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86th Congress, 2d Session

PHOENIX, ARIZONA
4701 EAST WASHINGTON
MARICOPA COUNTY

House Document No. 279

OF
FLOOD CONTROL DISTRICT
GILA AND SALT RIVERS, GILLESPIE DAM TO
McDOWELL DAM SITE, ARIZONA

LETTER
FROM
THE SECRETARY OF THE ARMY
TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED AUGUST 11, 1959, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND AN ILLUSTRATION, ON AN INTERIM REPORT ON GILA AND SALT RIVERS, GILLESPIE DAM TO McDOWELL DAM SITE, ARIZONA, AUTHORIZED BY THE FLOOD CONTROL ACT APPROVED JUNE 28, 1938

FLOOD CONTROL DISTRICT
of
MARICOPA COUNTY
4701 East Washington
Phoenix, Arizona



NOVEMBER 2, 1959.—Referred to the Committee on Public Works and ordered to be printed with one illustration, pursuant to Public Law 86-254, approved Sept. 10, 1959

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1959

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LETTER OF TRANSMITTAL



DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C.

October 9, 1959

The Speaker of the
House of Representatives

Dear Mr. Speaker:

I am transmitting herewith a favorable report dated 11 August 1959, from the Chief of Engineers, Department of the Army, together with accompanying papers and an illustration, on an interim report on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, authorized by the Flood Control Act approved 28 June 1938.

In accordance with Section 1 of Public Law 534, 78th Congress, and Public Law 85-624, the views of the State of Arizona and the Department of the Interior are set forth in the inclosed communications. The views of the Departments of Agriculture and Commerce are also inclosed, together with pertinent replies of the Chief of Engineers to the above comments.

The President recommended to the Congress in his January 1959 budget message that legislation be enacted to establish uniform cost-sharing standards for flood control and flood prevention projects. Enactment of S. 2060, now pending before the Senate Public Works Committee, would meet the President's objectives.

The Chief of Engineers, with my approval, has followed present policies and procedures in formulating the project recommended by him. However, since the non-Federal share of the cost proposed for this project is less than that required by S. 2060, I recommend deferral of authorization of the recommended project until the Congress has had an opportunity to consider and take action on that bill.

The Bureau of the Budget advises that while there would be no objection to the submission of the proposed report to the Congress, it would recommend that further flood control authorizations requiring less than 30 percent non-Federal participation in project costs allocated to flood control be deferred until the Congress has had an opportunity to consider and take action on S. 2060. In addition, no commitment can be made at this time as to when an estimate of appropriation would be submitted for construction of the project if authorized by the Congress, since this would be governed by the then prevailing fiscal situation. A copy of the letter from the Bureau of the Budget is inclosed.

Sincerely yours,

Wilber M. Brucker
Wilber M. Brucker
Secretary of the Army

COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT

BUREAU OF THE BUDGET

WASHINGTON 25, D. C.

The Honorable

The Secretary of the Army

August 31, 1959

My dear Mr. Secretary:

Assistant Secretary Short's letter of August 20, 1959, submitted the proposed interim report of the Chief of Engineers on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, authorized by the Flood Control Act approved June 28, 1938.

The Chief of Engineers recommends the improvement of Gila and Salt Rivers, Arizona, for flood control and water conservation to provide for construction of levees between Phoenix and Tempe, and channel improvements from Gillespie Dam to Granite Reef Dam consisting of a cleared floodway and two reaches of low-flow channels. The construction cost is estimated at \$3,300,000. The work would be subject to several conditions of local cooperation, including the requirement that, in consideration of water-conservation benefits, local interests will repay to the United States 25 percent of the total Federal construction cost (a repayment presently estimated at \$825,000) in 40 equal payments without interest. Local interests would also be required to bear all costs for lands, damages and relocations and operate and maintain the works after completion. The ultimate construction cost to the United States, exclusive of interest on the unpaid balance during the repayment period, is estimated at \$2,475,000.

The Chief of Engineers recommends further that the 160-acre limitation on ownership of lands benefiting from the water-conservation features of the project not be applied as a prerequisite for this project's qualifying for interest-free funds; and that, in the event the McDowell Reservoir is adopted for construction, the design be modified to provide such additional flood-control storage as may be found needed and justified at that time.

The President recommended to the Congress in his January budget message that legislation be enacted to establish uniform cost sharing standards for flood control and flood prevention projects. Enactment of S. 2060, now pending before the Senate Public Works Committee, would meet the President's objectives. In general, S. 2060 would provide for non-Federal interests to bear at least 30 percent of project construction costs allocated to flood control or flood prevention as well as all maintenance and operation costs allocated to these purposes. Except for part of the costs for rights-of-way and highway and utility relocations, no construction costs allocated to flood control are to be borne by local interests.

Accordingly, I am authorized by the Director of the Bureau of the Budget to advise you that, while there would be no objection to the submission of the proposed report to the Congress, the Bureau of the Budget would recommend that further flood control authorizations requiring less than 30 percent non-Federal participation in project costs allocated to flood control be deferred until the Congress has had an opportunity to consider and take action on S. 2060. In addition, no commitment can be made at this time as to when any estimate of appropriation would be submitted for construction of the project, if authorized by the Congress, since this would be governed by the then prevailing fiscal situation.

Sincerely yours,

E. Fenton Shepard, Acting Chief
Resources and Civil Works Division

COMMENTS OF THE STATE OF ARIZONA

ARIZONA HIGHWAY DEPARTMENT
PHOENIX, ARIZONA
June 1, 1959

Major General E. C. Itschner
Chief of Engineers
Headquarters, Department of the Army
Washington 25, D. C.

Dear Sir:

Reference is made to your letter of March 4, concerning the Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona.

In my belief, the recommended plan of improvement is feasible and, based on existing conditions, the most economically justified.

It possibly should be noted that, although based on price levels of October 1957, the various estimated costs may be somewhat low, since construction costs are now undergoing an upward revision in this area.

No additional comments have been received by this office from the Arizona Game and Fish Department, or the United States Fish and Wildlife Service since their letter of December 8, 1958 to the District Engineer. In that letter, definite objections were expressed to the recommended plan for the lower 45 miles of the proposed project, due to its detrimental effect on wildlife resources. In accordance with the comments of the Board of Engineers, January 27, 1959, these objections were to be given consideration within practical limits.

In a letter to the District Engineer on January 6, 1959, Mr. Tom Sullivan, Maricopa County Manager, on behalf of the Maricopa County Board of Supervisors, expressed complete accord with the recommended plan of improvement. It was suggested that consideration be given to those recommendations of the Fish and Wildlife Service which would not affect the cost of the project, or would not reduce the effectiveness of the plan.

No other views or comments have been received by this office from any other party or agency.

Very truly yours,

Martin Toney
Engineer of Bridges & Dams

LETTER TO THE STATE OF ARIZONA

**DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington 25, D.C.**

25 June 1959

Mr. Martin Toney
Engineer of Bridges and Dams
Arizona Highway Department
Phoenix, Arizona

Dear Mr. Toney:

Receipt is acknowledged of your letter of 1 June 1959 furnishing your comments on my proposed report on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona.

It is recognized that the project costs will change during the interval between completion of the investigations and appropriation of funds for construction. Any request, however, that we would make to Congress for an appropriation of funds to plan or construct an authorized project would be based on an estimate which reflects prices and conditions prevailing at the time of that request.

During the advance planning stage, consideration will be given to all practicable measures for conserving the wildlife resource.

Copies of your letter and this reply will be included with my report when it is sent to Congress.

Sincerely yours,

E. C. ITSCHNER
Major General, USA
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF THE INTERIOR



UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY

Maj. Gen. E. C. Itschner
Chief of Engineers
Department of the Army
Washington 25, D. C.

WASHINGTON 25, D. C.

June 15, 1959

Dear General Itschner:

As requested in your letter of March 4, 1959, we have reviewed your proposed report, together with the reports of the Board of Engineers for Rivers and Harbors, and of the District and Division Engineers, on an interim report on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona.

Your report recommends improvement of Gila and Salt Rivers, Arizona, for flood control and water conservation, to provide for construction of levees between Phoenix and Tempe and channel improvements from Gillespie Dam to Granite Reef Dam.

There has been close coordination between the District Engineer, Corps of Engineers, and the Regional Director, Bureau of Reclamation, in studies leading to the preparation of the District Engineer's report dated December 4, 1957. Review of the reports transmitted with your letter of March 4, 1959, discloses that the proposed plan of improvement is in accord with Reclamation's interests.

Your report recommends allocation of 25 percent of the total Federal construction cost to water conservation to be repaid by local interests in 40 equal annual payments, without interest, as permitted under reclamation law. The Secretary of the Interior would have the responsibility of contracting and accounting for repayment of these costs.

Your report also recommends that the excess land provisions of reclamation law not be applied in this instance to qualify the project for interest-free repayment of reimbursable costs as the anticipated water savings resulting from the improvements would accrue to the general ground-water supply. We agree that specific beneficiaries cannot be identified and that the 160-acre limitation is an unreasonable restriction.

In the event the proposed McDowell (Maxwell) Reservoir of the Bureau's potential Central Arizona Project is adopted for construction, your report recommends that consideration be given to the inclusion of additional flood control storage. It is our understanding that the future development potential of the McDowell Dam and Reservoir would not be limited with respect to designs, estimates and allocation of costs as presented in the Corps' report, although this presentation is adequate for the purpose of considering the recommended improvements.

The U. S. Fish and Wildlife Service advises that the proposed construction would have pronounced effects on wildlife resources. These effects generally will not be important in the 50-mile upstream reach from the Gila-Salt River confluence, but in the 40-mile downstream reach white winged and mourning dove losses and waterfowl habitat destruction would be extensive. Some quail and rabbit hunting losses also will occur. In the interest of preserving as much of the wildlife cover and the water area along the downstream 40-mile reach of river as is feasible, it is recommended that the Corps of Engineers cooperate with the Arizona Game and Fish Department to undertake certain project modifications. These modifications include meandering of the 2,000 foot floodway where possible to avoid destruction of the more valuable dove thickets, retention of such water areas within the floodway as it is feasible to preserve, and meandering of the proposed low flow channel within the floodway wherever possible.

The District Engineer assumed for the purpose of preparing cost estimates that clearing and maintenance work would be by mechanical means. It is further recommended that any consideration of the use of herbicides be approved by the Arizona Game and Fish Department as such means of control of vegetation could be highly destructive of both fish and wildlife. Although adoption of the foregoing recommendations would not completely offset wildlife losses due to the project, a worthwhile remnant of the wildlife habitat could be preserved.

We are pleased to note that the Board of Engineers for Rivers and Harbors believes consideration should be given in the advanced planning stage to all practicable measures for conserving wildlife resources and that the Chief of Engineers concurs in general with the report of the Board. It is suggested that the Fish and Wildlife Service report of December 2, 1958, two copies of which are attached, be included in Appendix 9 of the District Engineer's report in place of the April 13, 1951, report. The modifications recommended, however, would apply only to the 40-mile reach of the Gila River from Gillespie Dam to the Gila-Salt River confluence.

In addition to the considerations outlined by the Area Director in his letter of December 11, 1951, to the District Engineer, the Bureau of Indian Affairs calls attention to certain other interests of the Indians in lands to be taken for rights-of-way. The Salt River Channel contains deposits of gravel which are very valuable due to the volume of construction work being done in the Phoenix area. The Indians of the Salt River Reservation now receive revenue from the sale of gravel. In time there is likely to be demand for gravel from the Fort McDowell and Gila River Reservations as well. It is suggested that these current and future values be considered by the Corps for reservation for Indian utilization, if such can be done without unduly compromising the recommended provisions in prescribed regulations for keeping the flood channels free from encroachment. This thought would also apply if consideration is given the retention for the Indians of the recreational concessions that may be possible of development in the floodways.

In any and all phases of the appraisals of damages and the steps toward taking of Indian lands for this project it is requested that the Corps of Engineers keep the Indian Tribes fully advised through the Area Director, Bureau of Indian Affairs in Phoenix, Arizona.

This Department has no objection to the proposed construction. We appreciate the opportunity of reviewing your report.

Sincerely yours,

(Signed) FRED G. AANDAHL

Assistant Secretary of the Interior

LETTER TO THE SECRETARY OF THE INTERIOR

HEADQUARTERS
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D. C.

21 July 1959

The Honorable

The Secretary of the Interior

Dear Mr. Secretary:

Reference is made to the Assistant Secretary's letter of 15 June 1959, furnishing the comments of the Department of the Interior on my proposed report on the Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona. The views of the Fish and Wildlife Service with respect to the effect of the project on wildlife resources, and the views of the Bureau of Indian Affairs with respect to the interests of the Indians in lands to be taken for rights-of-way are noted in particular.

In commenting on my report, the Assistant Secretary suggested certain measures to mitigate the loss of wildlife habitat. Should this project be authorized full consideration will be given to the suggestions in developing plans for the work and these plans will be coordinated with the U. S. Fish and Wildlife Service and the Arizona Game and Fish Department.

The improvements recommended in my proposed report were based on the use of mechanical means for clearing the channel of phreatophyte growth. Should herbicides be considered as a means of clearing and maintenance of the cleared channel, approval of that use will be obtained from the Arizona Fish and Game Department.

A copy of the U. S. Fish and Wildlife Service's report of 2 December 1958, will be included in Appendix 9 of the District Engineer's report.

With regard to the interests of the Bureau of Indian Affairs in lands along the Salt River, it should be noted that, in general, only flowage easements within the proposed floodway will be acquired by local interests as a requirement of local cooperation. Acquisition of land in fee title would be restricted only to those areas required for construction of the proposed levees. In the 3.5 mile reach along Salt River from 40th Street, Phoenix, to Tempe Butte, Tempe, gravel

operations adjacent to the levees would be restricted to insure the stability of the levees. In the area required for the low-flow channels, temporary easements would be required for construction purposes only. Within the remainder of the 77 miles of channel improvements restriction of gravel operations would merely limit the stockpiling of material and equipment in such a way as not to impede flows. I do not expect that these necessary restrictions will have a major effect on gravel operations.

In the detailed planning for the project, full consideration will be given to current and future values of the gravel deposits within the channel area affected by the proposed project. Local interests will be advised of the need to cooperate with the Indian Tribes through the Director, Bureau of Indian Affairs in Phoenix, Arizona, at the time of acquisition of required rights-of-way.

A copy of the Assistant Secretary's letter, together with a copy of this reply, will be included with my report when it is submitted to Congress. These suggestions of the Assistant Secretary are appreciated.

Sincerely yours,

/S/ E. C. ITSCHNER

E. C. ITSCHNER
Major General, USA
Chief of Engineers

COMMENTS OF THE DEPARTMENT OF AGRICULTURE



DEPARTMENT OF AGRICULTURE
WASHINGTON 25, D. C.

August 20, 1959

The Honorable
The Secretary of the Army

Dear Mr. Secretary:

This is in reply to the Chief of Engineers' letter of March 4, 1959, transmitting for our review and comment his proposed report on an interim survey on the Gila and Salt Rivers, Arizona, which considers the area along the Gila River from Gillespie Dam to the mouth of the Salt River and the area along the Salt River from its mouth to the McDowell Dam site.

The report recommends the construction of levees between 40th Street, Phoenix and Tempe Butte, Tempe, and channel improvements from Gillespie Dam to Granite Reef Dam consisting principally of a cleared floodway 2,000 feet wide, and two reaches of low flow channels. The proposed improvements would provide a measure of flood protection to the urban developments and agricultural lands in the flood plain. In addition, the report indicates that the removal of the phreatophytes in the proposed floodway will result in a minimum annual increase in the groundwater supply of 16,000 acre-feet which will be available for irrigation.

The report estimates that the additional water made available by the proposed improvements will have an average annual value of \$8 per acre-foot. This estimated value is based on present land use and water supply. However, the report does not indicate whether or not the benefits attributed to the increased water supply actually would be realized from the irrigation of additional land or from an increased water supply on land which is now irrigated. A different value might be obtained under different assumptions of land use and water supply. An analysis showing the increased production and increased net income expected to result from the additional water made available would support the indicated estimate of water conservation benefits.

At the present time, farmers in this area, particularly on those lands least subject to damage, are improving their irrigation systems for increased irrigation efficiency and higher or sustained crop yields. This work is being carried out through the soil conservation districts with technical assistance by the Soil Conservation Service. If the proposed improvements are installed, it may be anticipated that there will be a more widespread application of sound farm conservation practices on the lands which are now subject to damage.

The removal of phreatophytes from stream channels in water-scarce areas is desirable as a means of water conservation where it can be economically accomplished, as appears to be possible in this case. Their removal by mechanical methods will require continuous maintenance to prevent their reestablishment by sprouting or reseeding. The report recommends that the local organizations be required to provide this maintenance.

Agencies of this Department have been cooperating with other Federal and State agencies in the South West in developing methods of control of phreatophytes. The Rocky Mountain Forest and Range Experiment Station of the Forest Service has established a research plot a short distance upstream from the Granite Reef Dam. However, it does not appear that the proposed improvements will affect these research studies. The agencies of this Department will be glad to assist the Corps of Engineers and local organizations in the technical aspects of phreatophyte control in connection with this project.

We appreciate the opportunity afforded us to review this report.

Sincerely yours,

/S/ MARVIN L. McLAIN

Assistant Secretary

LETTER TO THE SECRETARY OF AGRICULTURE

DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington 25, D.C.

The Honorable

1 September 1959

The Secretary of Agriculture

Dear Mr. Secretary:

Reference is made to the Assistant Secretary's letter of 20 August 1959, furnishing the comments of the Department of Agriculture on the proposed report of the Chief of Engineers on the Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona.

I note the Assistant Secretary's comment that the report does not indicate whether or not the benefits attributed to the increased water supply actually would be realized from the irrigation of additional land or from an increased water supply on land which is now irrigated. The Assistant Secretary also suggests that an analysis showing the increased production and increased net income expected to result from the additional water made available would support the indicated estimate of water conservation benefits.

The project, as proposed, involves the salvage of water presently used nonbeneficially by river-bottom growth. The water conserved would not be delivered to any individual, group, or irrigation district, but would be made available to the ground-water basin to be used by all farmers who pump water from underground. The ground-water basin benefited is not a closed basin, but underlies nearly all the irrigated land in Maricopa County. Since the benefits accruing to specific individuals or groups in the project area are not identifiable, the value of water obtained on the basis of present land use and water supply is considered to be reasonable and conservative. Local interests have recognized the general benefits to Maricopa County that would result from the salvage of water and, on that basis, have agreed to repay all costs allocated to irrigation.

A copy of the Assistant Secretary's letter, together with a copy of this reply, will be included with the report of the Chief of Engineers when it is submitted to Congress. The comments of the Assistant Secretary are appreciated.

Sincerely yours,

/S/ W. K. WILSON, JR.

W. K. WILSON, JR.
Major General, USA
Acting Chief of Engineers

COMMENTS OF THE SECRETARY OF COMMERCE



THE SECRETARY OF COMMERCE
WASHINGTON 25, D. C.

May 28, 1959

Major General E. C. Itchner, U. S. A.
Chief of Engineers
Department of the Army
Washington 25, D. C.

Dear General Itchner:

Reference is made to your letter of 4 March 1959, requesting comments of this Department on your proposed report, and related reports, on Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona.

The Coast and Geodetic Survey has advised that there is adequate horizontal and vertical control along the entire length of the proposed project. The scope of the project is such that it does not appear that any control monuments will be affected, with the possible exception of some recently completed work in the vicinity of Phoenix-Tempe area.

In the light of this possibility, the Coast and Geodetic Survey has suggested that the Corps of Engineers determine if any of the C&GS monuments need to be re-established due to construction of levees in the Phoenix-Tempe area. Upon receipt of this information the amount of work involved in replacing the monuments can be determined. It also can then be determined if it will be necessary to ask for reimbursement from the Corps of Engineers for this work.

Since the local interests are required to pay for all necessary highway relocations as a part of the local contribution toward this project, adjustments to any Federal-aid highway routes for the accommodation of this flood control project would not be eligible for Federal-aid financing. The denial of Federal-aid funds for such work does not involve the discretion of this Department. It is based upon a fundamental relationship in the administration of Federal programs. Under that relationship, in the absence of a clear expression of the Congress authorizing such action, funds appropriated to the care of one Federal agency may not be used to relieve local interests of all

or any part of the obligation they have assumed, or are required to assume, as a condition for receiving Federal funds appropriated by the Congress to the care of another Federal agency.

We greatly appreciate the opportunity to review this report.

Sincerely yours,

/S/ LEWIS L. STRAUSS

Secretary of Commerce

LETTER TO THE SECRETARY OF COMMERCE

DEPARTMENT OF THE ARMY
Office of the Chief of Engineers
Washington 25, D.C.

3 June 1959

The Honorable

The Secretary of Commerce

Dear Mr. Secretary:

Your comments of 28 May 1959 on my proposed report on the Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, noted the possible effects of the proposed improvement on Coast and Geodetic Survey control monuments.

Should the project be authorized as recommended, plans will be coordinated with the U. S. Coast and Geodetic Survey to develop mutually satisfactory arrangements for replacing monuments which are affected. Copies of your letter and this reply will be included with the report when transmitted to Congress.

Sincerely yours,

/S/ E. C. ITSCHNER

E. C. ITSCHNER
Major General, USA
Chief of Engineers

**GILA AND SALT RIVERS, GILLESPIE DAM TO
McDOWELL DAM SITE, ARIZONA**

REPORT OF THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY



**DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON 25, D. C.**

August 11, 1959

Subject: Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona

To: THE SECRETARY OF THE ARMY

1. I submit, for transmission to Congress, my interim report covering an important part of the survey of Gila River and tributaries, Arizona and New Mexico, authorized by the Flood Control Act of June 28, 1938. It is accompanied by the report of the District Engineer which contains detailed information and illustrations, and by indorsements thereto expressing the views of the Division Engineer and Board of Engineers for Rivers and Harbors. The report concerns primarily the problem of flood control and the related need to conserve water for irrigation along 80 miles of river in the central portion of the basin, between Gillespie Dam on Gila River and McDowell Dam site on Salt River, an upstream tributary. The basin area and locations of these features in southern Arizona are shown on Plates 1 and 2 of the report of the District Engineer. This interim report is presented to furnish Congress information on worthy improvements without awaiting completion of the entire extensive survey. Improvements found advisable for construction at this time include levees along Salt River at the cities of Phoenix and Tempe, improvement of low flow channels in two reaches, and general removal of plant growths which restrict flood flows and consume large quantities of ground water.

2. Gila River rises in New Mexico, flows westward across southern Arizona, and enters Colorado River on the Arizona-California boundary, near the Mexican border. It drains 58,200 square miles of generally arid land most of which is in Arizona. Salt River enters Gila River at mile 198. The site for McDowell Dam, proposed by the Bureau of Reclamation, is at mile 46 on Salt River. This is only a short distance above Granite Reef Dam, constructed by local interests to divert water for irrigation. Gillespie Dam, also a water diversion structure of local interests, is on Gila River, 34 miles below the mouth of Salt River. Although this report is primarily concerned with the 80 miles of river valley between the McDowell Dam site and Gillespie Dam, it contains information on flood conditions thence to the head of Painted Rock Reservoir, about 15 miles downstream. This flood-control reservoir is under construction by the Corps of Engineers.

3. The area under consideration is within Maricopa County, which has a population of about 550,000 including an urban population of 370,000 at Phoenix, about mile 16 on Salt River. Tempe, a short distance farther upstream, had a population of 7,684 in 1950. Agriculture, dependent on irrigation, and stock raising are the principal activities. In 1956 about 300,000 acres were irrigated along the 80 miles of these rivers, with about 45 percent of the water obtained by ground water pumpage and the remainder by surface diversions.

4. Although Congress has authorized several flood-control projects in the Gila River Basin, under direction of the Corps of Engineers, they are not importantly related to the water problems in the area under consideration. The proposed central Arizona project of the United States Bureau of Reclamation, now pending for consideration in Congress, includes Buttes Reservoir on Gila River at mile 287 and Charleston Reservoir at mile 121 on San Pedro River, an upstream tributary of Gila River. In the studies for this report it is assumed that these reservoirs will be in operation. The Bureau's central Arizona project also contemplates importation of Colorado River water and construction of a terminal reservoir at the McDowell site which would provide space for temporary storage of the imported water. Construction is dependent upon future authorization by Congress and the settlement of litigation between the states of California and Arizona over the rights to the Colorado River water. Due to the indeterminate nature of these matters, the effects of the proposed diversion and storage have not been included in the present studies. Local interests have made minor channel improvements, provided irrigation works, and constructed a small basin on Cave Creek which reduces flood damages at Phoenix.

5. Flows are intermittent in the river reaches under consideration. The normal flows are carried in wide meandering channels obstructed by sand bars and overgrown to various degrees with water consuming plants (phreatophytes), principally salt cedar. These growths seriously reduce the flood carrying capacities of the streams and consume large amounts of water needed for irrigation. This water loss from a 2,000-foot-wide strip between Granite Reef Dam and Gillespie Dam has been estimated at a minimum of 22,000 acre-feet annually. Salt River, and Gila River below Gillespie Dam, have channel capacities of about 50,000 cubic feet per second but between this dam and Salt River, where the infestation by phreatophytes is greatest, the capacity of Gila River has been reduced to about 20,000 cubic feet per second.

6. Major floods occur on these streams as a result of general winter storms. The greatest of record was in February 1891 with an estimated peak flow of 300,000 cubic feet per second near the site of Granite Reef Dam. Other major floods occurred in 1905, 1916, 1920 and 1938. Records are incomplete but the floods are known to have caused severe damages and the loss of several lives. Developed areas in the flood plain are mostly agricultural. During extreme floods about 102,000 acres between the McDowell Dam site and Painted Rock Reservoir, including channels and wasteland, are subject to overflow. This includes 4,000 acres of urban property at Phoenix, South Phoenix, and Tempe. Cultivated areas in the flood plain include about 16,000

acres on Salt River, 15,000 acres thence to Gillespie Dam, and 1,300 irrigated acres between that point and the head of Painted Rock Reservoir. Aside from the urban areas, the properties subject to flood damages include rural buildings, bridges, highways, irrigation works and utilities. The District Engineer estimates the average annual flood damages at \$460,000 along Salt River, \$198,000 on Gila River above Gillespie Dam, and \$33,000 thence to Painted Rock Reservoir, a total of \$691,000.

7. Local interests desire clearing and straightening of the channels of Gila and Salt Rivers to prevent flood losses; reduce erosion damages; avoid interruptions of irrigation, railroad and highway communications, and utility services; and to reduce water losses resulting from the growth of phreatophytes. They offer to cooperate.

8. The District Engineer finds that the best plan of improvement at this time would provide for levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, with channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam, consisting of a floodway 2,000 feet wide cleared of the growth of phreatophytes and two reaches of low-flow or pilot channels, one extending intermittently for about 29 miles above Gillespie Dam and the other about 9,000 feet long at Tempe. These works would provide complete protection to most of Tempe and to a part of Phoenix against a major flood that would be exceeded only on very rare occasions and partial protection elsewhere along Gila and Salt Rivers between Gillespie Dam and Granite Reef Dam. In addition, an estimated minimum of 16,000 acre-feet of water would be saved annually and would be available for beneficial use. On the basis of October 1957 prices, the District Engineer estimates the costs and benefits as follows:

<u>First costs</u>	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Levees, 40th St., Phoenix, to Tempe	\$1,160,000	\$ 70,000	\$1,230,000
Channels and clearing of growths	2,140,000	140,000	2,280,000
Construction	\$3,300,000	\$210,000	\$3,510,000
Preauthorization studies	60,000	--	60,000
Total	<u>\$3,360,000</u>	<u>\$210,000</u>	<u>\$3,570,000</u>

<u>Annual carrying charges</u>		
Interest and amortization on \$3,570,000, (Federal and non-Federal)		\$ 125,900
Maintenance and operation of all improvements (non-Federal)		53,000
Total		<u>\$ 178,900</u>

<u>Average annual benefits</u>		
Prevention of flood damages		\$ 226,000
Conservation of water		128,000
Total		<u>\$ 354,000</u>

Ratio of benefits to costs 2.0

In view of the water conservation benefits, the District Engineer believes that local interests should repay 25 percent of the construction cost, without interest, in 40 equal annual payments, a total repayment estimated at \$825,000. Thus the United States would be reimbursed eventually by this amount, leaving the net cost to the United States for construction estimated at \$2,475,000, exclusive of interest. He points out that reclamation law, which permits interest-free repayment for irrigation benefits, limits the individual ownership of lands benefited to 160 acres. However, in this case, the water saved would become ground water available for use in the area generally and he concludes that the 160-acre limitation should not apply.

