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Central Arizona Water Control Study

PLAN OF STUDY

Prepared by

ARIZONA PROJECTS OFFICE
WATER AND POWER RESOURCES SERVICE

Assisted by

LOS ANGELES DISTRICT
U.S. ARMY CORPS OF ENGINEERS

CENTRAL ARIZONA WATER CONTROL STUDY

JANUARY 1980

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WR-67

SUPPLEMENT TO

MEMORANDUM OF UNDERSTANDING
BETWEEN

CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

AND

WATER AND POWER RESOURCES SERVICE
DEPARMENT OF THE INTERIOR

PERTAINING TO A STUDY OF ALTERNATIVES
FOR CONTROL OF FLOODS ALONG THE SALT AND GILA RIVERS
AND REGULATION OF CENTRAL ARIZONA PROJECT WATERS

This Supplement to the Memorandum of Understanding is entered into this 19th day of February, 1980.

The attached Plan of Study serves to supplement the Memorandum of Understanding dated December 15, 1978, entered between the Corps of Engineers and the Bureau of Reclamation, which became known as the Water and Power Resources Service on November 6, 1979, as required by Article IIF.

Susan A. Teague — Dated: 1 February 1980
District Engineer
Corps of Engineers

Eugene Hinds — Dated: 2/19/80
Regional Director
Water and Power Resources Service

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SUMMARY

Central Arizona Water Control Study: A Study of Alternatives for Salt-Gila Flood Control and Regulation of Central Arizona Project Waters

In 1968, Congress enacted the Lower Colorado River Basin Act (Public Law 90-537) which authorized the Central Arizona Project (CAP) as a means of reducing water shortages in central Arizona. CAP is a multi-purpose water resource development and management project which will bring water from the Colorado River across Arizona into Maricopa, Pinal, and Pima Counties, utilizing a system of aqueducts, generating stations, pump stations, and reservoirs. Currently under construction by the Water and Power Resources Service (formerly the Bureau of Reclamation), the Project is scheduled to begin water deliveries in 1985.

One of the authorized features of the CAP is a dam located approximately 20 miles east of Phoenix at the confluence of the Salt and Verde Rivers, known as Orme Dam. Orme Dam, or a suitable alternative, was authorized to provide a reservoir for seasonal storage and regulation of CAP water upon its arrival in central Arizona. The existence of a regulatory storage capacity would increase CAP efficiency by permitting a relatively constant flow of water through the aqueduct system despite fluctuations in demand. Colorado River diversions could be stored during low water demand periods or aqueduct shutdowns; or transferred to the Salt-Gila Aqueduct during high demand or emergency conditions.

In addition to providing regulatory storage, Orme Dam or a suitable alternative would offer a high degree of flood protection to the Phoenix metropolitan area and provide for conservation of flows from the Salt and Verde Rivers that are currently lost for beneficial use. The Salt and Verde Rivers historically have generated serious floods in Phoenix, the largest metropolitan area in the Colorado River basin. Recent floods in March and December 1978 and January 1979 were so serious that federal disaster proclamations were issued for the area. It is estimated that construction of Orme Dam would prevent flood damages averaging over $4. million annually.

In preparation for the construction of Orme Dam, the Water and Power Resources Service issued, in May 1976, a draft environmental statement for the dam and reservoir (Int. DES 76-17). Response to this document revealed concern among some Arizona agencies and citizens regarding the environmental impacts of the proposed dam. Of particular concern are: inundation of the Fort McDowell Indian Community and riparian habitat, and impacts upon the habitat of the endangered bald eagle and other species; the safety aspects of the proposed dam; and possible restriction

of extensive recreational use of the Salt River. These concerns and others caused the Water and Power Resources Service to reassess the merits of Orme Dam and to delay the preparation of a final environmental statement and initiation of the construction of this CAP feature. In April 1977, President Carter, as a result of the Administration's water projects review, recommended that Orme Dam be eliminated from the CAP.

