. Of this amount, 215,000 m.g.d. will be used for industry, 110,000 m.g.d. for irrigation, and 25,000 m.g.d. for municipal and rural water supplies. Supplemental irrigation by pumping directly from streams and shallow wells in the normally humid eastern and southern portion of the country has increased three-fold since 1940.

Available water supplies may be increased by constructing more surface-water reservoirs to impound flood flows which now cannot be used; transporting water from areas with a surplus to areas of scarcity; improving irrigation practices so as to use water more effectively and economically; water salvage measures such as the elimination or reduction of non-beneficial use areas; reduction of pollution; greater reuse of water, which may mean that some measures must be taken to reduce the salinity; use of air to air cooling instead of the commonly-used water to air systems which waste a large amount of water even when recirculated.

The ultimate development of the water resources of a basin requires the cooperation and coordination of all interests. It cannot be done successfully by any one agency. The problem of each area must be considered independently of other sections of the country and the overall program adjusted to the particular needs of that area in the light of its own present and future problems. Such a comprehensive program can be successful only if local interests, through their proper agencies, can have a voice in planning such a program.