9. The District Engineer also considers the advisability of supplementing his plan described above, by the provision of storage for flood control in the reservoir proposed by the Bureau of Reclamation at the McDowell Dam site, if this project is constructed at some future time. He estimates the first cost of 672,000 acre-feet of such storage at \$5,700,000 and the annual carrying charges at \$203,500. This would increase the annual benefits by an estimated \$369,000. The benefit-cost ratio is 1.8.

10. The District Engineer recommends:

a. Accomplishment by the Corps of Engineers of the improvements described in paragraph 8 above, subject to certain indicated requirements of local cooperation,

b. That a 160-acre limitation on individual ownership of lands benefiting from the water conservation not be applied as a prerequisite for this project's qualifying for interest-free funds, and

c. That in event McDowell Reservoir is adopted for construction, the design be modified to provide such additional flood-control storage as is determined to be needed and justified at that time.

The Division Engineer concurs in these recommendations.

11. The Board of Engineers for Rivers and Harbors, after careful consideration of additional information presented by interested parties, concurs in general with the reporting officers and recommends the improvement, subject to certain requirements of local cooperation.

12. After due consideration of these reports, I concur in the views of the Board and accordingly recommend the improvement of Gila and Salt Rivers, Arizona, for flood control and water conservation, to provide for the construction of levees between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements from Gillespie Dam to Granite Reef Dam, consisting of a cleared floodway 2,000 feet wide and two reaches of low-flow channels; generally in accordance with the plan of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable; at an estimated cost of \$3,300,000 for construction; provided that, prior to construction, local interests

furnish assurances satisfactory to the Secretary of the Army that they will: (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project; (b) pay for all necessary highway and utility relocations; (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army; (d) keep the flood channel of Gila and Salt Rivers within the limits of the improvement free from encroachment; (e) repay to the United States 25 percent of the total Federal construction cost in 40 equal annual payments without interest, beginning the first year after completion of the work (the exact amount of the annual payments, presently estimated at \$20,625, to be adjusted on the basis of actual costs of construction, and such payments made to the Secretary of the Interior who, in turn, shall deposit such funds in the Treasury of the United States as miscellaneous receipts); (f) hold and save the United States free from damages due to the construction works; and (g) adjust all water-rights claims resulting from construction, operation, and maintenance of the improvements. The ultimate construction cost to the United States, exclusive of interest on the unpaid balance during the repayment period, is estimated at \$2,475,000.

13. I further recommend that the 160-acre limitation on ownership of lands benefiting from the water-conservation features of the project not be applied as a prerequisite for this project's qualifying for interest-free funds; and that, in the event the McDowell Reservoir is adopted for construction, the design be modified to provide such additional flood-control storage as may be found needed and justified at that time.



E. C. Itschner
Major General, USA
Chief of Engineers

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

Subject: Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona
(2d Indorsement)

The Board of Engineers for Rivers and Harbors, Washington 25, D. C.,
27 January 1959

To: The Chief of Engineers, Department of the Army

1. The Division Engineer issued a notice informing the public of the recommendations of the reporting officers, and affording interested parties an opportunity to furnish additional information to the Board. Careful consideration has been given to the communications received, including the supplemental comments of the United States Fish and Wildlife Service concerning the project effects on wildlife resources. The Board believes that consideration should be given in the advanced planning stage to all practicable measures for conserving the wildlife resource within the framework of the plan presented by the District Engineer.

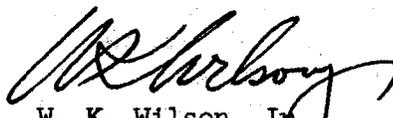
2. The Board concurs in general in the views and recommendations of the reporting officers. As pointed out by the District Engineer, the recommended improvements will afford substantially complete protection for the city of Tempe, partial protection to Phoenix and the commercial and agricultural area adjacent thereto, and partial protection to other property along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. Additional levees along Salt River for the protection of Phoenix, although considered, cannot be justified at this time by the resulting benefits. Consideration should be given to the inclusion of additional flood-control storage in McDowell Reservoir if and when that reservoir is adopted for construction for terminal storage of Colorado River water as a part of the central Arizona project. The Board is of the opinion that the proposed improvements are feasible from an engineering viewpoint and are economically justified.

3. The Board therefore recommends the improvement of Gila and Salt Rivers, Arizona, for flood control and water conservation, to provide for the construction of levees between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements from Gillespie Dam to Granite Reef Dam, consisting of a cleared floodway 2,000 feet wide and two reaches of low-flow channels; generally in accordance with the plan of the District Engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable, at an estimated cost of \$3,300,000 for construction; provided that, prior to construction, local interests furnish assurances satisfactory to the Secretary of the

Army that they will: (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for construction of the project; (b) pay for all necessary highway and utility relocations; (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of the Army; (d) keep the flood channel of Gila and Salt Rivers within the limits of the improvement free from encroachment; (e) repay to the United States 25 percent of the total Federal construction cost in 40 equal annual payments without interest, beginning the first year after completion of the work (the exact amount of the annual payments, presently estimated at \$20,625, to be adjusted on the basis of actual costs of construction, and such payments made to the Secretary of the Interior who, in turn, shall deposit such funds in the Treasury of the United States as miscellaneous receipts); (f) hold and save the United States free from damages due to the construction works; and (g) adjust all water-rights claims resulting from construction, operation, and maintenance of the improvements. The ultimate construction cost to the United States, exclusive of interest on the unpaid balance during the repayment period, is estimated at \$2,475,000.

4. The Board further recommends that the 160-acre limitation on ownership of lands benefiting from the water-conservation features of the project not be applied as a prerequisite for this project's qualifying for interest-free funds; and that, in the event the McDowell Reservoir is adopted for construction, the design be modified to provide such additional flood-control storage as may be found needed and justified at that time.

For the Board:


W. K. Wilson, Jr.
Major General, USA
Chairman

REPORT OF THE DISTRICT ENGINEER

SYLLABUS

The district engineer finds that a flood menace exists along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. He also finds that the river-bottom growth within the channels of the Gila and Salt Rivers not only greatly adds to the flood hazard but also, by transpiring large volumes of water annually, greatly depletes the ground-water supply.

After investigation of the various prospective solutions to the above problems, the district engineer finds that the most suitable plan at this time would consist of levees and channel improvements to provide a reasonable degree of flood protection, and to conserve water by eradication of water-consuming vegetation as a part of the channel improvement work. The plan would include short levees along Salt River between 40th Street in Phoenix and Tempe Butte in Tempe, and improvement of the Gila and Salt River channels from Gillespie Dam upstream to Granite Reef Dam.

The district engineer estimates the total Federal first cost of the project at \$3,360,000 (October 1957) comprising \$3,300,000 to be spent for construction and \$60,000 already spent for preauthorization studies; and the total non-Federal first cost at \$210,000 (October 1957). He estimates the total average annual charges at \$178,900, including an average of \$53,000 annually for maintenance and operation of the levee and channel improvements. He estimates the average annual benefits that would accrue from flood control and incidental water conservation at \$354,000. He states that the ratio of average annual benefits to average annual charges would be 1.98 to 1. He concludes that the project would be justified on the basis of the tangible benefits. Consideration of the intangible benefits would add weight to the justification.

The district engineer investigated the feasibility of the addition of flood-control storage to a terminal-storage reservoir at the McDowell site on Salt River. He concludes that the inclusion of sufficient flood-control space in a reservoir at the McDowell site to control the standard project flood would be justified in conjunction with development at that site of the terminal storage for the reclamation project proposed in House Document 136, 81st Congress, 1st session. Such flood-control space would be a desirable supplement to the above levee-and-channel improvement plan in order to insure an adequate degree of flood protection in the future for the rapidly growing urban area in the vicinity of Phoenix.

The district engineer is of the opinion that, because of the water-conservation benefits that would result from construction of the recommended project, local interests should be required to reimburse the United States for that part of the project construction cost allocated to water conservation, and such reimbursement should be made in 40 equal annual payments without interest. On the basis of October 1957 prices, the estimated amount of \$825,000 would be repaid in 40 equal annual payments of \$20,625.

The district engineer recommends that a flood-control project comprising levee and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam, as outlined above, be authorized for construction by the Corps of Engineers, United States Army, subject to the condition that local interests furnish assurances satisfactory to the Secretary of the Army that they will pay for the cost of highway and utility relocation; provide necessary lands, easements, and rights-of-way; repay, to the United States, 25 percent of the total construction cost in 40 equal annual payments without interest (the exact amount of the annual payments, presently estimated at \$20,625, to be adjusted on the basis of actual costs of constructing the project; annual payments to be made to the Secretary of the Interior who, in turn, will deposit such funds in the Treasury of the United States as miscellaneous receipts); maintain and operate the levee and channel improvements in accordance with regulations to be prescribed by the Secretary of the Army; keep the flood channel of the Gila and Salt Rivers free from encroachment; hold and save the United States free from all damages arising from construction and operation of the work; and adjust all water-rights claims resulting from construction, operation, and maintenance of the improvements.

The district engineer also recommends that, because of the special circumstances wherein the water-conservation benefits would be realized, the 160-acre limitation in ownership of lands benefiting from the water-conservation features of the project should not be applied as a prerequisite for this project's qualifying for interest-free funds.

The district engineer further recommends that, in the event McDowell Reservoir, proposed in House Document 136, 81st Congress, 1st session, is adopted for construction, the design be modified to provide such additional flood-control storage as is determined to be needed and justified at that time.

UNITED STATES ARMY CORPS OF ENGINEERS,
OFFICE OF THE DISTRICT ENGINEER,
LOS ANGELES DISTRICT,
Los Angeles, Calif., December 4, 1957.

Subject: Interim report on survey for flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

Through: The Division Engineer, United States Army Engineer Division, South Pacific, San Francisco, Calif.

To: The Chief of Engineers, United States Army.

AUTHORITY

1. This report is submitted pursuant to act of Congress, Public Law 761, Seventy-fifth Congress, approved June 28, 1938, which reads in part as follows:

SEC. 6. The Secretary of War is hereby authorized and directed to cause preliminary examinations and surveys for flood control including floods aggravated by or due to tidal effect at the following-named localities, and the Secretary of Agriculture is authorized and directed to cause preliminary examinations and surveys for run-off and water-flow retardation and soil-erosion prevention on the watersheds of such localities; ***:

* * * * *

Gila River and tributaries, Arizona and New Mexico.

* * * * *

2. A preliminary examination report on Gila River and tributaries, Arizona and New Mexico, dated January 10, 1939, was submitted by the district engineer in accordance with the act mentioned in the preceding paragraph. The report, which was reviewed by the Board of Engineers for River and Harbors, is the basis of authorization, dated April 18, 1939, by the Chief of Engineers for a report on a flood-control survey of the entire Gila River Basin.

3. The survey for the entire basin is being covered in seven interim reports, two review reports, and a final comprehensive report. Interim reports have been submitted as follows: Tucson, Ariz., and vicinity, dated November 20, 1945; Queen Creek, Ariz., dated February 2, 1946; Gila River and tributaries below Gillespie Dam, Ariz., dated September 1, 1948; and lower Agua Fria River and vicinity, Arizona, dated December 10, 1952. Two additional interim reports covering (a) Pinal Creek and tributaries and (b) Gila River, Camelsback Reservoir site to Salt River, Ariz., have recently been started.

This interim report, the seventh, considers the area along Gila River from Gillespie Dam to the mouth of Salt River and the area along Salt River from its mouth to the McDowell Dam site. Review reports to consider the Gila River and tributaries, Arizona, downstream from Painted Rock Reservoir site, and Gila River and tributaries in the vicinity of Tucson, Ariz., were authorized in 1954 and 1955, respectively. Work on these review reports is under way. The final comprehensive report will include summaries of findings and conclusions in all interim and review reports, consideration of problems in area not covered in any interim report, and analysis of the interrelation of problems and plans of improvement in all parts of the Gila River Basin.

SCOPE OF SURVEY

4. General.---The survey described in this interim report was made to consider (a) the need for flood control and (b) the solution of the flood problems in that part of the Gila River Basin, Ariz., that is along Gila and Salt Rivers between Gillespie Dam and McDowell Dam site. Consideration was given to the preservation and protection of established and potential uses of water and to the development of comprehensive and coordinated projects for improvement.

5. Topographic surveys and mosaics.---Aerial surveys of Gila and Salt Rivers from Gillespie Dam to McDowell Dam site were made by the Corps of Engineers in 1949. Cross sections of the river channel were taken at intervals of approximately 1 mile. Reconnaissance surveys of McDowell Dam site were made; detailed topographic surveys of the dam site were made by the United States Bureau of Reclamation.

6. Site investigations and explorations.---Geological reconnaissance of the McDowell Dam site was made by the Corps of Engineers. Logs of holes drilled at the site were supplied by the United States Bureau of Reclamation. Power-auger borings along the alignment of the Salt River levees considered were made by the Corps of Engineers. Samples of existing gravel pits near the city of Phoenix were analyzed. Adjacent areas from which adequate quantities of suitable embankment material for the levees considered and of suitable soils and aggregates that might be feasibly transported to McDowell Dam site were explored. Details of the subsurface explorations are given in Appendix 2: Geology and Soils.

7. Economic and other investigations.---Newspaper accounts of past floods were analyzed to determine the extent of overflow and damage from past floods. Field investigations were conducted to determine the extent of overflow from future floods and the type and value of property in the overflow areas. Assessed valuations of properties in the overflow areas were obtained and true valuations were estimated. Economic studies included analyses of crop values and farming costs. Local interests were interviewed about property values, agriculture, use and availability of water, and flood damage. A field inspection of the area was made by the district engineer.

PRIOR REPORTS

8. No prior survey reports on flood control in the Gila River Basin between Gillespie Dam and McDowell Dam site have been submitted to Congress by the United States Army Corps of Engineers.

DESCRIPTION

9. Location and extent.--The Gila River Basin, the largest drainage area tributary to lower Colorado River, includes the southern half of Arizona and a part of southwestern New Mexico. (See pl. 2.) The drainage area of the basin comprises about 58,200 square miles, 5,600 of which are in New Mexico, 51,500 in Arizona, and 1,100 in Sonora, Mexico.

10. The part of the Gila River Basin under consideration in this report comprises the Salt River Valley between McDowell Dam site (river mile 146) and the mouth of Salt River, and the Gila River Valley from the mouth of Salt River (river mile 198) to Gillespie Dam (river mile 164). The drainage areas of Salt River at McDowell Dam site and at the mouth are 12,900 and 13,700 square miles, respectively. The drainage area of Gila River at Gillespie Dam is 49,600 square miles. The Gila River Valley between Gillespie Dam and the upper end of the authorized Painted Rock Reservoir (now under construction) was also considered in this report because of the effect of a dam at the McDowell site on this area. (See index map, pl. 1, and map of Gila River Basin, pl. 2.)

11. Streams.--Gila River, the main stream in the drainage area, rises on the west slope of the Continental Divide in southwest New Mexico and flows generally westward about 650 miles to a point on Colorado River about 11 miles upstream from the California-Mexico boundary. The principal tributaries that join the main stream upstream from Salt River include the following streams: San Francisco and San Carlos Rivers, which enter the main stream from the north; and San Simon Creek and San Pedro and Santa Cruz Rivers, which enter from the south. The principal tributaries that join the main stream in the area under consideration in this report include Salt, Agua Fria, and Hassayampa Rivers, and Centennial Wash, which enter Gila River from the north. The principal tributaries of Salt River upstream from McDowell Dam site include Tonto Creek and Verde River. No major streams enter Salt River downstream from McDowell Dam site. The headwaters of Salt and Gila Rivers are perennial. Surface flow in other parts of the drainage area is mostly intermittent.

12. Topography.--The area along Gila and Salt Rivers from Gillespie Dam to McDowell Dam site is part of an alluvial valley that is very favorable for agricultural development. In the drainage area above Gillespie Dam, the mountains, in the headwaters of Verde River, rise to a maximum elevation of 12,600 feet. The divide, in general, ranges in elevation from 3,000 to 9,000 feet along the south side of the basin, and from 7,000 to 9,000 feet along the north and

northeast sides. The mountains are rugged and precipitous, and the valleys are sufficiently level to be favorable for agriculture.

13. Geology and soils.--The area drained by Gila and Salt Rivers is part of the Basin and Range Province, which covers a large part of southwestern United States. The surface of the area is a series of broad, connected desert valleys and plains, from which rise numerous hills and short, isolated mountain ranges. South of the area, a highland with similar topography extends many miles into Mexico. On the north, rugged mountains separate the area from the upland province known as the Colorado Plateau.

14. The rocks that form the hills and mountains and underlie the valleys and plains are chiefly great masses of Pre-Cambrian, metamorphose granites and volcanics, with which occur minor amounts of sedimentary rocks. During the Tertiary period, much block faulting occurred in this region and structural valleys were formed between the upthrown mountain blocks.

15. The intermontane valleys and plains are deeply filled with alluvium consisting of poorly assorted, coarse sediments interbedded with silt and clay. The soil in the valleys is fertile; and, where water without a high saline content is available for irrigation, the crop yields are high. The areal extent of sediments in the Salt River Valley and adjacent parts of the Gila River Valley totals several thousand square miles and includes the broad plain extending southward from Mesa and Chandler to Gila River. The maximum thickness of these sediments has not been determined but is known to exceed 1,300 feet at one point. Additional information on geology and soils in the Gila River Basin and detailed information on geology and soils at the McDowell Dam site and at the site of recommended levee and channel improvements are given in Appendix 2: Geology and Soils.

16. Stream characteristics.--In general, stream slopes in the Gila River Basin are not excessive. The gradients of Gila River and of most of the secondary streams are steep near the headwaters and decrease progressively downstream. The average slopes of Gila and Salt Rivers from the headwaters to their mouths are 13 and 25 feet per mile, respectively. The average slope of Salt River from McDowell Dam site to its junction with Gila River is about 9 feet per mile; the average slope of Gila River from Salt River to Gillespie Dam is about 5.5 feet per mile.

17. The channel capacity of Salt River from McDowell Dam site to its mouth is about 50,000 cubic feet per second. Normal flows meander over the bottoms of wide channels of various depths; major floods overflow the banks and spread over an area from 1 to 3 miles wide. Large flows are infrequent and the channel is partially blocked by sandbars and river-bottom growth.

18. In the area along Gila River from the mouth of Salt River to Gillespie Dam, the flow meanders over the flat bottom of a trench

5 to 20 feet deep and 1/2 to 1 mile wide. However, most of the channel bottom is overgrown with phreatophytes, principally saltcedar. This river-bottom growth has increased the aggradation of the channel and has restricted the channel to such an extent that flows in excess of 20,000 cubic feet per second will overflow and inundate the adjoining cultivated area. The overflow area of the standard project flood would range from 1 to 2-1/2 miles in width.

19. The channel capacity of Gila River from Gillespie Dam to the upper end of the authorized Painted Rock Reservoir (now under construction) is about 50,000 cubic feet per second. Flows in excess of this amount will inundate adjoining land and spread over an area from 1/2 to 2 miles wide.

20. Vegetation.--The type, density, and distribution of vegetation in the Gila River Basin reflect the differences in elevation, temperature, and precipitation. In general, the desert vegetation is sparse. The principal desert vegetation is cacti, creosotebush, and sagebrush. Saltcedar, mesquite, and arrowweed grow in dense thickets in stream bottoms and other areas where the water table is near the surface of the ground. Grasses interspersed with desert and semidesert shrubs grow at elevations ranging from 3,000 to 8,000 feet, but the density of vegetal cover is low below 4,500 feet and only fair at higher elevations. Overgrazing has destroyed much grass, which has been replaced by rabbitbrush and snakeweed over large areas. Chaparral, oak, pinon, and juniper grow at elevations ranging from 4,000 to 7,000 feet. Aspen and conifers, such as fir, spruce, and pine, are common above elevations of 6,000 feet.

21. Maps.--Maps of the Gila River Basin that were prepared by agencies of the Federal Government, by the State of Arizona, and by local interests were used in the preparation of this report. Maps included as plates to this report are as follows: Plate 1, Index Map, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona; and plate 2, Gila River Basin. Additional maps prepared for special use in connection with this report accompany appendixes to this report.

ECONOMIC DEVELOPMENT

22. Population.--The area affected by improvements considered in this report lies entirely in and includes most of Maricopa County, Ariz. Population in this area has increased steadily from 1900 to 1950 and has continued to increase at a rapid rate since that date. According to the United States census, the Maricopa County population was about 20,000 in 1900, 90,000 in 1920, 186,000 in 1940, and 332,000 in 1950. A local agency estimates the 1957 population of the county at 550,000. A number of cities, including Phoenix, the capital and largest city in the State of Arizona, would be affected by the improvements considered. The following table gives the 1950 population for these cities, for the Phoenix urban area, and for Maricopa County. Population estimates for 1957, where available, are also given.

1950 and 1957 populations in area affected by the improvements considered in the interim report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona

City or area	Population	
	1950	1957
Maricopa County.....	331,770	**550,000
Phoenix.....	*106,818	**172,000
Phoenix urban area.....	**230,000	**370,000
Mesa.....	16,790	(***)
Glendale.....	8,179	(***)
Tempe.....	7,684	(***)
Chandler.....	3,799	(***)
Tolleson.....	3,042	(***)

* A special census for the city of Phoenix made in March 1953 indicated a population of 128,840 in the city.

** Estimate made by Valley National Bank, Phoenix, Ariz.

*** Estimate not available.

23. Occupations and industries.--The principal activities in the Salt and Gila River Valleys from McDowell Dam site to Gillespie Dam are agriculture and stock raising. About 300,000 acres were irrigated in the area in 1956, providing an annual gross crop value of about \$85,000,000. The gross value of livestock in December 1953 was about \$15,000,000. The city of Phoenix is the trade and service center for most of the State of Arizona. The estimated value of retail sales in Maricopa County in 1956 was \$705,000,000, which was over 50 percent of the State total. The estimated manufacturing production in Arizona in 1956 was \$400,000,000, of which about 50 percent accrued in Maricopa County. Several large sand-and-gravel plants are located in the riverbed of Salt River.

24. Land use and development.--Irrigation of the Salt River Valley by white settlers began in 1867 soon after Arizona was given territorial status. Water was diverted to lands on the north bank of Salt River, near the site of the city of Phoenix. By 1871, staple crops were being produced on about 1,700 acres, and the new town of Phoenix had a population of about 300. The Santa Fe railroad was completed across northern Arizona to Colorado River in 1883, and in 1887 this line extended a branch to Phoenix. In 1900, Phoenix, with a population of 5,544, was the seat of the territorial government.

25. During the period 1890 to 1910, agriculture and associated industries expanded rapidly but spasmodically. Although the annual flows of the stream were more than adequate to supply the areas then irrigated, wide variations in flows occurred. Sudden rains would swell the streams to flood proportions, from which they would dwindle to

meager streamlets during the dry period. The agricultural economy was one of alternate prosperity and failure. Time after time, floods carried away the diversion dams, many of which had to be replaced every year. By the time these structures were repaired, the stream-flow would in many cases be insufficient to irrigate crops in the area, or the crops had withered and died from the intensity of the desert sun. After the passage of the Reclamation Act of 1902, the Salt River project was constructed by the Bureau of Reclamation from 1903 to 1911. Granite Reef diversion dam was completed in 1908, and Roosevelt Dam was completed in 1911 with resultant impetus to agricultural development and stability for urban and industrial growth. Further developments by the Salt River Valley Water Users' Association from 1920 to 1930 provided relatively cheap electric power. As a result, irrigation of new lands by pumping from wells expanded rapidly. Development of the Salt River project, which comprises most of the irrigated lands along Salt River, is shown by the following table:

Area in cultivation, Salt River project (1910-56)

Year	Area in cultivation
	Acres
1910.....	106,000
1920.....	193,000
1930.....	217,000
1940.....	227,000
1950.....	225,000
1956.....	192,600

26. Development of lands along Gila River below the mouth of Salt River started at the same time as development of lands along Salt River. The first irrigation canal in this area was built in 1886, and the settlement of Buckeye was founded about the same time. In 1921, the Gillespie diversion dam was built to serve about 16,000 acres of land, mainly on the left bank in the vicinity of Gila Bend.

27. Agriculture.--The agricultural economy of the valleys along Salt and Gila Rivers is well stabilized, and the farmers are generally prosperous, although they experience serious losses because of floods and water shortages. The supply of irrigation water under present conditions is not sufficient to provide a full supply of good quality water to the entire acreage under cultivation. The excess acreage has been kept in production temporarily by overdrafts on ground-water storage and by failure to make adequate releases to maintain a suitable salt balance in the area. A reduction in use to fit the yield and salt-balance requirements would greatly reduce the production of agricultural crops.

28. Facilitated by the mild winters and a long growing season, the area is adapted to a wide range of agricultural crops. Principal crops include alfalfa, barley, cotton, flax, sugar beets, citrus crops, and truck crops, such as lettuce, cantaloupes, watermelons, and carrots. Many acres are double-cropped. During 1956, the gross value of crops in the Salt River project was about \$55,300,000 for 192,600 acres, or about \$287 per acre.

29. Irrigation.--Agriculture along the Salt and Gila Rivers from McDowell Dam site to Gillespie Dam is entirely dependent on irrigation. Most of the irrigated lands have gentle slopes; they are favorable for the distribution of water and for surface and underground drainage. The extensive irrigation works constructed by the prehistoric occupants of the basin and the existing development both emphasize the favorable conditions for growing crops by irrigation.

30. In the area under consideration, irrigation water is obtained by surface diversions supplemented by pumping from the underground supply. Along Salt River, water is diverted from the river to the two main canals at Granite Reef Dam, which is downstream from the confluence of Verde and Salt Rivers. The combined capacities of the Arizona canal, serving the north side, and the Southern canal, serving the south side, permit the diversion of all flows up to 4,000 cubic feet per second. The irrigation flow is regulated by Bartlett and Horseshoe Dams on Verde River, and Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain Dams on Salt River. Lands in the Roosevelt Water Conservation District and the Roosevelt Irrigation District are also served by the diversion at Granite Reef Dam. Along Gila River, Buckeye and Arlington diversion structures and canals serve the Buckeye and Arlington Valleys, respectively. Gillespie Dam diverts the surface flow to lands of the Gillespie Land and Water Co. on the left bank and to lands supplied by the Enterprise canal on the right bank. Minor diversion structures, canals, and pumps serve the small irrigation districts along the Salt and Gila Rivers.

31. Use of ground water for the irrigation of lands in this area has increased rapidly since 1935. In 1956, about 45 percent of the total supply was obtained from wells. In the Salt River project in 1956, a total of 517,000 acre-feet were delivered from 264 wells.

32. The quantity of water applied annually to an acre of irrigated land varies with type of soil, kind of crops, efficiency of farm management, and amount of water available. The net duty of water varies from about 2.3 acre-feet per acre for truck crops to about 5.0 acre-feet per acre for alfalfa and grain. The average net duty of water is estimated at about 4.0 acre-feet per acre, measured at the farmer's headgate.

33. Water rights.--The water code of Arizona recognizes that both surface flow and underground waters flowing in definite channels belong to the public and are subject to appropriations governed by beneficial use. Percolating water in undefined channels is the property of the overlying land and is not subject to appropriation.

34. Water rights within the Salt River project are adjudicated under the Kent Decree, entered March 1, 1910. The Benson-Allison Decree of November 14, 1917, adjudicated water rights between the various users of water diverted by several ditches, including the Buckeye canal, from the Salt, Agua Fria, and Gila Rivers. Various arrangements have been made between the water users under these rights and the Salt River project for the delivery of their waters. A court decree effective January 1, 1944, fixed the amount of water that should be delivered to the Buckeye district by the Salt River project as 1.1 percent of the water actually diverted at Granite Reef Dam.

35. One of the most significant features in the use of irrigation water, and one that has grown in importance during the recent years of deficient water supply, is the increasing amount of pumping from underground storage to compensate for deficiencies in streamflow. Many pumping installations have been made indiscriminately according to individual requirements. Extension of this practice has led to overdevelopment and overdraft from ground-water sources of supply. In 1948, the Arizona Legislature passed an act authorizing the State Land Commissioner to designate critical ground-water areas for which adequate factual data indicate that the ground-water supply has been overdeveloped. After establishment of a critical area, no person is permitted to construct any irrigation well in that area without a permit, and no permit is to be issued for construction of any well that would tend to increase the acreage irrigated.

36. Power.--Most of the power used in the area under consideration is obtained from local sources. Power is obtained from the Salt River Project Agricultural Improvement and Power District and from the Arizona Public Service Company. To develop power, advantage is taken of the entire 723-foot fall on Salt River from high water level at Roosevelt Lake to tailwater below Stewart Mountain Dam. The combined generating capacity at the 4 structures is about 62,800 kilowatts. A standby diesel plant and modern steam plants are the other local sources of supply. In addition, the 2 local distributing agencies have contracts with the Arizona Power Authority and the United States Bureau of Reclamation, which obtain power from Parker and Davis Dams on Colorado River. A complete transmission and distribution system provides power for domestic use (including city and rural use) and for irrigation pumping. In general, the power supply (existing and contemplated) is adequate for the needs of the area.

37. Transportation facilities.--Arterial highways and railroads connect the areas along Gila and Salt Rivers with centers of manufacturing and commerce throughout the nation. United States

Highways Nos. 60, 70, and 80 cross the area on their routes from the Pacific coast to the Eastern States. United States Highway No. 89, which also crosses the area, extends from the Canadian to the Mexican border. Arizona State highways supply connecting links, and many local roads complete a network that adequately serves present needs. One of the main lines of the Southern Pacific railroad traverses much of the area under consideration. A branch line of the Atchison, Topeka and Santa Fe railway connects Phoenix with the main line to the north. The Sky Harbor Airport provides daily airmail, passenger, and freight service in and out of Phoenix. Many trans-continental bus routes pass through the area.

CLIMATOLOGY

38. General.--The climate of the area along Gila and Salt Rivers from Gillespie Dam to McDowell Dam site is subtropical and arid. Wind velocities are low to moderate. The average length of the season between frosts is about 300 days in Phoenix, Ariz. Recorded extremes of temperature for a 45-year period at Phoenix are 16° and 118° above zero Fahrenheit.

39. Precipitation records.--Precipitation records are available for more than 600 stations in and near the Gila River Basin. Many of these stations were established since 1935 in connection with projects of the United States Soil Conservation Service. The longest continuous record is for Yuma, Ariz., where precipitation was first measured in 1870; and the earliest records are for Fort McDowell, Ariz., and Prescott, Ariz., where precipitation was first measured in July 1866 and September 1866, respectively. Autographic records are available for more than 40 of the stations, most of which were established since 1939. The longest continuous autographic record is for Phoenix, where an automatic gage was installed in 1906.

40. For the 71-year period prior to about 1938, the average annual precipitation at stations in the Gila River Basin above Gillespie Dam ranged from about 33 inches at Carr's ranch (elev. 5,410 feet), about 14 miles northeast of Roosevelt Dam, to less than 7 inches at Saddle Mountain (elev. 1,125 feet), 20 miles northwest of Gillespie Dam. The mean annual precipitation in the Gila River Basin upstream from Gillespie Dam is about 15 inches. The largest annual precipitation recorded in the region was 58.45 inches, which occurred in 1905 at Pinal ranch (elev. 4,520 feet), about 6 miles east of Superior, Ariz. Precipitation data for the Gila River Basin are discussed in detail in Appendix 1: Hydrology. Pertinent data on representative stations in the Gila River Basin above Gillespie Dam are given in the following table:

Precipitation data, representative stations in the Gila River Basin above Gillespie Dam, Ariz. and N. Mex.

Station	Location		Elevation	Period of record	Complete years of record	Mean annual precipitation*
	Latitude	Longitude				
	Decrees- minutes	Degrees- minutes	Feet		Years	Inches
Luna ranger station, N. Mex....	33-50	108-56	7,050	1900-57	57	16.46
Red Rock, N. Mex.....	32-42	108-44	4,150	1905-57	50	11.99
Ashfork, Ariz.....	35-13	112-29	5,140	1902-57	55	12.92
Prescott, Ariz.....	34-33	112-28	5,354	1866-1957	81	18.75
Phoenix, Ariz.....	33-28	112-04	1,083	1876-1957	71	7.56
Gila Bend, Ariz.....	32-57	112-43	737	1889-1957	68	5.87
Roosevelt, Ariz.....	33-40	111-09	2,230	1905-57	52	16.50
Fort Apache, Ariz.....	33-48	109-59	5,300	1872-1934	62	18.42
Tucson, Ariz.....	32-15	110-58	2,423	1891-1957	66	11.46
Pinal Ranch, Ariz.....	33-20	111-00	4,520	1893-1957	64	25.04

* Computed for 71-year period (1868-1938) by index-of-wetness method. Data for period subsequent to 1938 were not considered necessary for adequate determination of mean annual precipitation.

41. Storms.--Most precipitation in the Gila River Basin occurs in two seasons: July through September, and December through March. Precipitation during the winter usually results from general winter storms associated with extratropical cyclones of North Pacific origin. During the months from December to March, such storms move south over the ocean and then inland to southern California, Arizona, and New Mexico and result in precipitation over areas of up to thousands of square miles. Precipitation during general winter storms may be more or less continuous for several days. Relatively localized showers near the end of such storms are common. In general, precipitation is small during spring and autumn. Most precipitation during the summer results from showers of short duration and small areal extent or from general summer storms. Storms of the thunderstorm type may occur separately or in conjunction with general storms. Detailed information on storms in the Gila River Basin is given in appendix 1.

42. Snow.--Many precipitation records since 1900 for stations in the area include information on snowfall. Snow-course observations have been made since about 1937 at several points in the drainage areas of Verde, Salt, and upper Gila Rivers. In winter, snow may accumulate to considerable depths at elevations above 4,000 feet but practically never falls at elevations below 2,000 feet. Heavy snowfalls in the drainage basin of Gila River are limited to areas tributary to Agua Fria, Verde, upper Salt, and San Francisco Rivers.

RUNOFF AND STREAMFLOW DATA

43. Streamflow records.--Streamflow records are available for 95 stations on Gila River and tributaries. Records of discharge at most stations during flood periods generally are inadequate. The earliest gagings for which records are available were on Salt River during 1888 near the site of Granite Reef Dam.

44. Records of stream discharge on Gila and Salt Rivers between Gillespie Dam and McDowell Reservoir site are available for four locations. Pertinent data for these locations are given in the following table:

Stream-gaging stations, Gila and Salt Rivers, Gillespie Dam to McDowell
Reservoir site, Arizona

Location	Drainage area	Period of record	Maximum recorded flow	
			Peak	Date
	Square miles		Cubic feet per second	
Salt River near McDowell.	6,280	1895-99; 1901-10; 1934-57.	138,000	Nov. 27, 1905.
Verde River near McDowell.	6,620	1889; 1895-99; 1901-9; 1913-57.	96,000	Do.
Salt River near Granite Reef Dam.	12,900	1888-91; 1895; 1913-57.	300,000	Feb. 24, 1891.
Gila River below Gillespie Dam.	49,600	1921-57.	70,000	Dec. 28, 1923.

45. Adequacy of streamflow for multiple-purpose uses.--The daily surface runoff in Salt and Gila Rivers varies greatly during the year, and the annual surface runoff varies greatly from year to year. Flow in the river is erratic and out of phase with irrigation requirements. As a result, many large reservoirs have been constructed upstream from Gillespie Dam to store the runoff until needed. The effect of these structures has been to conserve nearly all flow of the Salt River upstream from McDowell Dam site except during some flood seasons. During the period 1923-57, if existing reservoirs had been in operation during the entire period, flow would have been available for conservation at McDowell Dam site for only 4 of the 35 years of record. Preliminary estimates made by the United States Bureau of Reclamation show the following flow as being available at McDowell Dam site:

Flow available for conservation at McDowell Dam site, Salt River, Ariz.
(1923-57)

Year	Available flow
	Acre-feet
1927.....	80,600
1932.....	204,000
1937.....	188,800
1941.....	387,300
Total.....	860,700
Say.....	860,000

FLOODS

46. Floods of record.--Historical reference to floods on Salt and Gila Rivers from McDowell Dam site to Gillespie Dam extends back to 1833, but estimates of discharge measurements are for only the period 1888 to date. Large floods during this period occurred in 1891, 1905, 1916, 1920, and 1938.

47. The greatest flood of record occurred in February 1891. The peak discharge of this flood was estimated at 300,000 cubic feet per second on Salt River at Arizona Dam (approximately same location as the present Granite Reef Dam). Other major floods of record, for which adequate estimates of peak discharge along Salt River below Verde River are available, include: February 1920, 130,000 cubic feet per second; January 1916, 120,000 cubic feet per second; April 1905, 115,000 cubic feet per second; and March 1938, 95,000 cubic feet per second. Additional information on floods is given in Appendix 1: Hydrology; and in Appendix 5: Benefits from Improvements.

48. Flood characteristics.--Major floods along Salt and Gila Rivers from McDowell Dam site to Gillespie Dam result from general winter storms over the Gila River Basin. Many of the streams in the Gila River Basin rise in steep mountain areas where the rate of runoff is relatively high. During major storms, the water concentrates quickly in the channels and results in violent and destructive floods. The peak discharges of floods are relatively high in comparison with the total volume of floodwater. Channel storage and losses reduce the flood peaks when no additions are made by side drainage. Because Salt and Gila Rivers flow westward and winter storms usually move eastward over the basin, the probability of synchronization of peaks of winter floods from the different tributaries is small. Peaks from downstream (western) tributaries usually pass on before the runoff from the area farther east arrives. The base flow, made up of contributions from ground water, melting snow, and surface runoff from rain prior to rain of flood-producing intensities, is relatively small in comparison with the peak floodflows.

49. Flood frequencies.--The frequencies of floods considered in detail were determined under the assumption that all existing reservoirs in the Gila River Basin and the proposed Buttes and Charleston Reservoirs (see subsequent heading "Proposed Improvements Affecting the Problem") would be in operation. Records of peak flows and peak-flow estimates, based on data for the 69-year period 1889-1957, were used in preparing discharge-frequency curves. Detailed information on flood frequencies is given in Appendix 5: Benefits from Improvements. The estimated frequencies of floods of various magnitudes for Salt River at McDowell Dam site and Gila River at Painted Rock Dam site are listed in the following table:

Estimated frequencies of floods of various magnitudes, Salt River at McDowell Dam site and Gila River at Painted Rock Dam site, Arizona

Number of times that flood would be equaled or exceeded in 100 years	Peak discharge	
	Salt River at McDowell Dam site	Gila River at Painted Rock Dam site
	<u>Cubic feet</u> <u>per second</u>	<u>Cubic feet</u> <u>per second</u>
0.6.....	*290,000	*320,000
1.....	240,000	261,000
2.....	175,000	195,000
5.....	108,000	120,000
10.....	68,000	74,000
15.....	**50,000	52,000
20.....	(***)	38,000
32.....	(***)	**20,000

- * Standard project flood.
- ** Minimum damaging flood.
- *** Not determined.

50. Standard project flood.--A standard project flood may be defined as a large hypothetical flood that would be exceeded only on rare occasions. It could occur in the Gila River Basin if a storm equivalent in magnitude to the largest general storm or storms of record in the region were to center over the basin when ground and climatic conditions were conducive to a high rate of runoff. Estimates of the magnitude of such a flood serve not only as a reasonable yardstick for determining the flood-producing potentialities of the basin but also as a reasonable upper limit in determining the size of the flood that should be considered in designing flood-control improvements.

51. Estimates of the magnitude of the standard project flood for points on Salt River from McDowell Dam site to the mouth are based on calculations of runoff that would have resulted if a storm having characteristics of both the January 1916 and March 1938 storms were centered over the area above the McDowell Dam site. Estimates of the magnitude of the standard project flood for points on Gila River are based on the assumed occurrence of the January 1916 storm, centered over the area above Gillespie Dam, and assuming that the proposed Buttes and Charleston Reservoirs were in operation. Detailed information on the determination of the standard project flood is given in Appendix 1: Hydrology. The peak discharges of the standard project flood are given in the following table:

Estimated peak discharges, standard project flood, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona

Stream	Location	River mile	Peak discharge
			<u>Cubic feet</u> <u>per second</u>
Salt River.....	McDowell Dam site.....	46	290,000
Do.....	Mouth.....	0	250,000
Gila River.....	Just below Salt River..	198	370,000
Do.....	Gillespie Dam.....	164	350,000

52. Maximum probable flood.--The maximum probable flood is that flood that would result from the most severe combination of meteorological and ground conditions considered possible of attainment in the drainage area. The peak discharge of the maximum probable flood at McDowell Dam site is estimated at 600,000 cubic feet per second. This flood is used only for spillway-design purposes. Detailed information on the determination of the maximum probable flood is given in Appendix 1: Hydrology.

EXTENT AND CHARACTER OF OVERFLOW AREA

53. Location and extent.--The overflow areas considered in detail are as follows: (a) 44,000 acres along Salt River from McDowell Dam site to the mouth; (b) 41,000 acres along Gila River from Salt River to Gillespie Dam; and (c) 17,000 acres along Gila River from Gillespie Dam to the upper end of Painted Rock Reservoir site. The last area was considered because of the effect that McDowell Reservoir would have on floodflows of Gila River below Gillespie Dam. The overflow areas investigated in detail are described more fully in Appendix 5: Benefits from Improvements, and are shown on map, plate 1 of that appendix.

54. Type and value of improvements.--Developed areas subject to overflow by floods along Salt and Gila Rivers are mostly agricultural. However, the value of residential, business, industrial, and public properties in the cities of Phoenix and Tempe greatly exceeds the total value of other properties in these areas. Pertinent information on the type and value of improvements in overflow areas is given in the following subparagraphs.

(a) Overflow area along Salt River, McDowell Dam site to mouth.--The 1957 cultivated acreage in the overflow area of Salt River, McDowell Dam site to mouth, is estimated at 16,000 acres. In addition, about 4,000 acres of residential, commercial, and public property in Phoenix, Tempe, and South Phoenix are subject

to inundation. Other improvements subject to damage include highways, roads, two long highway bridges, one railroad bridge, irrigation works, and utilities including the Phoenix and Tempe sewage disposal plants.

(b) Overflow area along Gila River, Salt River to Gillespie Dam.--About 15,000 acres of the overflow area of Gila River, Salt River to Gillespie Dam, were cultivated in 1957. This acreage is mostly along the right bank of the river. The community of Liberty and many rural residences are subject to damage. The headings of the Buckeye and Arlington canals and the canals themselves are subject to overflow and repeated damage. Other property subject to damage includes short sections of highways and roads, the Buckeye sewer farm, and some utility crossings of Gila River.

(c) Overflow area along Gila River, Gillespie Dam to upper end of Painted Rock Reservoir site.--About 1,300 acres of irrigated land in the overflow area along Gila River, Gillespie Dam to the upper end of Painted Rock Reservoir site, are subject to inundation. Damage in this area will occur mainly to agricultural property, irrigation works including Gillespie Dam, and highways and roads.

(d) Summary.--A summary of information on the type and 1957 value of property in the overflow areas considered in detail is given in the following table:

Property subject to damage by the standard project flood in the overflow areas along Salt River from McDowell Dam site to the mouth and along Gila River from the mouth of Salt River to upper end of Painted Rock Reservoir site, Arizona

TRUE VALUE (1957)

Property	Overflow area		
	Salt River, McDowell Dam site to mouth	Gila River, mouth of Salt River to Gillespie Dam	Gila River, Gillespie Dam to upper end of Painted Rock Reservoir site
Residential.....	\$46,930,000	\$1,280,000	\$5,000
Business and industrial..	18,890,000	0	0
Public.....	22,200,000	0	8,000
Agricultural.....	14,580,000	13,470,000	670,000
Irrigation works.....	900,000	440,000	1,310,000
Highways and roads.....	2,000,000	290,000	500,000
Railroads.....	600,000	0	0
Utilities.....	4,940,000	80,000	0
Total.....	111,040,000	15,560,000	2,493,000
Grand total.....		129,093,000	
Say.....		129,000,000	

ACREAGE

	Acres	Acres	Acres
Cultivated.....	16,000	15,000	1,300
Urban.....	4,000	0	0
Other (stream channel and wasteland).....	24,000	26,000	15,700
Total.....	44,000	41,000	17,000
Grand total.....		102,000	

FLOOD DAMAGES

55. Damages from past floods.--Floods on Salt and Gila Rivers from McDowell Dam site to the upper end of Painted Rock Reservoir site have caused severe damage to property and loss of at least 6 lives. Available data on damages from past floods are incomplete. Newspaper accounts supply incomplete flood-damage descriptions of those floods that have occurred since 1890, but monetary estimates are very limited. The flood of February 1920, the last large damaging flood of record, caused an estimated damage of \$300,000 within the Salt River project. More complete information on damages from past floods is given in Appendix 5: Benefits from Improvements.

56. Damages from future floods--1957 conditions.--Damages from future floods under 1957 conditions would be greater than from past floods because of increased development in the area subject to overflow and because of the deterioration of the flood channels. In estimating the damage from a single flood, consideration was given to the probable extent of its overflow area, the type and value of property subject to damage, and the extent of damage that would occur to each type of property from floodwaters of computed depth and velocity. For each overflow area, the selected flood magnitudes range from the discharge that would cause a small amount of damage to the discharge of the standard project flood. Detailed data on damage from future floods are given in appendix 5. All damages evaluated in this report are classified as primary damages, which have been divided into direct and indirect damages. Such secondary damages as may exist are considered to be small and have not been included in the evaluation of the project. Direct damage to property is physical damage resulting from overflow or erosion. Indirect damage is the result of direct damage and includes (a) costs of flood fighting, rescue work, and similar emergency measures; (b) business and similar losses from decreased production, decreased profits and wages, and increased costs of normal operations and living; and (c) costs of rerouting traffic as a result of interruption of highway and railroad lines. Pertinent information on the direct and indirect damages in the overflow area along Salt River under 1957 conditions is given in the following tables:

Estimated damage from future floods of various magnitudes along Salt River from McDowell Dam site to mouth
(1957 conditions)

ESTIMATED DAMAGE FROM FUTURE FLOODS

Property subject to damage		Damage from future floods of various magnitudes*					
Type	Value (1957)	290,000 c.f.s.**		150,000 c.f.s.		100,000 c.f.s.	
		Direct	Indirect	Direct	Indirect	Direct	Indirect
Residential.....	\$46,930,000	\$3,140,000	\$630,000	\$650,000	\$130,000	\$43,000	\$9,000
Business and industrial.....	18,890,000	1,990,000	690,000	580,000	210,000	70,000	14,000
Public.....	22,200,000	870,000	170,000	260,000	50,000	2,000	0
Agricultural.....	14,580,000	3,430,000	570,000	900,000	150,000	210,000	30,000
Irrigation works.....	900,000	190,000	440,000	90,000	110,000	5,000	1,000
Highways and roads.....	2,000,000	290,000	60,000	110,000	20,000	3,000	1,000
Railroads.....	600,000	90,000	90,000	35,000	35,000	2,000	0
Utilities.....	4,940,000	210,000	210,000	80,000	80,000	35,000	35,000
Total.....	111,040,000	10,210,000	2,860,000	2,705,000	785,000	370,000	90,000
Total direct and indirect damage.....		\$13,070,000		\$3,490,000		\$460,000	

* Discharge on Salt River at McDowell Dam site.

** This is the standard project flood.

Estimated damage from future floods of various magnitudes in overflow
area along Salt River (1957 conditions)

Flood magnitude*	Estimated damage		
	Direct	Indirect	Total
Cubic feet per second			
290,000	\$10,210,000	\$2,860,000	\$13,070,000
150,000	2,705,000	785,000	3,490,000
100,000	370,000	90,000	460,000
50,000	0	0	0

* Discharge on Salt River at McDowell Dam site.

57. Estimates were made of the tangible damages under 1957 conditions from future floods of various magnitudes in the other overflow areas considered. These estimates are summarized in the following table:

Summary of estimated damage from future floods of various magnitudes
in the overflow areas along Gila River (1957 conditions)

Overflow area	Flood magnitude*	Estimated damage		
		Direct	Indirect	Total
	Cubic feet per second			
Gila River, mouth of Salt River to Gillespie Dam.	**320,000	\$3,590,000	\$890,000	\$4,480,000
	174,000	1,480,000	380,000	1,860,000
	115,000	704,000	156,000	860,000
	44,000	192,000	40,000	230,000
	20,000	0	0	0
Gila River, Gillespie Dam to upper end of Painted Rock Reservoir site.	**320,000	778,000	322,000	1,100,000
	193,000	346,000	131,000	477,000
	97,000	35,000	11,000	46,000
	50,000	0	0	0

* Discharge on Gila River at Painted Rock Dam site.

** Standard project flood.

58. Damages from future floods--average future conditions.--

Damages from future floods under average future conditions were computed on the basis of (a) estimated average future economic development of the overflow area and (b) average future channel conditions. The populations and property values of the city of Phoenix, of the Phoenix urban area, and of Maricopa County have increased steadily from 1900 to 1950 and have continued to increase since that date. Between 1950 and 1957, the population of the Phoenix urban area is estimated to have increased from 216,000 to about 370,000. The population and property development in the overflow area along Salt River will continue to increase in the future. A study of future population growth in the city of Phoenix and in the Phoenix urban area was made in 1951 by a private consulting firm. Actual growth since 1951 exceeded the estimates made by the engineering firm. On the basis of past growth and the forecasts of future growth made by the consulting firm (which appear to be conservative), the average future development of residential, business, industrial, public, and utility properties in the overflow area along Salt River during the 50-year period, 1958-2007, is estimated at about 55 percent greater than the 1957 development. In the overflow areas along Gila River below the mouth of Salt River, present property development and average future property development are considered identical. More detailed information regarding the estimates of future growth is given in appendix 5.

59. Along Gila River, channel conditions during the next 50 years will vary from year to year depending on many factors, including (a) the occurrence of wet or dry cycles and (b) the importation of water. The surface flow and a relatively high ground-water table that now sustain the growth of water-loving plants (phreatophytes) will probably continue to sustain the growth. The average channel conditions during the next 50 years were therefore considered identical to the present channel conditions. Along Salt River, the stream channel is relatively clear at present. In 1941, local interests had burned much of the growth existing at the time. Since that time, the water table has lowered and no flows, except relatively minor flows in short stretches of the river, have occurred. On the occurrence of spills from Stewart Mountain or Bartlett Dams, phreatophytes will reoccur and will reduce the channel capacity to some extent. Estimates of damages along Salt River under average future conditions were made on the basis of average future development of the overflow area and on assumed average future conditions of the stream-channel area. Estimates of damage in the two overflow areas along Gila River are the same under average future conditions as under present conditions. The following table summarizes the damage under average future conditions in the overflow area along Salt River:

Summary of estimated damage from future floods of various magnitudes, along Salt River from McDowell Dam site to mouth (average future conditions)

Peak discharge*	Total direct and indirect flood damage
<u>Cubic feet per second</u>	
290,000	\$19,400,000
150,000	5,600,000
100,000	1,000,000
50,000	0

* Discharge on Salt River at McDowell Dam site.

60. Average annual damages from future floods.--Curves were drawn showing the relationships between peak discharges and average future damages for the overflow areas. These curves were combined with the discharge-frequency curves previously described to obtain curves showing the estimated number of times in 100 years that damages from single floods would be equaled or exceeded. The areas under the damage-frequency curves represent the estimated total flood damages during a 100-year period, and the total for each overflow area divided by 100 is the estimated average annual flood damage for that area. A summary of the estimated annual damage from future floods is given in the following table:

Estimated average annual future flood damage in overflow areas, Salt and Gila Rivers, McDowell Dam site to upper end of Painted Rock Reservoir site, Arizona

Overflow area	Average annual damage
Along Salt River, McDowell Dam site to mouth.....	\$460,000
Along Gila River, Salt River to Gillespie Dam.....	198,000
Along Gila River, Gillespie Dam to upper end of Painted Rock Reservoir site.....	33,000
Total.....	691,000

61. Intangible damages from future floods.--In addition to the tangible damages evaluated in this report, future floods along Salt and Gila Rivers would cause serious damages not calculable in terms of monetary value. Such intangible damages would result from loss of

life; delay in the shipment of perishable products; interruption of passenger travel on railroads and highways; isolation of communities; interruption of home life and of school and other community activities; inconvenience caused by interruption of public utility services; lowering of property values because of fear of floods; and general lowering of community morale.

EXISTING CORPS OF ENGINEERS FLOOD-CONTROL PROJECTS

62. Existing Corps of Engineers flood-control projects in the Gila River Basin comprise one completed project, one project under construction, one project in the planning stage, and one project under review.

63. Public Law 209, 83rd Congress, 1st session, approved August 7, 1953, authorized the Secretary of the Air Force to construct a detention basin on Trilby Wash about 20 miles west of Phoenix, Ariz., and an outlet channel to convey flood releases from the Trilby Wash detention basin toward the Agua Fria River. This project was completed in July 1956. Flood problems along Trilby Wash and adjoining washes are local in character and do not affect the problem area under consideration.

64. The Flood Control Act of May 17, 1950, authorized construction of Painted Rock Dam for flood control at mile 126 on Gila River, Ariz. (See H. Doc. 331, 81st Cong., 1st sess.) The dam and reservoir (now under construction) would provide flood protection to lands along lower Gila River, along lower Colorado River, and in the Imperial Valley. The construction of Painted Rock Dam was assumed in the studies of this report and no benefits were considered to accrue to plans considered in this report below the upper end of the reservoir site.

65. The Flood Control Act of July 24, 1946, authorized construction of Whitlow Ranch Dam for flood control on Queen Creek, Ariz. (See H. Doc. 220, 80th Cong., 1st sess.) Definite design studies on this project were initiated in 1956. Floodwaters from Queen Creek very rarely reach Gila River, and problems of flood control and water utilization on the two streams are only slightly related.

66. The Flood Control Act of June 30, 1948, authorized construction of a diversion channel and levee system for flood control in the vicinity of Tucson, Ariz. Plans for the improvement provide for diverting floodflows from the upstream parts of the drainage areas of Tucson Arroyo and other minor adjacent streams to Santa Cruz River at a point upstream from Tucson. (See H. Doc. 274, 80th Cong., 1st sess.) In 1955, a review of the flood problems at Tucson was authorized, and work on this review report is under way. Flood problems in Tucson are local in character, and the authorized improvement would be unrelated to improvements in other parts of the Gila River Basin.

EXISTING IMPROVEMENTS BY OTHER FEDERAL AND NON-FEDERAL AGENCIES

67. Pertinent information on flood-control and water-utilization improvements constructed in the Gila River Basin above Gillespie Dam by other Federal and non-Federal agencies is given in the following subparagraphs:

(a) Flood-control improvements.--No adequate improvements for control of large floods are in the area under consideration. A small flood-control basin with a capacity of 14,000 acre-feet to spillway crest was constructed in 1923 on Cave Creek, a tributary of Salt River, to prevent overflow along that creek, and especially in the city of Phoenix. Minor channel improvements and emergency work have been constructed along Salt River to protect about one-quarter mile of stream banks.

(b) Other improvements.--Since 1936, the Soil Conservation Service of the United States Department of Agriculture has constructed some minor improvements along upper Gila River and tributaries, mostly for the control of erosion. Most water for irrigation of areas upstream from Gillespie Dam is supplied by storage reservoirs, diversion dams, and headgate structures on Gila River and tributaries. Many miles of canals serve these areas. Facilities for the production of hydroelectric power are provided at Coolidge, Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain Dams. Pertinent information on existing dams constructed in the Gila River Basin by other Federal and non-Federal agencies is given in the following table:

Existing dams, Gila River Basin, Ariz. and N. Mex.

Dam	Stream	Drainage area	Operating agency	Purpose	Year completed	Reservoir capacity*
		<u>Square miles</u>				<u>Acre-feet</u>
San Jose-Montezuma	Gila River	7,960	Local	Diversion	1936	0
Coolidge	do	12,900	U.S.I.I.S.	Storage, power	1928	1,205,000
Ashurst-Hayden	do	18,300	do	Diversion	1922	0
Sacaton	do	18,800	do	do	1925	0
Gillespie	do	49,600	Local	do	1921	0
Roosevelt	Salt River	5,830	do	Storage, power	1911	1,382,000
Horse Mesa	do	5,940	do	do	1927	245,000
Mormon Flat	do	6,100	do	do	1925	58,000
Stewart Mountain	do	6,220	do	do	1930	70,000
Granite Reef	do	12,900	do	Diversion	1908	0
Horseshoe	Verde River	5,990	do	Storage	1945	**144,000
Bartlett	do	6,160	do	do	1939	180,000
Cave Creek	Cave Creek	161	do	Flood control	1923	14,000
Lake Pleasant	Agua Fria River	1,460	do	Storage	1927	178,000

* Top of spillway gates, if gated; otherwise, spillway crest.

** Enlarged in 1950 from 68,000 to 144,000 acre-feet.

Note.--U.S.I.I.S. refers to United States Indian Irrigation Service.

PROPOSED IMPROVEMENTS AFFECTING THE PROBLEM

68. Three reservoirs of significance to the problems discussed in this report have been recommended by the United States Bureau of Reclamation as part of the central Arizona project now pending for consideration in Congress (see H. D. 136, 81st Cong., 1st sess.). Action by Congress on the project is being held in abeyance pending settlement in the Supreme Court of the controversy between the States of Arizona and California regarding rights to Colorado River water. Those reservoir units of the proposed central Arizona project that affect the problems considered in this report are described according to location in the following subparagraphs:

(a) Gila River Basin above Salt River.--Two multiple-purpose reservoirs, providing flood-control storage, have been proposed for construction upstream from the area under consideration, as follows: Buttes Reservoir on Gila River at river mile 287 and Charleston Reservoir on San Pedro River at river mile 121 (see pl. 2). In general, although the overall effect of the two reservoirs on the flood problems in the area under consideration in this report is small, some significant effects in that part downstream from the mouth of Salt River would result from the reservoirs during large floods originating from the Gila River Basin above Salt River. In the studies for this report, these two reservoirs have been assumed to be in operation.

(b) Salt River Basin.--The Bureau of Reclamation's proposed central Arizona project provides for the importation of water from the Colorado River to the Gila River Basin. A portion of this imported water, in excess of immediate demands, would be stored in a proposed reservoir to be constructed at the McDowell site on Salt River (see pl. 1). A capacity of 188,000 acre-feet, designated in this report as "terminal" storage, would be required under the proposed project to store the imported water. In addition to such terminal storage, the proposed project would provide for flood-control storage of 390,000 acre-feet, making a total proposed capacity for the McDowell Reservoir of 578,000 acre-feet. The McDowell Dam proposed by the Bureau of Reclamation in House Document 136, 81st Congress, 1st session, would be 126 feet in height. The dam, which would be of concrete slab-and-buttress construction with earthfill wings, would contain a power plant as an integral part of the dam with a capacity of 4,100 kilowatts. The estimated construction cost for the dam and reservoir based on July 1947 prices as shown in the document is \$16,326,000. The estimated construction cost of the power plant on the same basis is \$1,012,000. Consideration is given in this report to the need and justification for including additional capacity for flood-control storage in the proposed reservoir.

IMPROVEMENTS DESIRED

69. Public hearing.--A joint public hearing on flood control in the entire Gila River Basin was held at Phoenix, Ariz., on October 20, 1938, by the Departments of Army and Agriculture with the district engineer, United States Army Engineer District, Los Angeles, Calif., presiding. The hearing was attended by 114 persons including representatives of various agencies of the Federal Government, officials of the State of Arizona and its political subdivisions, representatives of local civic organizations, and interested private citizens.

70. Improvements desired by local interests.--Information obtained at the public hearing indicated that local interests desire clearing and straightening the channels of Gila and Salt Rivers to prevent flood damage along those streams. Since the public hearing, local interests have expressed grave concern about the deteriorated condition of the channels of Gila and Salt Rivers.

71. Reasons advanced in justification of improvements desired.--Representatives of local interests stressed the necessity of flood control on Gila and Salt Rivers between Gillespie Dam and McDowell Dam site to (a) prevent flooding and inundation of rural and urban properties in the cities of Phoenix and Tempe, in the communities of South Phoenix and Liberty, and in the project lands of the Salt River Valley Water Users' Association, the Buckeye Irrigation District, the Arlington Irrigation District, and on other lands; (b) prevent erosion of land; (c) prevent damage to cropland because of interruption of irrigation; and (d) prevent interruption of railroad and highway communication and of utility services. Representatives of local interests also stressed that control of floods by clearing the channel would result in reducing the evapotranspiration losses from the growth within the channel and thereby would increase the safe yield of the ground-water supplies.

FLOOD PROBLEMS AND RELATED PROBLEMS

72. Flood problems.--Salt River below Granite Reef Dam and Gila River below the mouth of Salt River and above Gillespie Dam flow through developed commercial and agricultural areas that have been subjected to flooding by these streams in the past. The cities of Phoenix and Tempe and the communities of Lehi, South Phoenix, and Liberty are subject to inundation. The most noteworthy of past floods occurred in 1891, 1905, 1916, 1920, and 1938.

73. During the 1891 flood, floodwaters eroded the right bank of Salt River near 40th Street, Phoenix, and then following a course along Henshaw Road (one-half mile south of the Southern Pacific railroad) inundated the developed area south of that road. Although extensive regrading of the area has taken place in

connection with construction of the Sky Harbor Airport, a recurrence of such an overflow probably would take place on the occurrence of a flood approaching the magnitude of the standard project flood.

74. Reservoirs on Salt and Verde Rivers have impounded much of the floodflows of recent years. The total storage space provided amounts to about 2,000,000 acre-feet. Since water-conservation storage has been provided, some flood control has been gained, especially in years of low flow or in years immediately following a depleted water supply. However, because of the great need for stored water for irrigation and for power, all reservoirs are filled to maximum capacity whenever possible, thus eliminating most of the flood-control features.

75. Since most floodflows were reduced by storage, the combination of a comparatively dry river channel and a high water table has resulted in an infestation of water-loving plants (phreatophytes) that have achieved in some places almost maximum density. With the channel thus choked, the occurrence of even a small flood on Salt and Gila Rivers could result in serious damage to highly improved rural and urban areas.

76. Water-conservation problems.--Flood problems in the Gila River Basin are related closely to the problems of water conservation and water utilization. The construction of the existing water-conservation reservoirs on Salt and Verde Rivers has conserved for use most of the flow of these streams. However, because of the nature of the streamflow, utilization of the runoff is incomplete. During the calendar years 1923-57, about 3,200,000 acre-feet have spilled over Granite Reef Dam. This amount is about 10 percent of the undepleted flow at Granite Reef Dam. During this period, Horse Mesa, Mormon Flat, Stewart Mountain, Bartlett, and Horseshoe Dams were constructed. Studies by the United States Bureau of Reclamation indicate that if these reservoirs had been in operation during the entire period they would have conserved all Salt River flow and most of Verde River flow. The amount of water that would have spilled under existing conditions of development is estimated at 860,000 acre-feet for the 35-year period, or an average of about 25,000 acre-feet per year. This water would have come during four flood seasons--1927, 1932, 1937, and 1941. In order to conserve the flow, large holdover storage would be required with attendant severe evaporation rates.

77. Phreatophytic growths within the channel area transpire and evaporate tremendous amounts of water annually. According to the United States Geological Survey, the annual use of water per acre by plants in the channel area, assuming 100 percent density, is estimated as follows: Saltcedar, 7.2 acre-feet; cottonwood and willow, 6.0 acre-feet; baccharis, arrowweed, and miscellaneous brush, 4.7 acre-feet; and mesquite and paloverde, 3.3 acre-feet. The minimum average annual transpiration by phreatophytes from a 2,000-foot-wide channel extending from Gillespie Dam on Gila River to Granite Reef

Dam on Salt River during a 50-year period under present conditions of water use (assuming no importation of water from outside the drainage area of Gila River) is estimated by the United States Geological Survey at 22,000 acre-feet. (See Appendix 6: Use of Water by Phreatophytes in 2,000-foot Channel between Granite Reef and Gillespie Dams, Maricopa County, Ariz.) Such use reduces the available safe yield of the ground-water reservoir and may reduce the surface flow farther downstream.

78. Methods of improvement considered.--Optimum utilization of the water resources of Gila and Salt Rivers is of utmost importance. In the investigations covered in this report, consideration was given not only to flood problems but also to the need for more adequate water supply for irrigation use. The control of floods by channel improvements, levees, flood-control reservoirs, reservoirs for multiple-purpose use including flood control, and various combinations of these improvements was considered.

PLANS OF IMPROVEMENT CONSIDERED

79. General.--Preliminary studies were made of plans for flood control by means of channel improvements, levees, reservoirs for flood control alone and for multiple-purpose use, and by combinations of these methods. Channel improvements comprising (a) removal of phreatophyte growth from an appropriate floodway and (b) pilot-channel excavation in some reaches were considered for Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam. Levees were considered for the urban area along Salt River from Tempe to Phoenix. Preliminary analysis of costs and benefits eliminated the necessity for detailed consideration of levee improvements along the remaining reaches of the river. An enlarged excavated channel was considered along Salt River from Tempe to Phoenix, but, because of the wide stream channel, the cost of an enlarged channel would greatly exceed the cost of levees in the same area. Excavation in that reach, in addition to that required to obtain fill material for a levee, is not justified.

80. Consideration was given to control by means of reservoirs. Investigations revealed no reservoir sites where storage (a) solely for flood control or for flood control and conservation of local flows originating in the Gila River Basin and (b) providing an adequate solution for the flood problems in the area could be economically justified. However, as discussed under the previous heading "Proposed Improvements Affecting the Problem," the United States Bureau of Reclamation has proposed construction of a reservoir principally for terminal storage at the McDowell site on Salt River. Preliminary analysis indicated that flood-control storage alone, water-conservation storage alone (for conservation of flows originating in the Salt River Basin), or the combination of flood-control and water-conservation storage at this site is unjustified. Consideration was therefore given to the justification of providing

flood-control storage or flood-control and water-conservation storage in addition to the storage required for a terminal reservoir.

81. Detailed consideration was given to three plans of improvement, as follows: (a) The recommended plan, which would provide for short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; (b) a plan for short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site; and (c) a plan for levees along Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.

82. Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam (recommended plan).--- The recommended plan provides for $3\frac{1}{2}$ miles of levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. As discussed under the subsequent heading "Benefits from prevention of flood damage," improvements under this plan would provide complete protection against the standard project flood for most of the city of Tempe and a part of the city of Phoenix, but only partial protection for an additional area in the city of Phoenix, for the adjacent developed areas, and for other areas along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. The average annual damages prevented would be 34 percent of the total average annual damages in the area under consideration. The short levees would consist of (a) a levee along the left bank of Salt River for about 2,000 feet from Tempe Butte to the Southern Pacific railroad bridge embankment and (b) a levee along the right bank of Salt River for about 16,700 feet from the Southern Pacific railroad bridge embankment to 40th Street, Phoenix. Construction of the major part of the right-bank levee would consist of enlarging the existing canal levee and of placing rock facing. The right-bank levee would incorporate the existing Joint Head Dam. The levees would be compacted earthfill structures that would range in height from 7 to 22 feet above the natural ground and from 23 to 28 feet above streambed. Slopes on both sides of the levee would be 1 on 2. The width of crown would be 18 feet. The levees were designed to accommodate the standard project flood of 270,000 cubic feet per second (290,000 cubic feet per second at McDowell Dam site) with a minimum freeboard allowance of 3 feet. Computed velocities would, in general, vary from 8 to 12 feet per second. The river side of the levees would be revetted with rock facing 1.25 feet thick on a gravel filter blanket 6 inches thick. The levee revetment would extend to a minimum depth of 5 feet below the existing streambed. Two ramps over the right-bank levee would be provided - one at Delano Avenue and the other at 40th Street.

83. Channel improvements would consist of a cleared floodway and of low-flow channels. Detailed studies were made to determine the width of cleared channel that would give optimum flood-control benefits (see appendix 5). Agricultural development and the natural topography limit the maximum width to about 2,000 feet. Channel widths of 500, 1,000, 1,500, and 2,000 feet were considered and evaluated. As indicated in appendix 5, incremental flood-control benefits exceed the incremental costs for all incremental widths considered. Additional clearing might be justified by the additional savings of water; however, such clearing, if determined to be desirable on the basis of actual experiences in savings of water, could be accomplished by local interests at a later date. Therefore, on the basis of this study, the 2,000-foot-wide cleared channel was determined as the most desirable at this time.

84. A floodway 2,000 feet in width would be created by clearing river-bottom growth along Gila River from Gillespie Dam to the mouth of Salt River and along Salt River from its mouth to Granite Reef Dam. Two reaches of low-flow or pilot channels located within the cleared floodway, the first along Gila River from Gillespie Dam to a point about 1 mile downstream from the mouth of Agua Fria River and the second along Salt River upstream from the highway bridge at Tempe, would be included in the improvement. The low-flow channels would tend to direct flows to within the cleared floodway, and would thereby accomplish desired river rectification; above the Tempe bridge, the low-flow channel would improve flow conditions on the approach to that bridge.

85. The removal of phreatophytic growth within a 2,000-foot channel along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam will greatly decrease the use of water by transpiration. The United States Geological Survey (see appendix 6) has estimated that the water saved and salvageable in Maricopa County by the removal of phreatophytic growth from the channel would amount to about 75 percent of the total water transpired by the river-bottom growth. The full savings could be obtained only by adequate maintenance of the channel area. Applying the factor of 75 percent to 22,000 acre-feet (the estimated average annual transpiration over the next 50 years), the amount of water saved by clearing the phreatophytes would be 16,000 acre-feet annually. This estimate is conservative, because the computed basic figures for use of water represent minimum amounts.

86. Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site.--Consideration was given to the justification of providing flood-control storage in addition to the storage required for a terminal reservoir at the McDowell site. The Bureau of Reclamation had proposed in its report on the central Arizona project that 390,000 acre-feet of flood-control storage be allocated in addition to the

188,000 acre-feet required for terminal and dead storage. The total storage capacity of the reservoir considered by the Bureau would be 578,000 acre-feet. Review of the Bureau design indicated that changes would have to be made to pass the spillway design flood as computed by the Corps of Engineers. A higher dam and an expensive spillway in the channel section of the dam would be required. Additional investigations indicated that, by further increasing the height of the dam, use could be made of a saddle about 1 mile southeast of the left abutment. A detached spillway in this saddle area would result in a relatively inexpensive structure. The resultant cost estimate for the larger structure (with the detached spillway) was determined to be appreciably less than the Corps' cost estimate for the 578,000-acre-foot reservoir with the spillway in the dam. Further details on the estimated costs for the various sizes of reservoirs considered for the McDowell site are given in appendix 4. Because construction of a reservoir at the McDowell site is dependent upon the outcome and settlement in the Supreme Court of the controversy between the States of Arizona and California regarding rights to Colorado River water and because predicting the outcome of the litigation is impracticable at this time, storage in a reservoir at the McDowell site was considered only as a supplement to the improvements under the recommended plan.

87. This plan provides for (a) short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; (b) channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and (c) 672,000 acre-feet of flood-control storage space added to the proposed terminal-storage reservoir at the McDowell site. Nearly all damages caused by the standard project flood along Salt River would be prevented by the construction of the improvements under this plan. Relatively minor damages along Salt River would still occur to property located in and immediately adjacent to the river channel. Downstream from the mouth of Salt River, partial flood protection would result. In addition to the flood control provided by the channel improvements, control of large floods originating in the Salt River Basin would be effected by reducing discharges to 82,000 cubic feet per second. Under average conditions, as a result of control effected by McDowell Reservoir, a flood of 320,000 cubic feet per second (at Painted Rock Dam site) would be reduced to a peak discharge of 170,000 cubic feet per second. Floods smaller than 82,000 cubic feet per second would not be affected by the operation of McDowell Reservoir. The average annual damages prevented by this plan would be 86 percent of the total average annual damages in the area under consideration.

88. The first two parts of the plan would be the same as under the recommended plan. The multiple-purpose dam would be an earthfill structure 169 feet high above streambed. The crest of the dam (elevation 1,494) would be about 5,180 feet long. A concrete overflow spillway structure 1,100 feet long would be located in a saddle about 1 mile southeast of the left abutment of the dam. At maximum water surface, elevation 1,486, the spillway would have a capacity of 288,000

cubic feet per second. The reservoir, at spillway crest elevation 1,470, would have an area of 15,200 acres and a capacity of 860,000 acre-feet. Allocation of storage space would be 46,000 acre-feet for sediment and dead storage, 142,000 acre-feet for terminal storage, and 672,000 acre-feet for flood control. The reservoir would be designed to reduce the standard project flood of 290,000 cubic feet per second to a maximum outflow of 82,000 cubic feet per second. Construction of the multiple-purpose reservoir with a capacity of 860,000 acre-feet would result in the flooding of the power plant at Stewart Mountain Dam. This power plant, operated by the Salt River Valley Water Users' Association, has a capacity of 10,400 kilowatts. Information obtained from the Bureau of Reclamation indicates that because of the diversion of Salt River flow from Sahuaro Lake, above Stewart Mountain Dam, to lands along Gila River, as proposed in the Bureau's report on the central Arizona project, it may be impractical to continue operating the Stewart Mountain power plant. Protection of the Stewart Mountain power plant therefore was not provided for in the design of the larger McDowell Reservoir described above.

89. Because available information indicates that water conservation cannot be justified at this time at McDowell Reservoir except as an addition to its use for terminal storage, detailed consideration was not given to the amount of conservation storage that might be provided under the plans considered. The Bureau of Reclamation in its report on the central Arizona project recommended the enlargement of Horseshoe Reservoir on Verde River from 68,000 acre-feet to 298,000 acre-feet. Since the preparation of that report, local interests have enlarged Horseshoe Reservoir to 144,000 acre-feet. Under these conditions, further enlargement of Horseshoe Reservoir might not be feasible. Therefore, consideration should be given to inclusion of water-conservation storage at McDowell terminal reservoir in the preparation of detailed plans prior to its construction.

90. Levees along Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.--This plan provides for the construction of 20 miles of levees on Salt River, 10 miles on each bank. The improvements would provide complete flood protection against the standard project flood to developed areas in and adjacent to Phoenix and Tempe and partial flood protection similar to that under the recommended plan to other areas along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. The annual damages prevented would be 60 percent of the total average annual damage in the area under consideration. The levees along Salt River would consist of (a) a levee on the left bank of Salt River for about 10 miles from Tempe Butte to 27th Avenue, Phoenix, and (b) a levee along the right bank of Salt River for about 10 miles from the Southern Pacific railroad bridge embankment at Tempe to 27th Avenue, Phoenix. The levees were designed to accommodate the standard project flood. The structural design of the levees would be similar to that under the recommended plan. The channel improvements would be the same as under the recommended plan.

RECREATIONAL DEVELOPMENT

91. Existing reservoirs behind Roosevelt, Horse Mesa, Mormon Flat, and Stewart Mountain Dams on Salt River are used extensively for boating, fishing, and picnicking. These reservoirs are operated for water conservation and water power and provide relatively stable pools. The proposed terminal-storage reservoir at the McDowell site would probably include some provision for recreational use. The extent of development would depend on the stability of the reservoir elevation.

92. Consideration was given to the possibilities of recreational development that might result from the addition of flood-control storage space at the McDowell Reservoir site. Although a large amount of storage would be allocated for flood-control use, the method of operation of the flood-control storage space precludes the use of that part of the reservoir for recreational purposes on an extensive scale. Any lake formed as a result of the flood-control storage at the reservoir would be temporary; the flood-control operation would provide for the emptying of the flood-control pool as fast as possible. The area of the flood-control pool normally would consist of mud flats that would become barren wastes during dry periods. Plans for flood-control storage at the McDowell Reservoir site therefore did not include any provision for recreational development. However, a favorable year-round climate and the scenic background of the dam and reservoir and its proximity to the centers of population in Arizona would contribute to the value of any recreational features that might be incorporated in the final plans for McDowell Reservoir.

ESTIMATES OF FIRST COST

93. The estimated first costs of the considered projects comprise expenditures for making preauthorization studies; for construction (including clearing river-bottom growth); and for relocating highways and utilities and purchasing rights-of-way. Estimates of cost are based on price levels for October 1957. Allowances are made for engineering, overhead, inspection, and contingencies.

94. Three methods of destroying phreatophytes, principally saltcedar, were considered: (a) Burning, (b) chemical treatment, and (c) mechanical means (see appendix 3). Numerous experiments are now being conducted by Federal, State, and local interests on these means of eradication, but no final conclusions have been reached. Information to date indicates that burning and chemical treatment are not completely effective and would still require mechanical means of clearing the floodway. Therefore, for the purpose of preparing an adequate cost estimate, destruction of phreatophytes by mechanical means was assumed.

95. Details of the estimated first costs of the recommended plan are given in Appendix 4: Cost estimates. The following table summarizes the estimated first costs of the improvements considered:

Summary of estimated first costs, plans considered, Gila and Salt Rivers,
Gillespie Dam to McDowell Dam site, Arizona (based on prices for October
1957)

Plan	Estimated first cost	
	Subtotal	Total
RECOMMENDED PLAN		
Short levees and channel improvements:		
Levees along Salt River between		
40th Street, Phoenix, and Tempe Butte,		
Tempe.....		\$1,240,000
Channel improvements along Gila and Salt		
Rivers from Gillespie Dam to Granite		
Reef Dam.....		2,330,000
Total.....		<u>3,570,000</u>
OTHER PLANS CONSIDERED		
Short levees, channel improvements, and		
storage space in McDowell Reservoir:		
Levees along Salt River between 40th		
Street, Phoenix, and Tempe Butte,		
Tempe.....		1,240,000
Channel improvements along Gila and Salt		
Rivers from Gillespie Dam to Granite		
Reef Dam.....		2,330,000
McDowell Reservoir:		
Multiple-purpose (terminal storage		
and flood control).....	*\$30,300,000	
Terminal storage.....	** -24,600,000	
Cost of flood-control storage.....		<u>5,700,000</u>
Total cost of flood control.....		<u>9,270,000</u>
Long levees and channel improvements:		
Levees along Salt River between 27th		
Avenue, Phoenix, and Tempe Butte,		
Tempe.....		8,660,000
Channel improvements along Gila and Salt		
Rivers from Gillespie Dam to Granite		
Reef Dam.....		<u>2,330,000</u>
Total.....		10,990,000

* Estimated cost of reservoir with capacity of 860,000 acre-feet, based on earthfill dam and detached spillway.

** Estimated cost of reservoir with capacity of 188,000 acre-feet, based on earth dam with concrete spillway in the dam.

ESTIMATES OF ANNUAL CHARGES

96. The estimate of annual charges for each plan of improvement comprises interest on the total investment, amortization of the total investment in 50 years, and average annual costs of maintenance and operation. The construction period of McDowell Reservoir for multiple-purpose storage or for terminal storage is estimated at 3 years; interest during construction was therefore computed. The construction period for the short levees would be less than 1 year; interest during construction would not be charged against that part of the plan. Because benefits from construction of the channel improvements and the levees between 27th Avenue, Phoenix, and Tempe Butte, Tempe, would accrue as the work proceeds, interest would not be charged. The entire first cost of the flood-control storage in the multiple-purpose reservoir would be borne by the United States. For the levees and for the channel improvements, the cost of construction and the cost of preauthorization studies would be borne by the United States, although local interests would repay that portion of the construction cost that is allocated to water conservation. The cost of highway and utility relocations, the cost of lands, easements, and rights-of-way, and the cost of maintenance and operation would be borne by local interests. Estimates of the first cost and annual charges for the recommended plan are given in the following table:

Estimated first cost and annual charges, recommended plan, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona (based on prices for October 1957)

(a) Federal investment:		
(1)	Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe.....	\$1,170,000
(2)	Channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.....	<u>2,190,000</u>
(3)	Total Federal first cost and total Federal investment.....	<u>3,360,000</u>
(b) Federal annual charges:		
(1)	Interest, 2.5 percent on item (a) (3)..	84,000
(2)	Amortization of Federal investment in 50 years at 2.5 percent, 0.01026 times item (a) (3).....	<u>34,500</u>
(3)	Total Federal annual charges.....	<u>118,500</u>

Estimated first cost and annual charges, recommended plan, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona (based on prices for October 1957)--Continued

(c) Non-Federal investment:	
(1) Rights-of-way and highway and utility relocations for short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe.....	\$70,000
(2) Rights-of-way and highway and utility relocations for channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.....	<u>140,000</u>
(3) Total non-Federal first cost and total non-Federal investment.....	<u>210,000</u>
(d) Non-Federal annual charges:	
(1) Interest, 2.5 percent on item (c) (3).....	5,200
(2) Amortization of non-Federal investment in 50 years at 2.5 percent, 0.01026 times item (c) (3).....	2,200
(3) Maintenance and operation (average annual):	
Short levees.....	5,000
Channel improvements.....	<u>48,000</u>
(4) Total non-Federal annual charges.....	<u>60,400</u>
(e) Total annual charges:	
(1) Federal.....	118,500
(2) Non-Federal.....	<u>60,400</u>
Total annual charges.....	178,900

97. For the purpose of comparing the three plans of improvement considered in detail and of selecting the best plan, annual charges were computed. A summary of annual charges for each plan is given in the following table:

Summary of annual charges, plans considered, Gila and Salt Rivers,
Gillespie Dam to McDowell Dam site, Arizona

Plan	Annual charges
RECOMMENDED PLAN	
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam..	\$178,900
OTHER PLANS CONSIDERED	
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site.....	382,400
Levee along Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.....	477,500

ESTIMATES OF BENEFITS

98. Tangible benefits.--Tangible primary benefits from plans of improvement considered in detail would result from prevention of primary (direct and indirect) flood damage and from reduction of water losses resulting from transpiration of river-bottom growth. Such secondary benefits as may exist are small and have not been included in the evaluation of the project. Consideration of the benefits from construction of McDowell multiple-purpose reservoir was restricted to the benefits from the addition of flood-control storage to a terminal reservoir at the site. No evaluation was made of the benefits from construction of the terminal-storage feature. Although power facilities probably would be constructed at McDowell Reservoir in connection with the terminal storage, the addition of flood-control storage space would not appreciably increase the amount of power generated. The rapid drawdown of the flood-control storage would preclude the generation of power from this source.

99. No appreciable benefits would result from increased or higher property utilization made possible through provision of flood protection. The acute shortage of water in the area would preclude

any appreciable increased agricultural utilization of property. In addition, other development of the flood plain in the Phoenix and Tempe area is proceeding in spite of the existing flood hazard.

100. A detailed analysis of benefits from the plans of improvement under consideration is given in Appendix 5: Benefits from improvements. A brief description of benefits under the recommended plan is given in the following paragraphs. A summary of the estimated benefits that would accrue from the three plans of improvement considered in detail is given in a subsequent table.

101. Benefits from prevention of flood damage.--The levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and the channel improvement would provide complete protection against the standard project flood to most of the city of Tempe and a part of the city of Phoenix, but only partial protection for an additional area in the city of Phoenix and the adjacent commercial and agricultural area. Low-lying lands downstream from the levees would still be subject to inundation. However, a breakthrough similar to the one that occurred during the flood of 1891 would be prevented. In addition, damage to most of the Sky Harbor Airport, to the Grand canal, and to the cooling system of the Cross-Cut power plant would also be prevented.

102. Construction of channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam would provide partial flood control to additional property along Gila and Salt Rivers by increasing channel capacities with attendant lowering of the water-surface elevations of future floods and with resultant reduction in the extent of the flooded areas. The average water-surface elevation of the standard project flood along Gila River from Gillespie Dam to the mouth of Salt River would be reduced by about $3\frac{1}{2}$ feet. Reductions would range, depending on location, from $1\frac{1}{2}$ feet to $5\frac{1}{2}$ feet. Nondamaging discharges in this reach would be increased from about 20,000 cubic feet per second (a discharge that would be equaled or exceeded about once in 3 years) to about 40,000 cubic feet per second (a discharge that would be equaled or exceeded about once in 5 years). As indicated in the previous paragraph, "Damages from future floods - average future conditions," the stream channel along the Salt River is relatively clear at present. However, on the occurrence of a wet cycle or of spills over Stewart Mountain or Bartlett Dams, phreatophytes will reoccur and would probably create a serious flood problem. The proposed clearing program would prevent the recurrence of this phreatophytic growth and would thereby prevent those damages that would occur under average future conditions as a result of the deteriorated channel condition. Analyses of the effect of clearing along the Salt River were based on detailed studies along the Gila River. It is not expected that phreatophytic growth along the Salt River would be as severe as along the Gila River. As a result of construction of the proposed channel improvements along the Salt River, the average water-surface elevation of the standard project flood along the Salt River from Granite Reef Dam to the mouth would be reduced under average future conditions by about $\frac{1}{2}$ foot. Reductions would range, depending on location, from 0.2 foot to 2 feet. Nondamaging discharges in this reach would be increased

about 10 percent, from about 50,000 cubic feet per second to 55,000 cubic feet per second. The average annual flood-control benefits from construction of the recommended plan are estimated at \$226,000.

103. Benefits from water conservation.--The clearing of phreatophytes from a 2,000-foot channel along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam would result in a savings of a minimum of 16,000 acre-feet of water annually. Conservation of the water resources of the area is essential in order to sustain land already under cultivation. In accordance with the recommendation of the Federal Inter-Agency River Basin Committee's report titled "Proposed Practices for Economic Analysis of River Basin Projects," dated May 1950, the net primary benefits from water conservation are evaluated in this report on the basis of such increase in production of irrigated crops as would result from construction of the project. This increase in production would result from construction of the project and also from the application of associated resources. Thus, the net benefit from water conservation would be the difference between the gross crop return to the farmer and the associated farm costs, which would include operating costs for production, interest on investment, maintenance and depreciation of equipment, property taxes, and management costs. After considering all the above factors, the value of water conserved by the elimination of transpiration losses from phreatophytes is estimated at \$8 per acre-foot (see appendix 5). The average annual primary benefits from the conservation of a minimum of 16,000 acre-feet of water are estimated at \$128,000.

104. Intangible benefits.--Many benefits not susceptible of monetary evaluation would accrue from the improvements considered in this report. Control of floods would save lives that might otherwise be lost by drowning and would reduce health hazards such as water-supply pollution resulting from overflow of sanitary facilities. Flood control would reduce the danger of temporary isolation of communities and would lessen the interference by floods with normal home and social life, public affairs, business transactions, and industrial activity. The safeguarding of the city of Tempe from all floods up to the standard project flood in magnitude and the prevention of a breakthrough into Phoenix similar to the one that flooded Phoenix in 1891 would result in large intangible benefits. The prevention of damage to the Grand canal of the Salt River project and the prevention of damage to the cooling system of the Cross-Cut power plant would result in large intangible benefits from prevention of interruption of irrigation to lands served by the Grand canal and the prevention of interruption of the power plant. Removal of the phreatophytes would improve flow conditions in the river channel and would thereby improve drainage conditions, especially in Buckeye and Arlington Valleys. Such benefits are considered intangible.

105. Intangible benefits from water conservation would include (a) stabilization of property values by partially alleviating the existing water shortage and (b) general improvement in the long-term social and economic welfare. The effect on the nation of the increased production of agricultural products is also considered an intangible benefit.

106. Summary of benefits.--The estimated annual benefits that would accrue from construction of improvements under the plans considered are summarized in the following table:

Estimated average annual benefits from plans considered, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona

Plan	Average annual tangible primary benefits			Intangible benefits
	Flood damages prevented	Water conservation	Total	
RECOMMENDED PLAN				
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.	\$226,000	\$128,000	\$354,000	Large.
OTHER PLANS CONSIDERED				
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site.	595,000	128,000	723,000	Do.
Levees along Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.	397,000	128,000	525,000	Do.

COMPARISON OF BENEFITS AND COSTS

107. Justification of improvements considered.--The recommended plan of improvement provides for short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. The first cost of the improvements is estimated at \$3,570,000 (October 1957), and the average annual charges, \$178,900. The total average annual primary benefits are estimated at \$354,000, including \$226,000 for flood control and \$128,000 for water conservation. The ratio of average annual primary benefits to average annual costs would be 1.98 to 1. Accordingly, the improvements are justified. The large intangible benefits previously discussed add support to this conclusion. A summary of the estimated costs, benefits, and economic ratios for all plans considered in detail is given in the following table:

Summary of economics of plans considered, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona

Plan	Total first cost (October 1957)	Average annual charges	Average annual tangible primary benefits	Benefit- cost ratio	Intan- gible benefits
RECOMMENDED PLAN					
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.	\$3,570,000	\$178,900	\$354,000	1.98	Large.
OTHER PLANS CONSIDERED					
Short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site.					
Total amount.....	9,270,000	382,400	723,000		
Amount incremented to recommended plan.....	5,700,000	203,500	369,000	1.81	Do.
Levees along Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.					
Total amount.....	10,990,000	477,500	525,000		
Amount incremented to recommended plan.....	7,420,000	298,600	171,000	0.57	Do.

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108. Comparison of plans.---The recommended plan providing for short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam is the best plan with a benefit-cost ratio of 1.98 to 1. Although the addition to the recommended plan of flood-control storage at a terminal reservoir at the McDowell site is justified as computed, the plan providing for this addition cannot be further considered until terminal storage is provided at the McDowell site. The report of the United States Bureau of Reclamation on the central Arizona project, which includes the recommendation for construction of the terminal-storage reservoir, was transmitted to Congress, but decision on the project has been held in abeyance pending settlement in the Supreme Court of the controversy between the States of Arizona and California regarding rights to Colorado River water. At the present time, no basis exists for determination of the outcome of the controversy. However, the plan for multiple-purpose utilization of the McDowell Reservoir site has value in future planning for the development of the water resources of the area. Levees along the Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe, although providing nearly complete protection to Tempe, Phoenix, South Phoenix, and adjacent commercial areas, are not justified at the present time.

ALLOCATION OF COSTS

109. The separable costs-remaining benefits method was used in arriving at an equitable distribution of costs between flood control and water conservation. The recommended levees and low-flow channels would provide flood-control benefits only, whereas recommended channel clearing would provide flood-control and water-conservation benefits. The following table summarizes the results of using the separable costs-remaining benefits method in the allocation of first costs for the recommended plan of improvement to flood control and water conservation. A more detailed development of the method of allocation of costs is given in Appendix 7: Allocation of Costs.

Allocation of first costs, recommended plan of improvement, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona (based on October 1957 prices)

Item	Flood control	Water conserva- tion	Total
First cost:			
Construction.....	\$2,475,000	*\$825,000	\$3,300,000
Preauthorization studies.....	45,000	15,000	60,000
Rights-of-way and highway and utility relocations....	157,000	53,000	210,000
Total.....	2,677,000	893,000	3,570,000

* On the basis of October 1957 prices, allocation of construction costs to water conservation amounts to 25 percent of the construction cost of \$3,300,000, which includes all planning and design costs subsequent to authorization.

110. In accordance with the general policies expressed in acts of Congress, the cost of the construction items allocated to flood control would be borne by the United States; and the cost of all highway and utility relocations, the cost of all lands, easements, and rights-of-way, and the cost of all maintenance and operation would be borne by local interests. The costs of all preauthorization studies are considered in this report to be nonreimbursable and thus would be borne by the United States.

111. Reclamation law permits local interests to repay in 40 years, without interest, that part of the first cost of reclamation projects allocated to water conservation. Although this project would be authorized as a flood-control project, local interests should be permitted to avail themselves of interest-free repayments in reimbursing the United States for the portion of the cost allocated to water conservation. Local interests have agreed to enter into a contract with the United States for repayment of the construction costs allocated to water conservation, such costs to be repaid without interest, in 40 equal annual payments.

112. The recommended levee and channel-improvements works would be constructed by the United States at an estimated construction cost of \$3,300,000, based on price levels prevailing in October 1957, subject to reimbursement by local interests, in consideration of water-conservation benefits, of 25 percent of the total construction cost in 40 equal annual payments without interest. On the basis of October 1957 prices, the estimated amount of \$825,000 would be repaid in 40 equal annual payments of \$20,625. The allocations and repayments would be adjusted on the basis of actual construction costs.

113. On the foregoing basis, local interests would (a) provide all rights-of-way and pay for the cost of all necessary highway and utility relocations; (b) maintain and operate the entire project at local expense after completion; and (c) reimburse the United States in 40 equal annual payments, without interest, for that portion of the project construction cost that is allocated to water conservation.

114. Federal laws that permit interest-free repayments of costs allocated to water conservation generally require that individual ownership of lands benefiting from irrigation projects constructed under these laws be limited to 160 acres. However, the project, as proposed, involves the salvage of water presently used nonbeneficially by river-bottom growth. The water conserved would not be delivered to any individual, group, or irrigation district - but would be made available to the ground-water basin to be used by all farmers who pump water from the underground. The ground-water basin benefited is not a closed basin, but underlies nearly all the irrigated land in Maricopa County. The Board of Supervisors of Maricopa County has recognized the general benefit to the county that would result from the salvage of water and has passed a resolution sponsoring the project, and has agreed to repay all costs allocated to irrigation. The district engineer is of the opinion that the 160-acre limitation should not be applied to the project because (a) the water salvaged

would accrue to the ground-water basin and could only be obtained by pumping and (b) the benefits of the salvaged water could not be limited to any individual group or irrigation district.

PROPOSED LOCAL COOPERATION

115. As a requisite to construction of the recommended plan by the United States, responsible local interests would be required to:

(a) Pay for the cost of highway and utility relocation and provide necessary lands, easements, and rights-of-way at a cost estimated at \$210,000 (October 1957);

(b) Maintain and operate the levee and channel improvements in accordance with regulations to be prescribed by the Secretary of the Army at an average annual cost estimated at \$53,000;

(c) Keep the flood channel of the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam free from encroachment;

(d) In consideration of water-conservation benefits, reimburse the United States an amount equal to 25 percent of the total construction cost in 40 equal annual payments without interest. On the basis of October 1957 prices, the estimated amount of \$825,000 would be repaid in 40 equal annual payments of \$20,625. The allocations and repayments would be adjusted on the basis of actual construction costs. Annual payments will be made to the Secretary of the Interior who, in turn, will deposit such funds in the Treasury of the United States as miscellaneous receipts;

(e) Hold and save the United States free from all damages arising from construction and operation of the work; and

(f) Adjust all water-rights claims resulting from construction, operation, and maintenance of the improvements.

116. The Board of Supervisors, Maricopa County, Ariz., has expressed willingness to participate in a flood-control project consisting of levees, channel rectification, and channel clearing along the Gila and Salt Rivers. The Board has agreed by resolution (see appendix 8) to cooperate with the Federal Government by paying the local interests' share of the costs of the project and by meeting other requirements of local cooperation.

COORDINATION WITH OTHER AGENCIES

117. Conferences on the related problems of flood control and water conservation along the Gila and Salt Rivers from Gillespie Dam to McDowell Dam site have been held with representatives of the United

States Bureau of Reclamation. In general, agreement was reached on the existing need for flood control and water conservation in the area. Both agencies agree that flood-control storage should be included in a reservoir at the McDowell site when a reservoir for terminal storage at the site is authorized and approved for construction by Congress. The evaluation of water-conservation benefits from construction of the recommended plan of improvement was worked out jointly between representatives of the Corps of Engineers and the Bureau of Reclamation. The proposed allocation of costs and the proposed repayment of those costs allocated to water conservation was discussed with representatives of the Bureau. Those representatives were in accord with the recommendations of the Corps of Engineers.

118. Conferences were held with representatives of the United States Department of Agriculture to correlate their plans with plans developed by the Corps of Engineers. A study of the use of water by phreatophytes in a 2,000-foot channel between Granite Reef and Gillespie Dams, Ariz., was made by the United States Geological Survey upon the request of the Corps of Engineers (see appendix 6).

119. In a letter dated April 13, 1951, the regional director, Region 2, of the Fish and Wildlife Service indicated that construction of the levee and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam would have little effect upon the fish and wildlife values in the project area (see Appendix 9: Comments of other agencies).

120. Conferences were also held with representatives of local agencies, including the Salt River Valley Water Users' Association and the Buckeye Water Conservation and Drainage District. Comments on this report were received from all other Federal agencies having an interest in water-resource development and from the States of Arizona and California (see appendix 9). Plans for the recommended improvement do not conflict with plans of other Federal and non-Federal agencies.

DISCUSSION

121. The Gila River Basin, the largest drainage area tributary to lower Colorado River, comprises about 58,200 square miles, mostly in Arizona and New Mexico. That part of the Gila River Basin that is under consideration in this report comprises the Salt River Valley between McDowell Dam site and the mouth of Salt River and the Gila River Valley from the mouth of Salt River to Gillespie Dam. The drainage area of Salt River at the McDowell Dam site is 12,900 square miles and of Gila River at Gillespie Dam is 49,600 square miles. The Gila River rises on the west slope of the Continental Divide in southwest New Mexico and flows generally westward about 650 miles to the Colorado River.

122. The principal tributaries that join the main stream in the area under consideration in this report include, in downstream order, Salt, Agua Fria, and Hassayampa Rivers, and Centennial Wash. In general, stream slopes are not excessive. The average slope of the

Salt River from McDowell Dam site to its junction with the Gila River is about 9 feet per mile; the average slope of the Gila River from Salt River to Gillespie Dam is about 5.5 feet per mile.

123. The area affected by improvements considered in this report lies entirely in and includes most of Maricopa County, Ariz., one of the most rapidly growing areas in the United States. According to the United States census, the population of Maricopa County increased from 186,000 in 1940 to 332,000 in 1950. A local agency estimates the 1957 population of the county at 550,000. Several cities, including Phoenix, the capital and largest city of Arizona, are affected by the improvements considered. The 1950 populations of these cities are: Phoenix, 106,818; Mesa, 16,790; Glendale, 8,179; Tempe, 7,684; Chandler, 3,799; and Tolleson, 3,042.

124. The principal activities in the area under consideration are agriculture and stock raising. About 300,000 acres were irrigated in the area in 1956, providing an annual gross crop value of about \$85,000,000. The city of Phoenix is the trade and service center for most of Arizona. The estimated value of retail sales in Maricopa County in 1956 was \$705,000,000, which was over 50 percent of the State total. The agricultural economy of the valleys along the Salt and Gila Rivers is well stabilized. The area is adapted to a wide range of agricultural crops. Principal crops include alfalfa, barley, cotton, and truck crops. Many acres are double-cropped. Agriculture is entirely dependent on irrigation. Irrigation water is obtained by surface diversions and by pumping from the underground.

125. Measurement and estimates of floods of record are available for the period 1888 to date. Large floods during this period occurred in 1891, 1905, 1916, 1920, and 1938. The greatest flood of record occurred in February 1891; the peak discharge of Salt River downstream from the mouth of Verde River was estimated at 300,000 cubic feet per second. Major floods result from winter storms over the Gila River Basin. Available data on damages from past floods are incomplete. The flood of February 1920 caused an estimated damage of \$300,000 to Salt River project lands. Since 1910, eight storage reservoirs for water conservation and power have been constructed on the Gila River and its tributaries upstream from Gillespie Dam. Their combined capacity is about 3,500,000 acre-feet. Since this water-conservation storage has been provided, some incidental flood control has been gained, especially immediately following a period of depleted water supply. However, because of the great need for water for irrigation and power, all reservoirs are filled to maximum capacity whenever possible, thus eliminating at that time most of the flood-control features.

126. Salt River downstream from Granite Reef Dam and Gila River downstream from the mouth of Salt River to Gillespie Dam flow through developed commercial and agricultural areas. The cities of Phoenix and Tempe and the communities of Lehi, South Phoenix, and Liberty are subject to inundation. Because most floodflows were curtailed

through storage, the combination of a comparatively dry river channel and a high water table has provided opportunity for an infestation of water-loving plants (phreatophytes) that in some places grow to almost maximum density. With the channel thus choked, the occurrence of even a small flood on the Salt and Gila Rivers could result in serious damage to highly improved rural and urban areas.

127. Flood problems in the Gila River Basin are related closely to the problems of water conservation and water utilization. The construction of the existing water-conservation reservoirs on the Salt and Verde Rivers has conserved for use most of the flow of these streams. However, because of the nature of the streamflow, utilization of the runoff is incomplete. The volume that would have spilled from existing reservoirs during the period 1923 to 1957 is estimated at 860,000 acre-feet; and all of it would have occurred during the four flood seasons 1927, 1932, 1937, and 1941. In order to conserve this flow, a large holdover storage capacity would need to be provided, with attendant severe evaporation losses. Phreatophyte growths within the channel area transpire tremendous amounts of water annually. The minimum average annual transpiration from a 2,000-foot-wide channel from Gillespie Dam on the Gila River to Granite Reef Dam on the Salt River during a 50-year period, under present conditions of water use (assuming no importation of water from outside the drainage area of the Gila River), is estimated by the United States Geological Survey at 22,000 acre-feet at least.

128. Preliminary studies were made of plans for flood control by channel improvements, levees, flood-control reservoirs, and multiple-purpose reservoirs. Construction of a terminal-storage reservoir at the McDowell site on the Salt River has been recommended by the United States Bureau of Reclamation as a part of the proposed central Arizona project. Preliminary analyses indicated that flood control alone, water conservation alone, or the combination of flood control and water conservation at this site is unjustified. Consideration was therefore given to the justification of providing flood-control storage or flood-control and water-conservation storage in addition to the storage required for a terminal reservoir.

129. Detailed consideration was given to three plans of improvement, as follows: (a) The recommended plan, which would provide for short levees along the Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; (b) a plan for short levees along the Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam; and flood-control storage added to the proposed terminal-storage reservoir at the McDowell site; and (c) a plan for levees along the Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe; and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.

130. Levees along the Salt River between 27th Avenue, Phoenix, and Tempe Butte, Tempe, would prevent nearly all damages to the city of Phoenix, the city of Tempe, the community of South Phoenix, the commercial area between the Phoenix city limits and the Salt River, and the agricultural area on both sides of the Salt River between Tempe and Phoenix. However, such levees were found to be unjustified at this time. Consideration was therefore given to a short levee system from 40th Street, Phoenix to Tempe. These levees would provide only partial protection to the city of Phoenix and adjacent commercial and agricultural areas by preventing a recurrence of a breakthrough similar to the one that occurred during the flood of 1891.

131. Consideration was also given to adding flood-control storage to the proposed terminal-storage reservoir at the McDowell site. The addition of flood-control storage to a terminal-storage reservoir at the McDowell site was found to be justified. However, the study was based on the assumption that provisions for terminal storage at the McDowell site would be required as a part of the central Arizona project recommended by the United States Bureau of Reclamation. The report on the central Arizona project was transmitted to Congress, but decision on the project has been held in abeyance pending settlement in the Supreme Court of the controversy between the States of Arizona and California regarding rights to Colorado River water. At the present time, no basis exists for determination of the outcome of the controversy. However, the plan for multiple-purpose utilization of the McDowell Reservoir site has value in future planning for the development of the water resources of the area.

132. Under the recommended plan of improvement, complete protection against the standard project flood would be provided to most of the city of Tempe and a part of the city of Phoenix, but only partial protection for (a) an additional area in the city of Phoenix and the adjacent commercial and agricultural area, and (b) additional property along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. In addition, a minimum of about 16,000 acre-feet of water would be saved annually by the clearing of the phreatophytic growth.

133. The total first cost of the improvements under the recommended plan is estimated at \$3,570,000 (October 1957), comprising \$1,240,000 for the short levees and \$2,330,000 for the channel improvements. Annual charges for maintenance and operation are estimated at \$53,000. The total annual charges under the recommended plan would be \$178,900.

134. For the recommended plan, the average annual tangible benefits from flood control are estimated at \$226,000 and the average annual tangible benefits from water conservation, at \$128,000. The total average annual tangible benefits therefore would be \$354,000. The resultant benefit-cost ratio would be 1.98 to 1. In addition, the intangible benefits from flood control would include (a) prevention of loss of life; (b) prevention of interruption of

home life, public affairs, business transactions, and industrial activity; and (c) improvement of drainage conditions. Intangible benefits from water conservation would include a stabilization of property values by partially alleviating the existing water shortage and a general improvement in the long-term social and economic welfare. The project is justified.

135. Allocation of costs between flood control and water conservation was arrived at by use of the separable costs-remaining benefits method. Costs of the recommended plan allocated to flood control and water conservation were further apportioned in accordance with the general policies expressed in acts of Congress. Under this apportionment, local interests would repay, to the United States, 25 percent of the total construction cost in 40 equal annual payments without interest. Based on the present (October 1957) estimated construction cost for the project of \$3,300,000, the total local reimbursement in consideration of water-conservation benefits would amount to \$825,000 and the annual payments by local interests for the 40-year period would amount to \$20,625. The actual amount of local reimbursement would be adjusted on the basis of actual construction costs. In addition to such annual payments, local interests, at their own expense, would (a) pay for the cost of highway and utility relocations and provide necessary lands, easements, and rights-of-way at a cost estimated at \$210,000 (October 1957), and (b) maintain and operate the completed project at an average annual cost estimated at \$53,000. Because of the special circumstances wherein the water-conservation benefits would be realized, the district engineer is of the opinion that the 160-acre limitation should not be applied as a prerequisite for this project's qualifying for interest-free funds.

136. The plans of improvement and the general requirements of cooperation were discussed with local interests. The Board of Supervisors of Maricopa County, Ariz., has expressed its willingness to participate in the costs of the project and in meeting other items of local cooperation.

CONCLUSIONS

137. The district engineer concludes that:

(a) A flood menace exists along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.

(b) River-bottom growth within the channels of the Gila and Salt Rivers is a major flood hazard and transpires large amounts of water annually.

(c) Complete protection to most of Tempe against the standard project flood, partial protection to Phoenix and the adjacent commercial and agricultural areas, and partial protection to other

areas along the Gila and Salt Rivers between Gillespie Dam and Granite Reef Dam can be provided by construction of short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam.

(d) The proposed improvement would result in the salvage of at least 16,000 acre-feet of water annually, which would be available for beneficial use. To assure this saving, adequate maintenance would be required.

(e) In consideration of the water-conservation benefits that would result from construction of the recommended project, local interests should be required to reimburse the United States for that part of the project construction cost allocated to water conservation, and such reimbursement should be made in 40 equal annual payments without interest.

(f) The total first cost of the proposed improvement would be \$3,570,000 (October 1957), and the total annual charges would be \$178,900. The average annual tangible benefits from this improvement would be \$354,000.

(g) The ratio of tangible benefits to cost would be 1.98 to 1. The proposed project is feasible from an engineering standpoint and is well justified by the tangible and intangible benefits.

(h) The inclusion of sufficient flood-control space in a reservoir at the McDowell site to control the standard project flood would be justified in conjunction with development at that site of the terminal storage for the reclamation project proposed in House Document 136, 81st Congress, 1st session. Such flood-control space would be a desirable supplement to the above levee-and-channel improvement plan in order to insure an adequate degree of flood protection in the future for the rapidly growing urban area in the vicinity of Phoenix.

RECOMMENDATIONS

138. The district engineer recommends:

(a) That the United States adopt a flood-control and water-conservation project for the construction of short levees along the Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam at a total first cost estimated at \$3,570,000 (October 1957), of which \$60,000 have been expended on preauthorization studies, and an average annual maintenance and operation cost estimated at \$53,000.

(b) That the Corps of Engineers, United States Army, construct the levee and channel improvements at a Federal construction cost estimated at \$3,300,000 (October 1957) subject to the condition that local

interests furnish assurances satisfactory to the Secretary of the Army that they will (1) pay for the cost of highway and utility relocations and provide necessary lands, easements, and rights-of-way at a cost estimated at \$210,000 (October 1957); (2) maintain and operate the levee and channel improvements in accordance with regulations to be prescribed by the Secretary of the Army at an average annual cost estimated at \$53,000; (3) keep the flood channel of the Gila and Salt Rivers free from encroachment; (4) repay, to the United States, 25 percent of the total construction cost in 40 equal annual payments without interest (the exact amount of the annual payments, presently estimated at \$20,625, to be adjusted on the basis of actual costs of constructing the project; annual payments to be made to the Secretary of the Interior who, in turn, will deposit such funds in the Treasury of the United States as miscellaneous receipts); (5) hold and save the United States free from all damages arising from construction and operation of the work; and (6) adjust all water-rights claims resulting from construction, operation, and maintenance of the improvements.

(c) That, because of the special circumstances wherein the water-conservation benefits would be realized, the 160-acre limitation on ownership of lands benefiting from the water-conservation features of the project should not be applied as a prerequisite for this project's qualifying for interest-free funds.

(d) That, in the event the McDowell Reservoir, proposed in House Document 136, 81st Congress, 1st session, is adopted for construction, the design be modified to provide such additional flood-control storage as is determined to be needed and justified at that time.

C. T. NEWTON
Colonel, Corps of Engineers
District Engineer

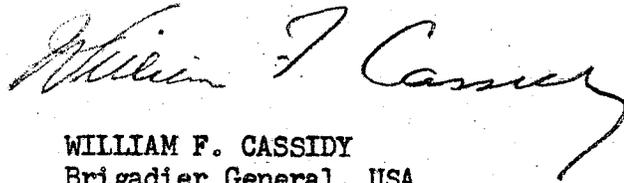
[First endorsement]

SUBJECT: Interim Report on Survey for Flood Control, Gila and Salt
Rivers, Gillespie Dam to McDowell Dam Site, Arizona

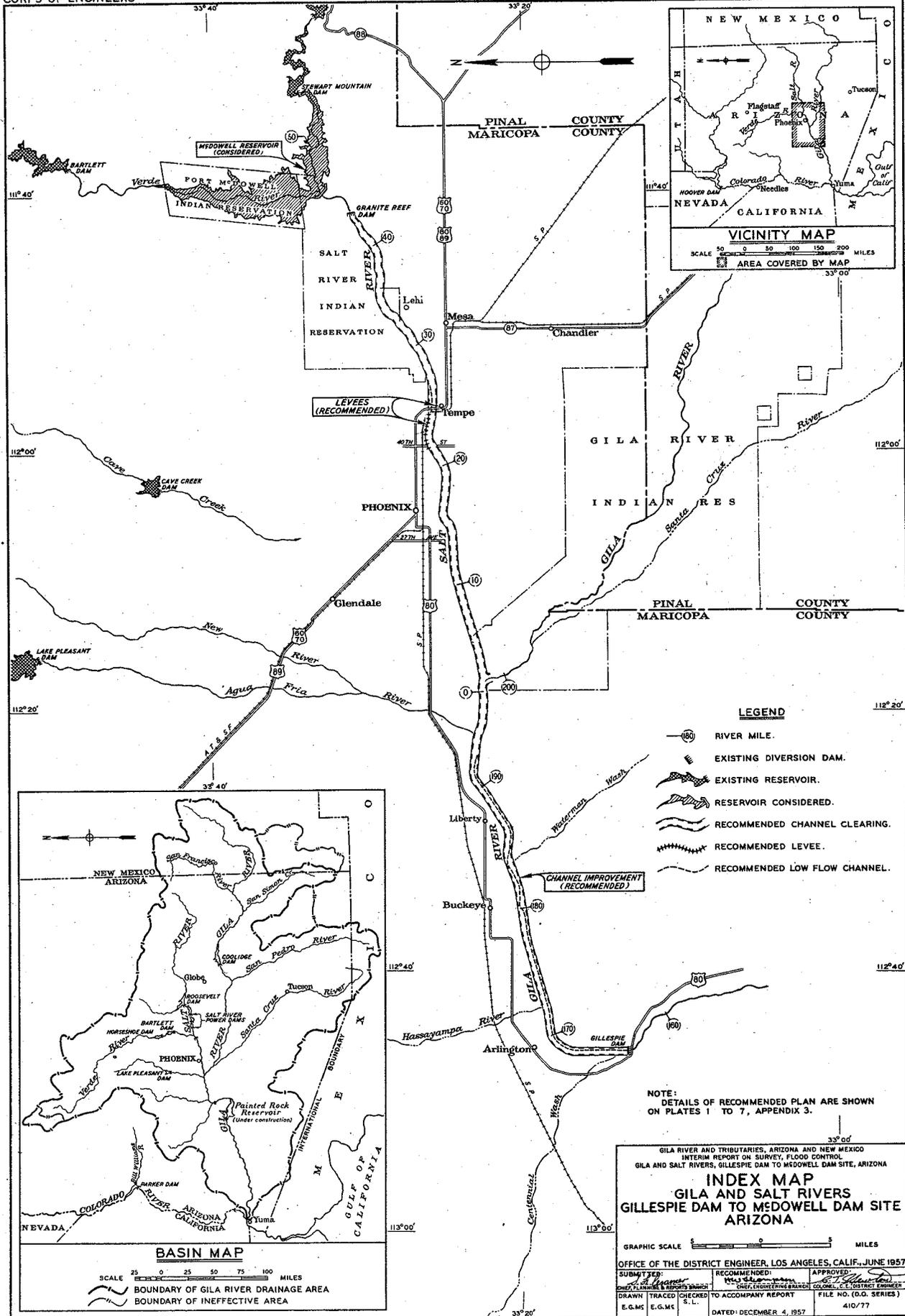
U. S. Army Engineer Division, South Pacific, San Francisco, California,
5 March 1958

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

I concur in the conclusions and recommendations of the District
Engineer.



WILLIAM F. CASSIDY
Brigadier General, USA
Division Engineer



OFFICE OF THE DISTRICT ENGINEER, LOS ANGELES, CALIF., JUNE 1957

SUBMITTED BY: E.G.M.S.	RECOMMENDED BY: E.G.M.S.	APPROVED BY: C. E. DISTRICT ENGINEER
DRAWN BY: E.G.M.S.	TRACED BY: E.G.M.S.	FILE NO. (D.O. SERIES) 410/77
CHECKED BY: S.L.	TO ACCOMPANY REPORT DATED: DECEMBER 4, 1957	

PI AT F

APPENDIX 8

RESOLUTION BY LOCAL INTERESTS--GILA AND SALT RIVERS GILLESPIE DAM TO McDOWELL DAM SITE, ARIZONA

RESOLUTION

WHEREAS, Section 6 of Public Law 761, 75th Congress, approved June 28, 1938, authorized the preliminary examination and survey for flood control on Gila River and tributaries, Arizona and New Mexico; and

WHEREAS, a preliminary-examination report on Gila River and tributaries, Arizona and New Mexico, indicated the advisability of a flood-control survey of the entire Gila River Basin, including the area along Gila and Salt Rivers between Gillespie Dam and McDowell Dam site; and

WHEREAS, an interim report on survey, flood control, Gila and Salt Rivers between Gillespie Dam and McDowell Dam site, has been authorized by the Chief of Engineers, United States Army; and

WHEREAS, Section 3 of Public Law 738, 74th Congress, provides that no money appropriated shall be expended on the construction of any project until States, political subdivisions thereof, or other responsible local agencies have given assurances satisfactory to the Secretary of the Army that they will assume certain enumerated obligations; and

WHEREAS, Section 3 of House Bill 254, 19th Legislature of the State of Arizona, authorizes Maricopa County to cooperate with the United States by assuming certain obligations in connection with flood-control projects built at the expense of the United States on Salt and Gila Rivers; and

WHEREAS, Protection against flood damages would be provided for property along Gila and Salt Rivers in the County of Maricopa, State of Arizona, by flood-control improvements considered for construction by the United States along Gila and Salt Rivers between Gillespie Dam and McDowell Dam site; and

NOW, THEREFORE, BE IT RESOLVED by the Board of Supervisors of Maricopa County, that, if a flood-control project consisting of levees, channel rectification, and channel clearing along Gila and Salt Rivers be found economically feasible and be authorized by act of Congress, the County of Maricopa will participate to the best of its ability by assuming the following obligations:

(a) Acquire and provide, without cost to the United States, lands, easements, and rights-of-way necessary for the construction of the project; the cost of such rights-of-way and the cost of performing the work required under item "b" below is presently estimated at \$194,000;

(b) Perform, without cost to the United States, all necessary utility and highway relocations and all necessary street modifications required in connection with the project;

(c) Hold and save the United States or any instrumentality, department, or agency thereof, free from any claim for damages arising from the construction, maintenance, and operation of the project;

(d) Maintain and operate, upon completion, all works in accordance with regulations prescribed by the Secretary of the Army;

(e) Establish and enforce flood-channel limits and regulations satisfactory to the Secretary of the Army for the protection of the flood-carrying capacity of the channel;

(f) Enter into a contract with the United States for repayment of the costs allocated to water conservation; such costs, estimated at \$810,000, to be repaid, without interest, in 40 equal annual payments of \$20,250; and

BE IT FURTHER RESOLVED, That this resolution be entered in the minutes of the Board of Supervisors of the County of Maricopa and that the Clerk of said county be, and he is hereby directed to forward a certified copy of this resolution to the District Engineer, Los Angeles District, Corps of Engineers, U. S. Army, P. O. Box 17277, Fdy Station, Los Angeles 17, California.

Passed and approved by the Board of Supervisors of the County of Maricopa this 16th day of July, 1956.

Approved this 16th day of July, 1956.

James G. Harth
Chairman, Board of Supervisors

APPENDIX 9

COMMENTS OF OTHER AGENCIES—GILA AND SALT RIVERS GILLESPIE DAM TO McDOWELL DAM SITE, ARIZONA

SCOPE

This appendix includes the comments of other Federal and State agencies on the interim report on survey for flood control along the Gila and Salt Rivers from Gillespie Dam to the McDowell Dam site in Arizona. The report was initially submitted for review and comment in June 1951, was subsequently revised in September 1953, and was resubmitted for review and comment in December 1957. Where pertinent, replies of the United States Army Engineer District, Los Angeles, are included.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

REGION III
BOULDER CITY, NEVADA

July 26, 1951

District Engineer
Corps of Engineers, U. S. Army
Los Angeles District
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

As requested in your letter of June 28, 1951, the "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona", has been reviewed by this office.

The Bureau of Reclamation has been carrying on investigations for a number of years in this part of Arizona, in connection with the Salt River Project and the proposed Central Arizona Project. The construction of almost any type of flood control works in the reach of the Gila and Salt Rivers covered by your report would necessitate at least minor changes in our plans for irrigation development.

We agree with your statement that even a minor flood passing through this reach of river in its present condition would cause considerable damage to residential, industrial and agricultural developments located near the river channel.

The flood control improvements which would be provided under your recommended plan consisting of (1) short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and (2) channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Rock Dam, would benefit present irrigation developments in the area and could be coordinated with potential irrigation developments under consideration by this office.

We note that you conclude that the addition of flood control storage to the required terminal storage is justified in the potential McDowell Dam and Reservoir, which is a feature of the Bureau of Reclamation plan for development of the Central Arizona Project. Also, you recommend that flood control storage be included in the reservoir when the project is authorized for construction. The Bureau plan provides for flood storage capacity of 390,000 acre-feet.

Your plan of development for the multiple-purpose McDowell Dam and Reservoir differs somewhat from that of the Bureau of Reclamation, which introduces a number of problems related to design, allocation of storage, and allocation of costs which we believe should be resolved before the project is constructed. One problem in particular is the effect of the reservoir on Stewart Mountain Power Plant, to which effect we have been unable to find a reference in your report. This plant, having a capacity of 10,400 kw would be completely inundated at your maximum proposed water surface elevation of 1486. We feel that it would be impracticable to protect this plant against complete inundation and, therefore, abandonment of the plant would be necessary if the McDowell Dam were constructed to the height recommended. Abandonment of the power plant would necessarily require inclusion in the cost of the project of a sizeable amount to reimburse the Salt River Valley Water Users' Association for its loss. We question whether the construction of protective works for the Stewart Mountain Power Plant above elevation 1443 could be economically justified.

Very truly yours,

C. A. Bissell
C. A. Bissell
Acting Regional Director

6 August 1951

Mr. C. A. Bissell
Acting Regional Director
United States Bureau of Reclamation
Boulder City, Nevada

Dear Sir:

Thank you for your letter of 26 July 1951 commenting on the interim report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

It is noted that you agree that the flood-control improvements which would be provided under the recommended plan would benefit present irrigation developments in the area and that you state that those improvements could be coordinated with potential irrigation developments under consideration by your office.

You state that our plan of improvement for the multiple-purpose McDowell Dam and Reservoir differs somewhat from the plan of the Bureau of Reclamation. Inasmuch as the Corps' report did not recommend construction of the multiple-purpose reservoir at McDowell site at the present time because of the imponderable political, legal, and economic considerations, it was not believed necessary to resolve all of the problems of design, allocation of storage, and allocation of costs. We agree that before the project is constructed, agreement must be reached on these points.

With regard to the effect of the reservoir on Stewart Mountain Power Plant, we had noted that your report on the Central Arizona Project, page R62, states that "it is considered the reduction in inflow to Stewart Mountain Power Plant might make it impractical to continue operating this unit, and consequently, the total output would be lost." On the basis of this statement in your report, and on other factors, this office did not believe it necessary to provide for the protection of the power plant. Here again is a matter to be resolved prior to the construction of the project.

A copy of your letter will be forwarded to the Chief of Engineers, Washington, D. C., for his consideration.

Your promptness in reviewing the report and submitting your comments is appreciated.

Very truly yours,

JOHN R. JANNARONE
Lt. Col., Corps of Engineers
Acting District Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION III
BOULDER CITY, NEVADA

December 11, 1951

District Engineer
Corps of Engineers
Los Angeles District
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

The revisions to your "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, dated June 8, 1951, have been received and reviewed by this office.

As stated in our letter of July 26, 1951, we believe that the flood control improvements which would be provided under your recommended plan consisting of short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam, would benefit present irrigation developments in the area and could be economically coordinated with potential irrigation developments under consideration by this office.

There is no doubt that the construction recommended in your report would alleviate damage to residential, industrial, and agricultural developments located near the river channel in case of a flood.

We agree that if the McDowell Dam is to be built for terminal storage as a unit of the Central Arizona Project consideration should be given to increasing the capacity to provide for flood control storage. Also, in view of the recent improvements made at Horseshoe Dam by local interests it might be desirable to include some water conservation storage in the McDowell Reservoir. However, we believe that there are a number of problems related to design, allocation of storage, and allocation of costs which cannot be firmly resolved at this time. A detailed comparison of cost estimates of the McDowell Dam as planned by the Bureau of Reclamation and the larger structure considered by your office has not been made. However, we do not feel that your

statement that the larger structure recommended in your report can be built for one percent more than the structures presently considered by the Bureau is based on entirely comparable hypotheses. It is realized that the river channel spillway in the Bureau of Reclamation plan is a relatively expensive structure, but it is believed that silting damage to the Granite Reef forebay and the canal system would be much less in case of high flood flows than with the detached type spillway proposed in your report. This office has not made subsurface investigation at the weir location but it is believed that the discharge channel would require substantial protection to prevent erosion.

The "Report on Central Arizona Project" recognizes the reduction of power output of the Stewart Mountain Powerplant due to diversion above this plant and provides for replacement of energy equal to the reduction. It is also recognized that the flow remaining after the upstream diversion is made might not be sufficient for economic operation of this plant, although that remains a question at this time. If it is determined that it would be economical to operate the Stewart Mountain Powerplant after the Salt-Gila diversion is made and McDowell Dam constructed as planned by the Bureau, and further, that increasing the capacity to that contemplated by the Corps of Engineers would force abandonment of the plant, then we believe that adjustment or compensation to the Salt River Valley Water Users' Association, in addition to that contemplated by the Bureau, would be necessary, and that the cost of such additional adjustment should be a charge against the increased flood control storage capacity.

We wish to call your attention to the fact that the name McDowell Dam and Reservoir has been changed to Maxwell Dam and Reservoir.

Sincerely yours,

E. G. Nielsen
E. G. Nielsen
Acting Regional Director

28 December 1951

Mr. E. A. Moritz
Regional Director, Region 3
U. S. Bureau of Reclamation
Boulder City, Nevada

Dear Sir:

Thank you for Mr. Nielsen's letter of 11 December 1951 commenting upon the interim report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

It is noted that you believe that the flood-control improvements that would be provided under the recommended plan would benefit present irrigation developments in the area and could be economically coordinated with potential irrigation developments under consideration by your office.

You agree that if the McDowell Dam is to be built for terminal storage as a unit of the Central Arizona Project, consideration should be given to increasing the capacity to provide for flood-control and water-conservation storage. You also state that there are a number of problems related to design, allocation of storage, and allocation of costs that cannot be firmly resolved at this time.

You state that the silting damage to the Granite Reef forebay and the canal system would be much less in case of high flood flows if a river channel spillway were constructed as contemplated in the Bureau of Reclamation plan than if the detached-type spillway were constructed as proposed by the Los Angeles District. McDowell Reservoir, as contemplated in the report of this office, would reduce the standard project flood of 290,000 cubic feet per second to a peak outflow of 82,000 cubic feet per second. The chance of occurrence of such a flood is very small. The entire discharge of such a flood and all lesser floods would be through the outlet structure in the river channel and no flow would be over the spillway. On the infrequent occurrence of floods larger than 290,000 cubic feet per second, only discharges in addition to those passing through the outlet structure would pass over the spillway. If a large flood resulting in flow over the spillway were to occur, such spillway discharge would probably erode the discharge channel above Granite Reef diversion dam. It is doubtful whether much water would be diverted into the canals during the period of high-water stages in the river. After the recession of the high water, the entire 672,000 acre-feet capacity of the reservoir reserved for flood control would be emptied at the rate of 82,000 cubic feet per second. This uniform flow would tend to sluice the river channel above

Granite Reef Dam and transport the sediment downstream from the canal intakes. Therefore, it was not considered economical or necessary to provide substantial protection to the discharge channel at the detached spillway location.

With regard to the effect of the reservoir on Stewart Mountain power plant, you agree that the flow remaining after the upstream diversion is made (under the Central Arizona project) might not be sufficient for economic operation of this plant. However, you indicate that the economy of operating the Stewart Mountain power plant with that remaining flow has not been finally determined. You further state (1) that increasing the capacity of McDowell Reservoir under the plan described in the interim report would force abandonment of the Stewart Mountain power plant, (2) that additional compensation or adjustment to the Salt River Valley Water Users' Association would be necessary as a result of such abandonment, and (3) that such additional compensation or adjustment should be a charge against flood control. As discussed at the conference held in Boulder City on 3 October 1951 between representatives of the Los Angeles District, Corps of Engineers, and Region 3, Bureau of Reclamation, the maximum annual loss to the Salt River Valley Water Users' Association because of the abandonment of the Stewart Mountain power plant would not exceed \$20,000. This is a minor item in the justification of flood-control storage at the McDowell Reservoir.

It is noted that the name of McDowell Dam and Reservoir has been changed to Maxwell Dam and Reservoir. Because the report is dated 8 June 1951, prior to the change in name, the name was not changed in the report.

A copy of your letter will be forwarded with the report to the Chief of Engineers, Washington, D. C., for his consideration.

Your promptness in reviewing the report and submitting your comments is appreciated.

Very truly yours,

W. R. SHULER
Colonel, Corps of Engineers
District Engineer

DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

REGION 3
BOULDER CITY, NEVADA

February 6, 1958

District Engineer
Los Angeles District
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

This office is pleased to have the opportunity to review your "Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona", dated December 4, 1957, which was transmitted to this region by your letter of January 8, 1958.

Our review paid particular attention to Appendixes 4, 5, and 7, and it was concentrated for the most part on the recommended plan of improvement which provides for (a) short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and (b) channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. Revision in your present report to bring costs up to date and to allocate costs between flood control and water conservation are straightforward, and are not, therefore, deemed to require comment.

Our letters of July 26 and December 11, 1951 commented on matters connected with the potential McDowell (Maxwell) Dam. No additional comments are made at this time because so many uncertainties seem to lie ahead of its being authorized.

We appreciate your courtesy in making your report available for our comment.

We would appreciate your furnishing us an extra copy of the report for use in our Phoenix Development Office.

Very truly yours,

/s/ W. H. Taylor
W. H. Taylor
Regional Director

FEDERAL POWER COMMISSION
REGIONAL OFFICE
100 McAllister Street
San Francisco, Calif.

July 18, 1951

Lt. Colonel W. R. Shuler, District Engineer
Los Angeles District
Corps of Engineers, U. S. Army
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Colonel Shuler:

In compliance with your request of June 28, 1951, your File No. SPLGD, we have reviewed your proposed Interim Survey Report on Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, dated June 8, 1951. Enclosed are three copies of a memorandum by Mr. Robert H. Griffin of this office giving his conclusions on the proposed development.

Since the developments recommended in your report will consist of levees and channel improvements, the proposed project offers no possibility for the inclusion of hydroelectric power. However, your studies do include the consideration of the prospective multiple-purpose dam and reservoir at the McDowell site on the Salt River. This is a part of the Bureau of Reclamation's Central Arizona Diversion Project.

Your report suggests certain changes in the McDowell Project, namely, an increase in the reservoir capacity to provide for more flood control storage, and the possible addition of storage capacity for water conservation purposes, as distinguished from storage required for terminal use in connection with the Central Arizona Diversion Canal. Inasmuch as you do not recommend the McDowell Reservoir as part of your proposed plan, Mr. Griffin's only purpose in discussing the McDowell Project has been to consider the possible effect of the construction of this reservoir, as a part of the Central Arizona Diversion Project, on the economics of the levee and stream-channel improvements proposed in your report.

I concur in the conclusions presented in Mr. Griffin's memorandum. Apparently the McDowell Reservoir, if constructed at present as a terminal reservoir for the Central Arizona Diversion Project,

would offer an economical means of controlling the downstream floods. The construction of this reservoir depends, however, on so many imponderable political, legal, and economic considerations that I believe the project recommended in your report, providing immediate flood control and water conservation benefits, should be constructed.

Very truly yours,

Leshar S. Wing
Regional Engineer

By /s/ Daniel J. Fee
Acting

Enclosure:

Copy of memo 7/13/51
RHG to RE (in trip.)

FEDERAL POWER COMMISSION
SAN FRANCISCO REGIONAL OFFICE

July 13, 1951

MEMORANDUM FOR THE REGIONAL ENGINEER:

Subject: Investigation - U. S. Engineer's Survey Report
on Gila River Basin (W. A. No. 32)

Introduction

On June 29, 1951, this office received from the Corps of Engineers in Los Angeles an "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona" dated June 8, 1951. Our informal comments on this report were requested.

This report by the Army is the fifth of a series of interim reports. Of the other four, three have been completed and one - concerning the Gila River and Tributaries above Salt River - is under consideration. The three completed reports cover Tucson, Arizona and vicinity; Queen Creel and Gila River and Tributaries below Gillespie Dam. A final report covering the entire Gila Basin, and summarizing the several interim reports, is planned. The area covered by the present report and the other interim reports is shown on a map taken from the Army's report and reproduced as Plate 1 of this memorandum.

Basin Description

The Gila River Basin includes the southern half of New Mexico and part of southwestern New Mexico. The total drainage area is 58,200 square miles. The Gila heads in the high mountains and flows westerly across hot, dry, desert areas to its junction with the Colorado. Its principal tributaries are the Salt, Santa Cruz, and San Pedro Rivers. The largest tributary of the Salt River is the Verde. The drainage area of the Salt River at its junction with the Gila is 13,700 square miles; the area of the Gila at Gillespie Dam, below the Salt River, is 49,600 square miles.

The area considered in the report under review is the Salt River Valley from the McDowell dam site to the Gila River (38 miles) and the Gila River Valley from the Salt River to Gillespie Dam (28 miles). The Gila Valley from Gillespie Dam to the backwater of the proposed Painted Rock Reservoir is also considered as it would be affected by a dam at the McDowell site. (See map - Plate 1).

The Gila River and its tributaries are usually perennial streams at their origin in the higher mountains, but are intermittent in their lower reaches. Local summer thunder storms occur, but do not cover sufficient area to cause major floods. General storms occur in the winter and may cause large floods. The maximum recorded flood at the Gillespie dam site is 70,000 cfs, although much greater flows have occurred; and the Army estimates the "standard project flood" at the McDowell site on the Gila River as 290,000 cfs. The estimate for the Gila River at Gillespie Dam is 350,000 cfs.

Economic Development

The area affected by the proposed improvements lies entirely within Mariposa County, Arizona, and includes the cities of Phoenix, Mesa, Glendale, Tempe, Chandler, and Tolleson. Phoenix, the capital of Arizona, has with its surrounding urban area an estimated 1950 population of 235,000. Irrigated areas in the Salt and Gila Valleys from McDowell dam site to Gillespie Dam total 320,000 acres. Crop production is entirely dependent on irrigation, which is in turn dependent on a highly developed and complex system of irrigation works including dams, reservoirs, canals, power plants, and numerous deep-well pumps. A large overdraft of ground water is occurring in the area at present.

Prior Reports

Many prior reports on the Gila River Basin, or portions thereof, are available. Three interim reports by the Army have already been mentioned. These have been commented upon by this office. Other important reports are:

Survey Report, Queen Creek Watershed, Arizona,
June 1950, U. S. Department of Agriculture

Power Market Survey, Colorado River - Lower Basin,
Part 1 - Power Requirements, May 1950, Federal
Power Commission, San Francisco Regional Office

Staff Report on the Colorado River Basin, October
1948, Federal Power Commission, San Francisco
Regional Office

Staff Report on Central Arizona Project as pre-
sented by the Department of Interior in its
report of December 1947 - March 1948, Federal
Power Commission, San Francisco Regional Office

Report on Central Arizona Project, December 1947,
U. S. Bureau of Reclamation

The Colorado River, March 1946, U. S. Bureau of
Reclamation

Plans of the Army Department

The recommended plan of the Army Department consists of short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe; and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. The levees along the left and right banks of the Salt River would have lengths of 2,000 feet and 16,700 feet, respectively. The height above streambed would be 23 to 28 feet. The leveed channel would accommodate the standard project flood for that location of 270,000 cfs.

The channel improvements would consist of a floodway 2,000 feet wide and low-flow channels to reduce stream meandering and assist in keeping floods in the intended area. The floodway would be constructed by clearing river-bottom growths, largely salt cedar, from the river channel. The floodway would be about 71 miles long. The original clearing would probably be done by mechanical means, although clearing by use of chemicals followed by burning is also under consideration. Maintenance of the cleared areas would be by cultivation of areas where regrowth occurs. Other means of maintenance such as planting grasses and pasturing are under study.

It is expected that the floodway clearing and maintenance program would reduce transpiration losses by about 16,000 acre-feet per year. In this area, where a serious and chronic water shortage exists, this water saving is of considerable importance.

The floodway and levees would not affect any present or future power development; and offer no opportunity for production of hydroelectric power.

The District Engineer also investigated the potential multiple-purpose dam and reservoir at the McDowell site on the Gila River. This structure is not economically feasible for flood control alone. However, it has been proposed by the Bureau of Reclamation as the terminal storage reservoir for the Granite Reef aqueduct of the Central Arizona Project. The Bureau's proposal provides for terminal storage of 142,000 acre-feet, dead storage of 16,000 acre-feet, and flood control storage of 300,000 acre-feet, giving a total storage of 578,000 acre-feet. The Army suggests a reservoir of 860,000 acre-feet total capacity, of which 672,000 would be flood control and the remainder allocated as proposed by the Bureau of Reclamation. The Army also recommends that if the McDowell Reservoir is constructed consideration be given to additional storage for water conservation purposes, as distinguished from that required for terminal use.

The Bureau of Reclamation proposed a power plant of 4,100 kilowatts at the McDowell site. Additional flood control storage would not affect the power installation. However, if conservation storage should be provided in addition to terminal storage the power installation would probably be changed. There are other uncertainties

in connection with this project, especially as to the available Colorado-River water supply, which is dependent on the final settlement of the Arizona-California controversy. Any change in water supply would affect the power installation. It is suggested that further studies of the power feature be made after (1) the amount of conservation storage is determined, (2) the available Colorado River water supply is definitely known.

Costs and Benefits

The capital cost of the Army's recommended plan is \$3,583,000, of which \$1,240,000 is for levees and \$2,343,000 for channel improvements. If flood control storage is provided at the multiple-purpose McDowell site, as suggested by the Army, the incremental capital cost, for flood control storage, would be \$4,864,000. The annual cost of the recommended program is estimated at \$224,800, of which \$133,100 is Federal and \$91,700 is non-Federal. The non-Federal costs include \$80,000 annually for floodway maintenance. The additional flood control storage at the McDowell site would increase the total annual costs to \$417,400.

Estimated tangible benefits from the recommended plan are \$262,000, of which flood control gives \$166,000 and water conservation (at \$6.00 per acre-foot) gives \$96,000. The addition of flood control storage at the McDowell site would increase the flood control benefits to \$437,000, giving a total annual benefits of \$533,000.

The benefit-cost ratio of the recommended plan is 1.17, and of the recommended plan plus McDowell flood control storage is 1.28.

Alternative Plan Considered by FPC

The Army report does not include an estimate of benefits from the 672,000 acre-feet of flood control storage in the McDowell Reservoir without any downstream channel clearing or levees. However, according to the Army's estimates the annual benefits of the McDowell Reservoir, considered as an increment to the recommended plan, amount to \$271,000. The corresponding annual costs are \$192,600, giving an incremental benefit-cost ratio of 1.41.

The benefit-cost ratio of McDowell Reservoir considered as an increment to the recommended plan is higher than the benefit-cost ratio for either the recommended plan of channel improvements alone or the recommended plan plus McDowell Reservoir. This indicates that flood control storage at McDowell Reservoir, assuming this reservoir constructed as a part of the Central Arizona Project, might be the most economical means of controlling floods in the stretch of river under consideration. This conclusion cannot be checked without detailed studies of the benefits which would be produced by flood control storage at McDowell Reservoir operating without downstream improvements. These studies cannot be made in this office because the necessary data are not available.

Cost estimates in the Army report show conclusively that the McDowell Reservoir is not feasible as a single-purpose flood control project. If this reservoir were constructed as a part of the Central Arizona Project, and if detail studies show that the addition of flood control storage would be the most economical means of preventing flood damages, the most desirable project would depend primarily upon the relative timing of the Central Arizona Project and the proposed flood control measures. If the Central Arizona Project were to be constructed immediately, it is possible that flood control could be obtained in connection with the McDowell Reservoir and that the remaining benefits available for the channel improvement would not be sufficient to make this work feasible. However, if the Central Arizona Project is to be indefinitely delayed, it would be desirable to proceed with the channel improvements as recommended by the Army. This would allow immediate realization of the water-conservation and flood-control benefits.

A bill authorizing the Central Arizona Project has passed the United States Senate. However, the House Interior Committee has voted 16 to 8 not to consider the project further until the Arizona-California dispute over water rights in the Colorado River has been settled. It is evident that authorization of the Central Arizona Project (including McDowell Reservoir) depends on many imponderable political, economical, and legal factors; and may be indefinitely delayed. It is, therefore, believed that the Army's recommended plan is the most appropriate for existing conditions.

Summary

The Los Angeles District Office of the Corps of Engineers has submitted to us for informal comments its "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona" June 8, 1951. This report is the fifth of a series of interim reports which will be followed by a final report covering the entire Gila River Basin.

The report under review recommends construction of a cleared floodway 71 miles in length between Granite Reef Dam on the Salt River and Gillespie Dam on the Gila River. Also recommended is construction of short levees on the right and left banks of the river near Phoenix, with lengths of 16,700 and 2,000 feet, respectively. The estimated capital cost of the recommended project is \$3,583,000; the annual cost is \$224,800; annual benefits are \$262,000; and the benefit-cost ratio is 1.17. The recommended plan would have no effect on present or future power developments, but offers no opportunity for power generation.

The Army also investigated the proposed McDowell Reservoir on the Salt River. This reservoir is not economically feasible for flood control purposes alone. However, if it should be constructed as the terminal reservoir for the Bureau of Reclamation's Central Arizona Project, the provision of flood control storage on an incremental basis would be feasible. The addition of this flood control storage to the Army's recommended project would give an overall benefit-cost ratio of 1.28.

The McDowell Reservoir, if constructed at present as a terminal reservoir for the Central Arizona Project, with the suggested flood-control capacity would apparently provide an economical means of controlling floods in the stretch of river considered. Since construction of the reservoir depends on many imponderable political, legal, and economic factors it is believed that the Army's recommended plan, providing immediate flood control and water conservation benefits, is preferable under present conditions to the Bureau of Reclamation's plan for McDowell Reservoir.

A power development of 4,100 kilowatts has been proposed by the Bureau of Reclamation at the McDowell dam site. Further investigation of this proposed installation should be made if conservation storage is to be provided at the McDowell Project, or if the amount of Colorado River water available for the Central Arizona Project is definitely determined.

Robert H. Griffin
Senior Hydraulic Engineer

FEDERAL SECURITY AGENCY
PUBLIC HEALTH SERVICE
Norman Building
Dallas, Texas

July 10, 1951

W. R. Shuler
District Engineer
Los Angeles District
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

We are pleased to acknowledge the receipt of the proposed Interim Survey Report on Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona, dated June 8, 1951.

Your courtesy in supplying this report is greatly appreciated and we find it a valuable reference work.

Very truly yours,

/s/ R. F. Poston
R. F. Poston
Senior Sanitary Engineer
Officer in Charge

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
Region Three
Santa Fe, New Mexico

July 25, 1951

Lt. Col. W. R. Shuler
District Engineer, Los Angeles
District
Corps of Engineers, U. S. Army
P. O. Box 17277, Foy Station
Los Angeles 17, California

My dear Colonel Shuler:

Reference is made to your letter of June 28 (your file reference No. SPLGD) addressed to our Regional Director, Region 4, in San Francisco. As explained in Mr. E. M. Hilton's letter of July 3 to you, your Interim Survey Report and Appendices on Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, June 6, 1951, transmitted with your above letter, was forwarded to this office for review and informal comment.

No National Park Service area or direct interest will be affected by the flood control features proposed. However, the entire Salt River Valley, from above the proposed McDowell Dam to the confluence with the Gila River, is an area very rich in significant archeological remains. Along the Gila River also, many archeological sites are known above the mouth of the Salt River and below Gila Bend; presumably, archeological remains of importance may be expected to occur between the mouth of the Salt River and the Gillespie Dam. In the Gila-Salt channelization work and levee construction from Granite Reef Dam to Gillespie Dam, provision should be made for archeological survey and recovery work before and during construction operations. A crew of an Archeologist GS-7 or GS-9, and a junior professional assistant or archeological aid, GS-5, plus occasional use of unskilled labor as required, for a period of three to six months, should be sufficient for this, including preparation of a final report. Archeological investigation of the McDowell Reservoir, as of other proposed reservoirs of the Central Arizona Project, will have to be made upon authorization of construction or before; a survey can be done by an Archeologist and his assistant in two weeks to a month, but it is not possible to predict how much salvage excavation of archeological sites will be found to be essential.

The opportunity to review your report has been very much appreciated.

Sincerely yours,

Hugh M. Miller
Assistant Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Region Three
Santa Fe, New Mexico

January 22, 1958

District Engineer
U. S. Army Engineer District, Los Angeles
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

This refers to Chief, Engineering Division, H. W. Thompson's letter of January 8, concerning your Interim Report on Survey for Flood Control, Gila and Salt Rivers - Gillespie Dam to McDowell Dam Site, Arizona.

We have reviewed the report and find no reason to change our comment as was submitted by our letter of July 25, 1951. You may, therefore, consider those comments as currently applicable.

Sincerely yours,

/s/ John J. Moseley
John J. Moseley
Acting Regional Chief
Division of Recreation Resource
Planning

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Albuquerque, New Mexico
July 16, 1951

Lt. Col. W. R. Shuler
Corps of Engineers
District Engineer
Los Angeles District
751 South Figueroa Street
Los Angeles 17, California

Dear Col. Shuler:

We have reviewed your "Interim Report on Flood Control for the Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site". We are particularly interested in this area because of our cooperative work with several soil conservation districts in improving the use of land and water resources. We are also quite interested in the control of salt cedars and other useless river-bottom vegetation because it is a serious problem in many soil conservation districts here and elsewhere. We have made no attempt to check the engineering or economic phases of this report but the program which you recommend appears to be sound and should contribute materially to the stabilization and future welfare of this area.

Before long this Service expects to be called on by increasing numbers of land owners who need technical assistance in clearing their lands of these phreatophytes so they can be restored to production of crops or forage for livestock. Irrigation and other water-using interests are becoming increasingly concerned about the inroads these useless growths make on their water supplies. The program which you propose for this reach of the Gila and Salt Rivers is a much larger test of phreatophytes so they can be restored to production of crops or forage for livestock. Irrigation and other water-using interests are becoming increasingly concerned about the inroads these useless growths make on their water supplies. The program which you propose for this reach of the Gila and Salt Rivers is a much larger test of phreatophyte control than has been carried out so far. We hope that during this operation a few different methods of control can be tested, for the information that will be useful in other areas.

If this floodway develops into one like that constructed and maintained by the International Boundary and Water Commission on the Rio Grande between Caballo Dam and El Paso, there will be extensive areas of stream bank between the low-water channel and the levees on which a grass cover must be established. This Service maintains a nursery at Tucson and numerous observational plots throughout Arizona, for testing various grasses and methods of revegetation. We also intend to undertake field trials of various methods of revegetating cleared areas so

they will not be exposed to serious erosion during the conversion from phreatophytes to useful vegetation. Please feel free to consult this office about that phase of your project when you begin operations.

The only point we noticed in your report that seemed open to question is the value of water, \$6 an acre-foot, that is used in evaluating the channel improvements. This appears to be low for the productive value of water, particularly since farmers in that area now pay from \$5 to \$9 an acre-foot for pumped water and the water saved by clearing this channel will largely recharge underground reservoirs. We have not yet made any calculations in this respect but expect to do so during our current watershed survey of the Gila Basin in aid of flood control. Our experience in the Pecos and Rio Grande Basins leads to the conclusion that the productive value of water in the Phoenix area is much higher than \$6 an acre-foot. Since that value shows a favorable cost-benefit ratio there is no need to change it in this report. We mention this point chiefly because our forthcoming survey report for the Gila watershed may carry a higher value on water.

We appreciate the opportunity to review this report and hope that this project can get underway soon. Any improvement of this kind will help to stabilize the agriculture of this area and should fit in well with our programs of land and water conservation and watershed improvement.

Sincerely yours,

/s/ Cyril Luker
Cyril Luker
Regional Director

23 July 1951

Mr. Cyril Luker
Regional Director
Soil Conservation Service
U. S. Department of Agriculture
Albuquerque, New Mexico

Dear Sir:

Thank you for your letter of 16 July 1951 commenting on the interim report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

It is noted that you state that the recommended program appears to be sound and should contribute materially to the stabilization and future welfare of this area.

Your invitation to consult with your office about methods of revegetation of the cleared floodway is appreciated. When that phase of the operation is considered, we shall be very glad to avail ourselves of your services and expert advice.

We note that you question the value of water at \$6 per acre-foot. It is true that the \$6 per acre-foot value is a conservative figure, but not unduly so. The unit value applies to the value of water in Buckeye and Arlington Valleys and in the areas below Gillespie Dam, all in Maricopa County. According to the United States Geological Survey (see page 13 of Appendix 6), "probably not more than 20 percent of the salvaged water would be available to the Buckeye Canal and possibly another 20 percent would be available to the Arlington Canal. The remaining 60 percent would be available to canals and wells along Gila River below the Arlington Canal intake, but within the limits of Maricopa County." The average value of crops is not so high in these areas as in the Phoenix area.

A copy of your letter will be forwarded to the Chief of Engineers, Washington, D.C., for his consideration.

Your promptness in reviewing the report and submitting your comments is appreciated.

Very truly yours,

W. R. SHULER
Colonel, Corps of Engineers
District Engineer

UNITED STATES
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Albuquerque, New Mexico
Post Office Box 1348
December 5, 1951

Lt. Col. John R. Jannarone
District Engineer
Los Angeles District
Corps of Engineers
Post Office Box 17277 Foy Station
Los Angeles 17, California

Dear Colonel Jannarone:

Thank you for providing us with the revised pages for our copy of your interim report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona, dated June 8, 1951.

The initial draft of this report was reviewed in July, 1951, and our comments were sent to your office on July 16, 1951. Colonel Shuler's letter of July 23 cleared up the question we raised relative to the value of irrigation water used in the report.

We have no further comments on the report.

Very truly yours,

Cyril Luker
Cyril Luker
Regional Director

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
Forest Service Building
Ogden, Utah

July 13, 1951

Lt. Col. W. R. Shuler
District Engineer
Corps of Engineers
751 South Figueroa Street
Los Angeles 17, California

Dear Colonel Shuler:

The report "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona" dated June 8, 1951 has been reviewed with interest since this office has been assigned primary responsibility for a Department of Agriculture flood control survey of the watershed lands comprising the Salt, Verde, Hassayampa, and Agua Fria watershed.

We have no comments to raise concerning either the report or supporting appendix material, except to raise a question concerning the evaluation of benefits anticipated from water conservation to be obtained through the control of phreatophytes.

We agree fully with the philosophy and reasons stated in paragraphs 101, 102, and 103 on pages 43 and 44. This approach is generally similar to procedure which we have followed in several surveys, primarily because of our conviction that evaluation of water conservation should at least partially reflect benefits to the dependent community. Our question, therefore, does not concern the procedure but rather the \$6 per acre-foot value which seems to be quite conservative in view of the preponderance of specialized, high value crops produced in the Salt River area.

When funds become available, we expect to initiate a survey of watershed lands in this area and since your report contains much basic data which will be useful to us, we wish to retain your report in our files unless you prefer that it be returned.

Very truly yours,

/s/ Reed W. Bailey
REED W. BAILEY
Director

23 July 1951

Mr. Reed W. Bailey
Director, Intermountain Forest and
Range Experiment Station
Forest Service
U. S. Department of Agriculture
Forest Service Building
Ogden, Utah

Dear Sir:

Thank you for your letter of 13 July 1951 commenting upon the interim report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

It is noted that you have no comments to raise concerning either the report or supporting appendix material, except to raise a question concerning the evaluation of the water-conservation benefits.

It is true that the \$6 per acre-foot value is a conservative figure, but not unduly so. The unit value applies to the value of water in Buckeye and Arlington Valleys and in the areas below Gillespie Dam, all in Maricopa County. According to the United States Geological Survey (see page 13 of Appendix 6), "probably not more than 20 percent of the salvaged water would be available to the Buckeye Canal and possibly another 20 percent would be available to the Arlington Canal. The remaining 60 percent would be available to canals and wells along the Gila River below the Arlington Canal intake, but within the limits of Maricopa County." The average value of crops is not so high in these areas as in the Phoenix area.

A copy of your letter will be forwarded to the Chief of Engineers, Washington, D. C., for his consideration.

Your promptness in reviewing the report and submitting your comments is appreciated.

Very truly yours,

W. R. SHULER
Colonel, Corps of Engineers
District Engineer

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SOUTHWESTERN REGION
Post Office Building
Albuquerque, New Mexico

August 9, 1951

District Engineer
Los Angeles District
P.O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

Reference is made to your letter of June 28, File SPLGD, and the "Interim Report on Survey, Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona", which was enclosed.

We are interested in your discussion of "Floods of Record" that listed the flood of 1891 as being the largest. It may be significant that this date coincides with the period of the great increase in livestock numbers in the southwest. The rather frequent recurrence of subsequent floods, the ultimate channel erosion and sedimentation problem of the present, might well be closely associated with overgrazing and abuse of watershed lands that started before the turn of the century.

In paragraph 20, "Vegetation", you state that "overgrazing has destroyed much grass, which has been replaced by rabbitbrush and snakeweed over large areas". This loss of grass has undoubtedly reduced the rate of infiltration which in turn would increase surface run-off and summer floods peaks. A program to restore the grass and herbaceous cover would reduce future flood peaks and aid in erosion control, and lengthen the effective life of downstream structures. We believe the report might include some such statement. This subject has been studied at the Southwestern Forest and Range Experiment Station at Tucson. These studies at Sierra Ancha are reported in their report "Watershed Research Aids Salt River Valley", a mimeographed publication dated 1947.

Many of the high water yielding areas of the watershed are within National Forests. The objective is to administer these lands in such a way that the watershed function is not impaired. In some places the vegetative cover is not sufficient to control erosion and provide for proper watershed functions. In these places we are taking corrective action as rapidly as possible under present limitation.

It is noted that as a result of the studies covered by the report the District Engineer recommends: The adoption of a project incorporating short levees along Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and channel improvements along Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. He also recommends that flood-control storage be included in the planning and authorization for a terminal-storage reservoir at the McDowell site.

This office recognizes the need for channel clearing and levee work where proposed in the report. Improved watershed conditions would lengthen the life of major channel improvements by retaining sediment in place on the watershed. This improvement should be accomplished not later than concurrently with heavy channel works. The flood-control survey by the Department of Agriculture has been authorized for the area being considered but has not been accomplished. Early completion of this survey and the program to be proposed for the watershed is desirable.

This office has no suggestions to offer in regard to the report. Your kindness in making it available for review is appreciated.

The report (No. 32) is being sent to the Southwestern Forest and Range Experiment Station, Tucson, Arizona for review and information. In case that office of the Forest Service has important comments in regard to the report, these will be forwarded to you.

Sincerely yours,

O. OTTO LINDH, Regional Forester

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
SOUTHWESTERN REGION

P. O. Box 1310
Albuquerque, New Mexico

January 15, 1958

Mr. H. W. Thompson
Chief, Engineering Division
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Mr. Thompson:

We appreciate receiving a revised copy of the Interim Report on the Gila and Salt Rivers which was transmitted by your letter of January 8.

These reports, even though the structures do not affect national forest land, complete our file on river basin work and are valuable to us for reference purposes. We have no comments to make other than those made in our letter of August 9, 1951.

Very truly yours,

FRED H. KENNEDY, Regional Forester

By W. L. Hansen

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Washington 25, D. C.

March 4, 1958

Mr. H. W. Thompson, Chief
Engineering Division
U. S. Army Engineer District
P. O. Box 17277
Foy Station
Los Angeles, California

Dear Mr. Thompson:

Several weeks ago you forwarded a draft copy of your interim report on flood control improvements, Gila and Salt Rivers - Gillespie Dam to McDowell Dam site, Arizona.

This report and your request for review and comment was delayed considerably in reaching me since I have been absent from my Ogden office on an extended detail.

I have no additional comments to make on your report at this time. However, I am forwarding the copy which I received to the Regional Forester, U. S. Forest Service, Albuquerque, New Mexico, with a request that he write you directly concerning any comments which he may desire to make.

Very truly yours,

Henry L. Lobenstein
HENRY L. LOBENSTEIN
Forest Service Liaison Representative
Pacific Southwest Interagency Committee

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Office of the Regional Director
Albuquerque, New Mexico
P. O. Box 1306

April 13, 1951

Lt. Col. W. R. Shuler
District Engineer
Corps of Engineers, U. S. Army
Post Office Box 17277, Foy Station
Los Angeles 17, California

Dear Colonel Shuler:

Reference is made to your letter dated 26 February 1951, File PSLGD 800.92, in which you request our comments on the plan for flood control to be recommended in your forthcoming report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

It is our understanding that the features to be recommended in the plan would consist of short levees along the Salt River from 40th Street in the City of Phoenix to the City of Tempe, and channel improvements along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam. The short levees would consist of (1) a levee along the left bank of Salt River for about 2,000 feet from Tempe Butte to the Southern Pacific Railroad bridge embankment, and (2) a levee along the right bank of Salt River for about 16,700 feet from the Southern Pacific Railroad embankment to 40th Street, Phoenix. The channel improvements would consist of a cleared floodway and low-flow channels. A floodway 2,000 feet in width would be created by clearing river bottom vegetation along the Gila River from Gillespie Dam to the mouth of Salt River and along Salt River from its mouth to Granite Reef Dam. Two low-flow channels within the cleared floodway, the first along Gila River from Gillespie Dam to a point about one mile downstream from the mouth of Agua Fria River, and the second along Salt River upstream from the highway bridge at Tempe, would be included in the plan. The report will also point out that the addition of flood control storage at the McDowell Reservoir site (proposed by the Bureau of Reclamation in a report on the Central Arizona Project) is justified when a reservoir at the site is authorized and approved for construction.

The projects briefly outlined above would affect the fish and wildlife which now exist in the approximately 70 miles of river bottom lands between Granite Reef Dam and Gillespie Dam. Generally, stream flows in this reach are low--the river consisting of a shallow, narrow

ribbon of water bordered by thick and extensive stands of saltcedar with some willow, cottonwood, mesquite, and arrowweed. Except during flash floods along the lower reaches of the Salt River, the water from the river is all diverted at the Granite Reef Dam for irrigation of the area north of the Salt and Gila Rivers.

Fisheries - The fishery resources of the project site are of little importance. A few channel catfish, bluegills, and large-mouth black bass are taken from the pools from below the mouth of Salt River. Construction of a low flow channel would probably eliminate this meager fishery.

Wildlife - Wildlife resources are of considerable importance, especially on that part of the project area below the mouth of Salt River. Game animals found on the area consist of mourning doves, white-winged doves, Gambel's quails, cottontails, jack rabbits, and waterfowl. The upper portion of the project, lying within, and adjacent to, the Salt River Indian Reservation, contains some quail habitat and is used for nesting by both mourning doves and white-winged doves. The entire project area is used to some extent by the white-winged doves which are found in great numbers along the Gila River just above the mouth of Salt River.

Below the mouth of Salt River water is found in the river channel at all times. The presence of water, cultivated crops north of the river, and suitable nesting cover south of the river makes this a good habitat for quails. There are a few areas of brushland south of the river which are being cleared for irrigated cropland, but this is still so limited and scattered that it tends to improve the quail habitat. The presence of water along this section of the Gila River attracts a considerable number of waterfowl during the fall and spring migrations and some teals and shovellers winter here. The area is grazed heavily and this results in limiting the desirable wildlife food and cover plants as, for the most part, these are taken first by the cattle. Desert mule deer are found on the higher ground south of the Gila River, but they do not use the proposed project area.

The proposed channel improvements would have little effect upon the wildlife resources of the project site. It would greatly reduce, but not eliminate, the saltcedar growth along the improved sections of the Salt and Gila Rivers. Saltcedar has little value to wildlife except for protection in stormy weather. It provides little, if any food. It is used to a considerable extent by nesting doves, but mesquite serves this purpose at least as well. It is assumed that the recommended low flow channel would result in the loss of the present waterfowl habitat along the Gila section of the project.

The Arizona Game Department is planning the development of two waterfowl areas adjacent to the Gila River, between the town of Buckeye and Gillespie Dam. It does not appear that the proposed floodway would seriously affect these plans; however, future investigations would clarify this point.

Recommendations - Provided some other form of vegetation is planned to help prevent the reestablishment of the saltcedar, consideration should be given to those species which would have some value to wildlife as well as serving their primary purpose of retarding the growth of saltcedar. Continued grazing on the floodway would encourage the regrowth of saltcedar and limit the wildlife value of the project area.

The proposed plan of improvement would probably necessitate the use of heavy equipment in clearing the floodway and constructing the low flow channel. If, in connection with this work, shallow depressions of about one-tenth acre could be excavated to below the normal water table in the floodway area, there would result a considerable waterfowl value. Such excavation, if they could be made without reducing the effectiveness of the floodway, would compensate for the destruction of the existing waterfowl habitat and create new waterfowl habitat of a value more than commensurate with their cost of construction.

Your consideration of fish and wildlife interests in this project is sincerely appreciated. We would like to have an opportunity to participate in the future planning for this project at such time as the project may be authorized.

Yours very truly,

John C. Gatlin
John C. Gatlin
Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
Post Office Box 1695
Albuquerque, New Mexico

July 26, 1951

Lt. Col. W. R. Shuler
District Engineer
Los Angeles District
Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Sir:

Reference is made to your letter of June 28, 1951 (File SPLGD), in which you request our comments on the proposed interim survey report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona, dated 8 June 1951.

We have reviewed the interim report and appendixes (No. 36) and have no comment to offer. Based upon a review of the report, very little land under the jurisdiction of the Bureau of Land Management will affect or be affected by the contemplated flood control projects described.

We thank you for the opportunity of reviewing this report and are retaining the copies for our files and future reference.

Very truly yours,

Harold T. Tysk
Harold T. Tysk
Acting Regional Administrator

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF INDIAN AFFAIRS
FIELD SERVICE
Phoenix Area Office
P. O. Box 7007
Phoenix, Arizona

July 10, 1951

Colonel W. R. Schuler
District Engineer
Corps of Engineers
P. O. Box 17277
Los Angeles 17, California

Dear Sir:

This is to acknowledge receipt of your letter of 28 June 1951 (File SPLGD) and the transmitted copy of the proposed interim survey report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona, dated 8 June 1951.

Your sending of the copy of the proposed report is appreciated.

It is noted that practically all of the irrigated lands and about half of the grazing lands of the Fort McDowell Indian Reservation would be flooded if the flood-control storage in a multiple-purpose reservoir at the McDowell site is provided.

Also there may be a possibility that improved channel conditions on Salt River above its mouth will deliver more water into the Gila River than the channel of the Gila will carry away without backing water up the Gila above the mouth of the Salt and thus flooding Indian lands. This would be most likely if maintenance on the Gila River portion of the proposed channel improvement is neglected.

The above comments are offered, although your letter did not specifically ask for comments.

When the time is appropriate for making formal comments regarding the report, please advise.

Very truly yours

L. L. Nelson
for Ralph M. Gelvin
Director, Phoenix Area Office

23 July 1951

Mr. Ralph M. Gelvin
Director, Phoenix Area Office
Office of Indian Affairs
P. O. Box 7007
Phoenix, Arizona

Dear Sir:

Thank you for your letter of 10 July 1951 commenting on the interim survey report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site.

The flooding of practically all of the irrigated lands and about half of the grazing lands of the Fort McDowell Indian Reservation was given full consideration in the report. Agreement to maintain the entire cleared channel on Salt and Gila Rivers between Granite Reef and Gillespie Dams is one of the conditions that is required of a responsible organization of local interests prior to initiation of construction. Therefore, the probability of Salt River flows' flooding Indian lands along Gila River above the mouth of Salt River as a result of inadequate maintenance of the Gila River cleared channel is considered unlikely.

A copy of your letter will be forwarded to the Chief of Engineers, Washington, D. C., for his consideration. Formal submission to the Secretary of the Interior will be made by the Chief of Engineers in accordance with the Flood Control Act approved 22 December 1944.

Your promptness in submitting your comments is appreciated.

Very truly yours,

W. R. SHULER
Colonel, Corps of Engineers
District Engineer

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF INDIAN AFFAIRS
Phoenix Area Office
P.O. Box 7007
Phoenix, Arizona

December 11, 1951

John R. Jannarone
Lt. Col., Corps of Engineers
Acting District Engineer
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

This is to acknowledge receipt of your letter of 27 November 1951 (file SPLGD) and the transmitted material covering minor changes in the proposed interim report on survey, flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona, dated 8 June 1951.

An inspection of the changes indicates that they do not affect the general conclusions which have been made, nor do they warrant any changes in the comments which this office submitted to you in our letter of 10 July 1951. However, we take this opportunity to emphasize the fact that practically all of the irrigated lands and about half of the grazing lands of the Fort McDowell Indian Reservation would be flooded if the flood control storage in a multiple purpose reservoir at the Fort McDowell site is provided. We realize that flood control storage is part of an alternate plan which is not recommended at this time in your interim survey report, but is proposed for construction if and when the Central Arizona Project's terminal reservoir is constructed. The flooding of the Fort McDowell Reservation would necessitate moving the tribe of Indians occupying this reservation, and we doubt that the \$300,000 set up in the cost estimate for Lands, Easements and Rights of Way would be sufficient.

We also desire to call attention again to the possibility that improved channel conditions and levees along Salt River above its mouth, as provided in the recommended plan, will deliver a greater flood peak into Gila River than possible under present conditions and unless the channel of Gila River downstream is maintained with adequate capacity there may be flooding of Indian lands at the lower end of Gila River, caused by back water from Salt River floods.

Articles 109 and 112 mention coordination with other agencies. Statements concerning comments of the Phoenix Area Office of the

Bureau of Indian Affairs pointing out the situation mentioned above have not been included. Possibly you have omitted mention of our comments because you desire that the Chief of Engineers decide whether or not these comments should be included in the interim report.

Very truly yours,

/s/ Ralph M. Gelvin
Ralph M. Gelvin
Area Director

28 December 1951

Mr. Ralph M. Gelvin
Area Director
Office of Indian Affairs
P. O. Box 7007
Phoenix, Arizona

Dear Sir:

Thank you for your letter of 11 December 1951 commenting on the interim survey report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site.

You state that an inspection of the changes indicates that they do not affect the general conclusions that have been made and do not warrant any changes in the comments that your office submitted in the letter dated 10 July 1951.

You express a fear that improved channel conditions and levees along Salt River above its mouth, as provided in the recommended plan, may result in a greater flood peak on Gila River than possible under present conditions; and that unless the channel of Gila River downstream is maintained with adequate capacity, backwater from Salt River floods might flood Indian lands along Gila River above the mouth of Salt River. At present about 90 percent of the dense vegetative growth that will be cleared is in the bed of Gila River. The remaining 10 percent is in the bed of Salt River mostly near the mouth of the river and near Tempe.

The recommended clearing along Gila River will provide an escape channel for flood flows and thereby reduce such flooding of Indian lands as would result from direct flow or from backwater conditions created by the present channel growth. Agreement to maintain the entire cleared channel on Salt and Gila Rivers between Granite Reef and Gillespie Dams is one of the conditions that is required of a responsible organization of local interests prior to initiation of construction. Therefore, the probability of Salt River flows' flooding Indian lands along Gila River above the mouth of Salt River as a result of inadequate maintenance of the Gila River cleared channel is considered unlikely.

The flooding of practically all of the irrigated lands and about half of the grazing lands of the Fort McDowell Indian Reservation was given consideration in the report. However, because the report could not recommend construction of McDowell Reservoir for multiple purposes, including flood control, at this time, the cost of lands, easements, and rights-of-way were not investigated in detail. It is also pointed out that this office considered only the justification of adding

flood-control storage to the proposed terminal storage reservoir at the McDowell site. Therefore, we were concerned mostly with the difference in cost of construction of a multiple-purpose reservoir and a reservoir for terminal storage alone. Furthermore, rights-of-way are only a relatively minor item in the total cost of the project.

A copy of your letter will be forwarded with the report to the Chief of Engineers, Washington, D. C., for his consideration.

Your promptness in submitting your comments is appreciated.

Very truly yours,

W. R. SHULER
Colonel, Corps of Engineers
District Engineer

STATE LAND DEPARTMENT
STATE OF ARIZONA
PHOENIX, ARIZONA

December 4, 1951

Colonel W. R. Shuler
District Engineer
Corps of Engineers, U. S. Army
751 South Figueroa Street
Los Angeles 17, California

Dear Sir:

Reference is made to your letter of November 23d with respect to your report on flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, and forwarding to me the changes that have been made since the original interim report was made June 8, 1951.

In connection with this report I wish to advise that I have reviewed the interim report together with the changes recently forwarded to me, and I have no suggestions to make with respect to it. I think the work as outlined in the report, when completed, will afford protection to the area with the possible exception of extreme conditions. Even under such extreme conditions the protection afforded will be of material advantage.

Thanking you for sending me copies of the report, I am

Very truly yours,

W. W. Lane
W. W. Lane
State Land Commissioner

ARIZONA HIGHWAY DEPARTMENT

PHOENIX, ARIZONA

February 17th, 1958

Mr. H. W. Thompson
Chief, Engineering Division
U. S. Army Engineer District,
Los Angeles
Corps of Engineers
751 South Figueroa Street
Los Angeles 17, California

Dear Mr. Thompson:

Reference is made to your letter of January 8th, with a copy of the interim survey report for flood control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam site, Arizona.

Subject to further study, I had no specific comment at this time except that I concur with the report in general.

Thank you for a copy of this report and for keeping me informed on this project.

Very truly yours,

WM. E. WILLEY
State Highway Engineer

Martin Toney
MARTIN TONEY
Engineer of Bridges & Dams

STATE OF CALIFORNIA
DEPARTMENT OF WATER RESOURCES
SACRAMENTO

February 4, 1958

Colonel Carroll T. Newton, District Engineer
Los Angeles District
U. S. Army Corps of Engineers
P. O. Box 17277, Foy Station
Los Angeles 17, California

Dear Colonel Newton:

Reference is made to your letter of January 8, 1958, transmitting for our information a copy of your "Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona," dated December 4, 1957.

The report which proposes construction of short levees along the Salt River between 40th Street, Phoenix, and Tempe Butte, Tempe, and removal of phreatophytes along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam was inspected with great interest. The proposed channel improvement would undoubtedly increase flood peaks downstream, but would not appear to affect flows in the Colorado River bordering California, especially after completion of Painted Rock Dam. It is noted the report states that removal of native vegetation along the Gila and Salt Rivers would increase the safe yield from the ground water reservoir in the project area.

This Department greatly appreciates receipt of this report and being kept informed of flood control and water conservation projects proposed in California and adjoining states.

Very truly yours,

Harvey O. Banks
HARVEY O. BANKS
Director

UNITED STATES
DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE
Bureau of Sport Fisheries and Wildlife

OFFICE OF THE REGIONAL DIRECTOR
Albuquerque, New Mexico
P. O. Box 1306

December 2, 1958

Colonel C. T. Newton
District Engineer
Los Angeles District
Corps of Engineers, U. S. Army
751 South Figueroa Street
Los Angeles 17, California

Dear Colonel Newton:

The following comments constitute our report on the "Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona," dated December 4, 1957, corrected to August 27, 1958.

The plan proposes short levees along the Salt River between 40th Street, Phoenix, and Tempe Butte; clearing of a 2,000-foot channel along the Gila and Salt Rivers from Gillespie Dam to Granite Reef Dam (McDowell Dam Site); and channelization at two sites--one within the cleared floodway from Gillespie Dam to a point 1 mile downstream from the mouth of the Agua Fria River and the other, a 2-mile stretch, just upstream from the highway bridge at Tempe.

Since the reach of Salt River extending from Granite Reef Dam downstream through Tempe and Phoenix is only sparsely vegetated, usually dewatered, and largely within what is rapidly becoming an urbanized area, its fish and wildlife values are considered insignificant.

As a decided contrast, the reach of the Salt and Gila Rivers downstream from Phoenix is an important wildlife area.

This report is accordingly concerned with the effects of the proposed project upon fish and on wildlife in the 45-mile reach of the Gila and Salt Rivers, extending upstream from Gillespie Dam to a point about 5 miles above their confluence. (See map) It is our understanding that channel rectification and clearing in this 45-mile reach is proposed for flood control in the immediate agricultural area and is not essential for flood prevention for the city of Phoenix.

Due to dewatering there is no fishery in the Salt River from Granite Reef Dam downstream through the city of Phoenix. Below Phoenix, the Salt and Gila Rivers retain permanent pools. Water quality and habitat, however, are not generally satisfactory for the survival of significant numbers of game fishes, and the proposed project is not likely to cause a significant change in fishing opportunities for the people of the area.

Without the project, the 45-mile reach of the Salt and Gila Rivers will continue to offer some of the finest dove hunting in the Nation. In addition, the area will provide the only permanent source of waterfowl hunting for a future Central Arizona population that is expected to approximate 2 million people within the next 50 years. Substantial quail and rabbit hunting opportunities will also be afforded by this portion of the project area.

Originally, small-game populations in the broad valley of the Gila were unconfined and well distributed along the many large washes and tributaries emptying into the Gila River. As agriculture advanced and more land was cleared and leveled to grow crops, these washes gradually disappeared until at present the only small-game habitat remaining in this valley is restricted to the bottom-land thickets of the Gila River and to a few of the major washes.

The extensive desert areas bordering the Gila River Valley also provide small-game hunting. However, if we were to weigh desert hunting against river-bottom hunting, the river-bottom hunting would be far superior in terms of hunter success and the variety of small-game species available.

Dove hunting in Arizona is unsurpassed. There is no other State in which a hunter is permitted to take more than 10 white-winged doves. Yet, in Arizona, a bag of 25 white-winged doves is permitted in addition to the 10-bird limit of mourning doves. Moreover, no other State can match the Arizona dove hunter's success, which in 1957 was 16.4 doves per hunter on the opening day and 13.0 per hunter-day for the entire season. Doves are hunted during the entire month of September, and the long season and high hunter success attracts sportsmen from all over the United States.

In recent years there has been a rapid increase in the number of dove hunters. This increase has been due to the generous bag limit, an abundance of white-winged and mourning doves, increased prosperity, a rapid population expansion, and an overall demand for more recreation. In view of the anticipated population growth of Maricopa County, to 1,000,000 within the next 17 years, the local hunting pressure is certain to increase tremendously. Arizona, with a 93.7 percent 19-year gain in population, is the Nation's second most rapidly growing State and the greatest part of this growth is occurring in the Phoenix area. Another factor contributing to increased future dove use will be the necessity for the Arizona Game and Fish Department to direct more hunting pressure on doves as hunting pressure on big game and other species exceeds the possible supply.

Regarding dove hunting, most of the above-mentioned pressure is and will continue to be centered in one locality. This locality is the Gila and Salt River bottoms beginning north of Phoenix and continuing along the Gila River to Gillespie Dam. White-winged doves nest in large colonies in the bottom-land thickets and many winter in this same area. Large numbers of mourning doves also nest and winter here. Moreover, both white-winged and mourning doves make extensive use of the area during migration. There is no other place in Central Arizona which can offer as much hunting opportunity for small game. In 1957, the Arizona Game and Fish Department calculated 12,597 man-days of dove hunting in the area, and this use represented only a part of the potential.

For one basic reason, desert dove hunting can never be considered an alternative or substitute for river-bottom hunting. The unsurpassed bottom-land hunting is due to the large flights of white-winged doves which nest in the thickets along the river in concentrated colonies. In the fall of the year, their feeding flights from roosts in these thickets to the nearby grain fields provide hunters with the chance to bag a limit from one stand. These thickets are an absolute necessity to the maintenance of high-quality dove hunting for the people of Arizona and for many nonresidents. In fact, this area is one of the few remaining places in the entire nation where white-winged doves can be seen in such concentrations.

In view of the foregoing facts, the average annual use of the 11,500 acres of river-bottom thickets to be cleared in the 45-mile reach above Gillespie Dam is estimated to be 30,000 dove-hunter-days during a 50-year period of analysis without the project.

Quail hunting is another popular sport in Arizona for which there is a continual demand for more and better hunting. At present, quail hunting occurs primarily in the desert areas, not because the desert provides more quail to hunt, but because the hunting conditions are more favorable. The mesquite and salt cedar thickets along the Gila River provide excellent cover and will support very high populations of Gambel's quail whenever food is available. This bottom-land habitat will provide a vast reserve of huntable birds for the not distant future when it will become necessary to manage these thickets more intensively. The thick growth is presently the primary deterrent to hunters. With some selective thinning of coppice and other management measures, the river bottom will provide a more productive area to manage for quail than the desert areas. The day when such management will be necessary is very near.

Average annual hunter use of the river-bottom thickets along the 45-mile reach above Gillespie Dam is estimated to be 2,000 quail hunter-days during a 50-year period of analysis without the project.

Cottontail rabbit hunting, like quail hunting, is also more popular on the desert simply because hunting conditions are more favorable. The bottom-land thickets, however, provide suitable habitat for the cottontail, and a future management plan for quail will also benefit rabbit hunting. Although rabbit hunting has not been the popular sport

in Arizona that it has been in many of the eastern states, it is anticipated that with a future increase in hunting demand of future years this sport will increase in popularity. Average annual use is estimated at 2,000 rabbit-hunter-days without the project.

The Arizona Game and Fish Department has had many requests from local sportsmen to establish more small-game species. At present, the Department is attempting to establish the chukar partridge in the wild. If, however, the need arises for public hunting areas where exotics such as the pheasant must be released on a put-and-take basis in order to meet public demands, it is likely that the Gila River bottom would provide the best areas for such practices.

The vast areas and washes in Central Arizona which were formerly inhabited by large populations of quail, rabbits, and nesting doves have been reduced gradually by agricultural practices, until at present the Gila River bottom lands offer the only remaining habitat that will support large populations of small game. Most of these thickets must be preserved, if the people of Arizona and neighboring states are to have the benefit of the few remaining large colonies of nesting white-winged doves as well as other small-game animals.

As might be expected in the desert of Central Arizona, waterfowl hunting is concentrated in the few areas of permanent water. The larger reservoirs, generally because of their lack of waterfowl food and location at the edge of the mountains a long distance from agricultural lands, offer only resting areas. As a result, both migrating and wintering waterfowl concentrate in any small pools which they can find near the food supplies offered by irrigated lands.

The 45 miles of the Gila and Salt Rivers upstream from Gillespie Dam comprise the one major area where a significant amount of water is available for waterfowl use adjacent to irrigated lands. The river meanders through dense, offer impenetrable thickets of salt cedar and mesquite which protect the birds from outside disturbances and create ideal refuge. This situation exists despite the fact that the permanent pools usually do not exceed 60 feet in width. Hunters penetrate the thickets at road crossings and game trails from which they usually can hunt short distances up and downstream. Close spacing of hunters in the natural growth of the streamside thickets is surprisingly effective. Ducks principally baldpates, mallards, and green-winged teal, decoy readily to closely spaced blinds.

Anticipated average annual use of the area without the project is estimated as 20,000 duck-hunter-days.

This reach of river possesses more than a duck hunting value. It has been in many years the most important waterfowl wintering area in Arizona for mallards, baldpates, green-winged teal, and pintails. These birds spend about 4 winter months in the area, and it is this wintering population which has been largely responsible for the annual harvest of about 20,000 birds. The interest of the Arizona Game and Fish Department in this area has been evidenced by their withdrawal and acquisition of 6,856 acres along the subject reach of the Gila River for a waterfowl project.

In summation, the Gila River bottoms extending upstream 45 miles from Gillespie Dam offer the richest small-game resource in Arizona and potentially the finest small-game management area in the State. In fact, this is the last major nearby area where the people of Phoenix and surrounding communities will be able to hunt white-winged doves, mourning doves, and waterfowl.

The proposed project through channelization and clearing of a 2,000-foot floodway through the heart of this area will largely destroy waterfowl values. Permanent pools will be drained and bank-side cover will be destroyed. The project also will deplete white-winged and mourning doves resources by about 50 percent as a direct result of the destruction of about 11,500 acres of natural nesting and roosting habitat and escape cover. Quail and rabbit management opportunities will be reduced by approximately 25 percent. Annual maintenance of the 11,000 acres of cleared area will result in the destruction of plants which otherwise would offer winter food for quail and rabbits.

The ensuing losses will be about 18,000 days of duck hunting, 15,000 days of dove hunting, 500 days of quail hunting, and 500 days of rabbit hunting. Such losses in an area which has no other way to turn for comparable hunting are so serious that the Bureau of Sport Fisheries and Wildlife must object to construction of the project as presently planned for the 45-mile reach of the Gila and Salt Rivers, extending upstream from Gillespie Dam to a point 5 miles above the confluence of the Salt and Gila Rivers.

In view of the above-mentioned project losses we request particular attention to table 10, appendix 5 of your December 4, 1957, report, wherein you have indicated incremental benefit-cost ratios of 4.63, 2.06, 1.32 and 1.26, respectively, for channel-clearing widths of 500, 1,000, 1,500 and 2,000 feet. Inasmuch as clearing and maintenance and operation costs at 500 feet offer an incremental benefit-cost ratio much more favorable than at greater widths, please note that wildlife losses also would be much less at 500 feet than at the 2,000-foot width proposed in your report.

Accordingly, our recommendations, which pertain only to the 45-mile reach of the Salt and Gila Rivers immediately upstream from Gillespie Dam, are:

1. That an alternate project plan which would involve channel clearing to a maximum width of 500 feet rather than 2,000 feet be adopted.
2. That the cleared area be meandered, where feasible, to minimize destruction of dove habitat, and provide waterfowl use of the area.

3. That the low-flow channel be widely meandered within the cleared area.

4. That the low-flow channel be excavated to an incremental depth of at least 3 feet at intervals of about one-fourth of a mile to form a series of permanent pools throughout the 45-mile reach of river, with each pool at least 400 feet in length.

5. That the construction agency and those individuals or organizations charged with maintenance cooperate with the appropriate fish and wildlife conservation agencies during all phases of construction and maintenance to devise and apply means and methods for mitigating fish and wildlife losses, particularly through the planting of wildlife food plants in parts of the cleared area.

6. That no herbicides toxic to fish and wildlife be used in the subject area without the written approval of the Arizona Game and Fish Department.

If the project is modified as suggested in all of the six foregoing recommendations, fish and wildlife losses can be largely avoided, and the project will not jeopardize the important public benefits which this area holds for the people of Arizona.

In the event, however, that the project is undertaken as currently planned with a 2,000-foot channel clearing, recommendations Nos. 2 through 6 should be adopted as a means of partial mitigation of wildlife losses.

Adoption of recommendations Nos. 2, 3, 4, and 5 would result in a reduction of dove losses from 15,000 dove-hunter-days to a loss of about 8,000 hunter-days. Complete mitigation of the remaining 7,000 dove-hunter-days by means of a dove development project would involve replacement of about 3,500 acres of habitat similar to the cleared area. Irrigated land of this type is not available at reasonable cost. If an attempt were made to purchase irrigated lands with values often in the vicinity of \$1,000 per acre, the replacement and development cost of 3,500 acres could exceed \$3,500,000. Mitigation of dove losses on the basis of such costly development is not considered justifiable.

Adoption of recommendations Nos. 2, 3, 4, and 5 also would reduce the estimated annual loss of 18,000 waterfowl-hunter-days to a loss of about 8,000 hunter-days. This remaining 8,000 hunter-days could be mitigated through development projects for waterfowl costing about \$240,000 initially with annual operation and maintenance costs of \$12,000. If recommendations Nos. 2, 3, 4, and 5 are not adopted, mitigation will need to be made entirely through acquisition and development of waterfowl management areas in the Gila River bottoms. The cost of this type of mitigation, exclusive of land acquisition, will amount to about \$540,000 capital investment plus \$27,000 annual operation and maintenance costs, for 18,000 hunter-days, or about

\$30,000 investment and \$1,500 annually, per 1,000 hunter-days. The costs of land acquisition are not estimated at this time due to the fact that the use of presently withdrawn lands will offer possibilities for solving this problem.

Adoption of recommendation No. 5 with proper use of winter food plants in the cleared area could completely mitigate the loss of 500 quail-hunter-days and 500 rabbit-hunter-days.

Recommendation No. 6 has been made to prevent the possibility of increasing the assigned wildlife losses.

Any modification of the plans for the project as presently proposed should be brought to the attention of the Bureau of Sport Fisheries and Wildlife in order that this report may be revised to reflect the effects of proposed changes in project plans.

Sincerely yours,

/s/ William T. Krummes
Acting Regional Director

12 January 1959

Regional Director
Fish and Wildlife Service
Bureau of Sport Fisheries and Wildlife
P. O. Box 1306
Albuquerque, N. Mex.

Dear Sir:

Receipt is acknowledged of your letter dated 2 December 1958 containing your revised comments on this office's report entitled "Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona," dated 4 December 1957.

* * *

* * * * *

Your comments regarding the effect of the proposed plan of improvement on wildlife in the area are noted. You indicate that clearing the 2,000-foot channel along the Gila and Salt Rivers from Gillespie Dam to a point about 5 miles above the mouth of the Salt River would result in the following annual losses during a 50-year period:

18,000 days of duck hunting out of 20,000
15,000 days of dove hunting out of 30,000
500 days of quail hunting out of 2,000
500 days of rabbit hunting out of 2,000

Such conclusions are surprising, if you consider that we are proposing to clear only 9,300 acres out of a total phreatophyte area of 19,000 acres along the Gila River from Gillespie Dam to a point on the Salt River 5 miles upstream from the mouth. An additional phreatophyte area of 13,000 acres located along the Gila River from the mouth of Salt River to a point about 32 miles upstream remains untouched. It should also be noted that the phreatophyte area in Arizona, which exists in all parts of the State, has increased greatly since 1940. Informed opinion is that the phreatophyte area will continue to occupy greater areas in the future unless checked.

For a long time, water experts have recognized that phreatophytes pose a severe flood-control and water-conservation problem. The phreatophytes obstruct and restrict channel capacities of streams with resultant overflow and severe damage to adjoining properties. In addition, the consumptive water use of saltcedar, the principal phreatophyte in the area, is about twice the consumptive water use of cultivated crops. In a water-shortage area such as Arizona every effort must be made to conserve the existing water supplies. Unless water is available to sustain the economy of Arizona and unless floods are controlled, the needs for recreation will not exist. Interested Federal and State agencies, recognizing the need for further investigation on means of control and eradication of phreatophytes, have

formed the Phreatophyte Subcommittee in the Pacific Southwest Inter-Agency Committee with the aim of determining the best methods of destroying these undesirable phreatophytes. Mr. George Barclay of your Albuquerque office represents the Fish and Wildlife Service on this subcommittee, but has never presented any agency views against eliminating phreatophytic growth along southwestern streams.

We have given consideration to the six proposals listed in your letter and have the following comments regarding your suggestions:

1. "That an alternate project plan which would involve channel clearing to a maximum width of 500 feet rather than 2,000 feet be adopted." You refer to table 10 of appendix 5 of our report wherein we have indicated incremental benefit-cost ratios of 4.63, 2.06, 1.32, and 1.26, respectively, for channel clearing widths of 500, 1,000, 1,500, and 2,000 feet. Reference is made to the report entitled "Proposed Practices for Economic Analysis of River Basin Projects" prepared by the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee. This report is commonly referred to as the "Green Book." On pages 11-13, the economic limitations on scale of project development are discussed. It is emphasized here that "The scope or scale of development of a project should be established at the point where the net benefits from use of resources for project purposes are at a maximum. Net benefits are at a maximum when the scale of development is established at the point where the benefits added to the last increment of extension of scope are equal to the cost necessary to add that increment of scope to the project. * * * At the point of maximized net benefits, the total project benefits will necessarily exceed the total project costs by the maximum." Table 10, appendix 5, proved that, considering flood-control benefits only, increasing the width to 2,000 feet was justified. In addition, water-conservation benefits would further increase the justification of the 2,000-foot-wide clearing. If the channel width were reduced to 500 feet, flood-control benefits in the area would be reduced 50 percent and water-conservation benefits by 75 percent. The total reduction in benefits would amount to about \$150,000 annually, compared with incremental annual charges of about \$41,000 annually. Such large benefits, meeting the needs of local interests, should not be foregone, when justified by such a large margin.

2. "That the cleared area be meandered, where feasible, to minimize destruction of dove habitat, and provide waterfowl use of the area." At present, the stream channel meanders widely over the relatively flat bottom of a trench one-half to one mile wide. In laying out a floodway to carry large floods, it was realized that the floodflows would tend to follow straight courses; the high velocities would not permit the large meanders. At the same time, if flood control were to be effected, the 2,000-foot floodway would require the removal of the restriction - the river-bottom growth. In general, the cleared area might be meandered more than recommended, but probably

such increase in meanders would result in greater removal of phreato-phytic growth - not less as implied. Meandering the channel to miss the phreatophyte areas would reduce the effectiveness of the floodway for flood control and for water conservation. We would be happy to develop, with your assistance, the optimum meandering for a floodway during the preparation of detailed plans for the area.

3. "That the low-flow channel be widely meandered within the cleared area." In laying out the floodway, the existing low-flow channel was not always included within the floodway area. To ensure that the floodflow would follow the floodway rather than the existing channel, it was necessary to include a low-flow or pilot channel in the plan. We realize it would be impracticable to maintain the course of any low-flow channel. The varying streamflows (including the varying sediment loads) would cause changes in the low-flow channel. After a short time, unless the low-flow channel were leveed, the stream slope (which would be reflected in the length of the course of the channel) would be restored to the same stream slope that now exists. Thus, meanders, similar to those existing, would be reflected in the low-flow channel after a short period of operation of the project. This matter will be discussed with you more fully during the preparation of detailed plans.

4. "That the low-flow channel be excavated to an incremental depth of at least 3 feet at intervals of about one-fourth of a mile to form a series of permanent pools throughout the 45-mile reach of river, with each pool at least 400 feet in length." These pools could be accomplished during construction, but they would be impracticable to maintain. As for the previous item, no attempt will be made to maintain a low-flow channel, once constructed. Any attempt to maintain such a channel would be very costly and could not be justified. The first flows (they need not be floodflows) would tend to change the regimen of the stream, as it attempts to restore the previous gradient. In addition, any stagnant pools might tend to breed mosquitoes and measures would have to be taken for the control of such insects.

5. "That the construction agency and those individuals or organizations charged with maintenance cooperate with the appropriate fish and wildlife conservation agencies during all phases of construction and maintenance to devise and apply means and methods for mitigating fish and wildlife losses, particularly through the planting of wildlife food plants in parts of the cleared area." This office can assure you that it would cooperate in every way to devise and apply means and methods for mitigating fish and wildlife losses, within the limits of our authority. It should be pointed out that maintenance of the floodway would be the responsibility of Maricopa County. The only property rights to be acquired for the project in this area would be flowage-easement rights and rights to keep the channel clear of phreatophytes and other encroachments.

6. "That no herbicides toxic to fish and wildlife be used in the subject area without the written approval of the Arizona

Game and Fish Department." This office recognizes that herbicides may be harmful not only to the fish and wildlife, but also to the cultivated crops. Therefore, unless a herbicide could be developed that would not be harmful to the crops and wildlife and the cost of application of such herbicide would be less than the cost of mechanical means of control, mechanical means would be utilized.

You also suggest that 8,000 waterfowl hunter-days could be mitigated through development projects for waterfowl costing about \$240,000 initially with annual operation and maintenance costs of \$12,000. Because of the intangible nature of the waterfowl losses that may result from clearing of the phreatophytes, this office does not consider that such waterfowl development projects should be made a part of the recommended plan of improvement.

It is hoped that these comments on your proposals will meet with your approval. If you feel it desirable, we would be pleased to have personnel from this office discuss the matter with you further. We are forwarding copies of your letter and of our reply to our higher authority for their consideration. After authorization of the project by Congress and after the appropriation of funds for advance planning, we shall be pleased to work out with you, in detail, the optimum plan of improvement to provide the required flood control and water conservation and, at the same time, to minimize any adverse effects on the wildlife resources. It is believed that any required changes are details that would not affect the overall conclusions and recommendations and can be worked out within the framework of the recommended plan of improvement.

Your letter of 2 December 1958 was forwarded to the Board of Supervisors of Maricopa County, Phoenix, Arizona, for its comments inasmuch as that agency is the sponsoring agency for the proposed plan of improvement and because suggested revisions in the plan would have involved additional costs for the project, part of which would have to be borne by that agency. A copy of the reply from the Board of Supervisors is inclosed. (That letter informed the Corps of Engineers that Maricopa County expresses its complete confidence in the design proposed by the Corps and urges that nothing be done to delay approval of funds for the final design and construction. The County also suggests that in preparing the final detailed design, the Corps might consider the recommendations contained on page 6 of the 2 December 1958 letter of the Fish and Wildlife Service with a view towards adopting those portions of the recommendations which may be adopted without otherwise increasing the initial cost or the cost of maintenance of the project, and which would not adversely affect the principal objective of the project, namely, flood protection.)

It should be noted that Maricopa County, in recognizing the need for flood control and storm-drain construction in the County and especially in view of the large increases in population taking place in the area, has formed the Maricopa Flood Control Agency with authority to undertake studies and construct flood-control improvements. The County

recognizes that the Salt and Gila Rivers are the major outlets for any additional flood-control work that may be undertaken and considers our recommended plan the first step in an overall comprehensive plan of improvement for the area.

This office has been advised that as a result of a meeting held on 30 October 1958 between members of the Board of Directors of the Maricopa Flood Control Agency and representatives of the Arizona Game and Fish Department, Mr. R. J. Smith, Director of the Arizona Game and Fish Department, has verbally notified the Maricopa Flood Control Agency that the Arizona Game and Fish Department has no objection to the report as written.

Very truly yours,

JOHN R. OSWALT, JR.
Lt. Col., Corps of Engineers
Deputy District Engineer

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