The Central Arizona Water Control Study (CAWCS) centers on identification of a suitable alternative to Orme Dam and Reservoir that would provide flood control and CAP regulatory storage capacity. This CAWCS report presents the results of a preliminary analysis of alternatives and includes a Plan of Study for the remainder of the CAWCS; it also concludes Stage I of a three-stage study process. In Stages II and III, a number of alternative plans will be formulated by combining the various flood control and regultory storage components identified during Stage I. All proposed alternatives will be measured against a "No Action Alternative" projecting future conditions that would exist if no federal action is taken to provide either flood control or CAP regulatory storage capacity. Alternatives also will be evaluated in terms of their economic, social, and environmental impacts; their potential to provide opportunities for recreation, hydroelectric power generation, water conservation, and ground-water recharge; their enhancement of fish and wildlife resources, archeological and historical resources; and extent of open space.

Specifically, to meet the CAP regulatory storage objective, it is proposed that two sites near the confluence of the Salt and Verde Rivers, along with a New Waddell Dam site on the Agua Fria River, continue to be studied at a feasibility level. In addition, initial studies should be performed for the Florence and Buttes sites on the Gila River and for the use of Tat Momolikot Dam on the Santa Rosa Wash. To meet the primary objectives for flood control, alternatives proposed include modification of Roosevelt and Horseshoe Dams to improve their effectiveness by raising the existing structures, by increasing the outlet size, and by preparing and implementing new operating criteria; construction of dams at the New Bartlett and Cliff sites on the Verde River; and providing local protection through channels and levees and various non-structural measures.

In addition to Stage I Study Results, this report contains a Plan of Study developed by the Water and Power Resources Service with assistance from the Corps of Engineers. The CAWCS will follow the applicable guidelines contained in Principles and Standards for Planning Water and Related Land Resources promulgated by the Water Resources Council, a federal executive branch agency. The PLAN OF STUDY provides for assembling additional information required for evaluation of the alternatives and informing and involving the general public and interested agencies in

this Study process. The majority of the field work and engineering will be accomplished during Stage II which concludes with the presentation of intermediate alternative plans for review by the Corps of Engineers, other interested agencies, and the general public. Based on public response and comprehensive assessment of the intermediate plans, Stage III efforts will concern development of several detailed alternative plans, determination of plans preferred by the Agencies and the public, and publication of required planning documents and environmental impact statements.

The Water and Power Resources Service (WPRS) has primary responsibility for the CAWCS. The Corps of Engineers, having considerable experience in flood control matters, is responsible under the Flood Control Act of 1944 for prescribing regulations for operation of flood control projects constructed by the WPRS. Therefore, the Corps will assist the WPRS by formulating and evaluating plans for flood control. Each Agency's area of responsibility for this Study is specified in a Memorandum of Understanding and the PLAN OF STUDY. The Agencies will follow a common schedule and will avoid duplication of effort by pooling resources in areas of mutual interest, such as environmental assessment and public involvement.

Funding for the Study will be provided through the Water and Power Resources Service to support the efforts of both Agencies. The total estimated cost of the 4-year Study is $8,720,000 with fiscal year costs by Agency as follows:

	FY 78	FY 79	FY 80	FY 81	FY 82	TOTAL
Corps	50,000	590,000	2,380,000	1,210,000	460,000	4,690,000
WPRS	70,000	1,270,000	1,440,000	970,000	280,000	4,030,000
TOTAL	$120,000	$1,860,000	$3,820,000	$2,180,000	$740,000	$8,720,000

Efforts providing support to the needs of both Agencies, such as environmental, economic/demographic and social assessments, and public involvement are included in the cost estimates for the WPRS.

The Study schedule developed by both Agencies indicates that the final report describing the selected alternative plan will be completed in May 1982.

INTRODUCTION AND AUTHORITY

I. INTRODUCTION AND AUTHORITY

The Central Arizona Project (CAP) was authorized for construction by Public Law 90-537, approved September 30, 1968. The CAP is a multipurpose water resource development and management project which will provide supplemental water to central Arizona and western New Mexico. Construction of the water-related features of CAP began in 1973. When completed, the Project will benefit both Arizona and New Mexico in the areas of water conservation, flood control, recreation, and fish and wildlife resources.

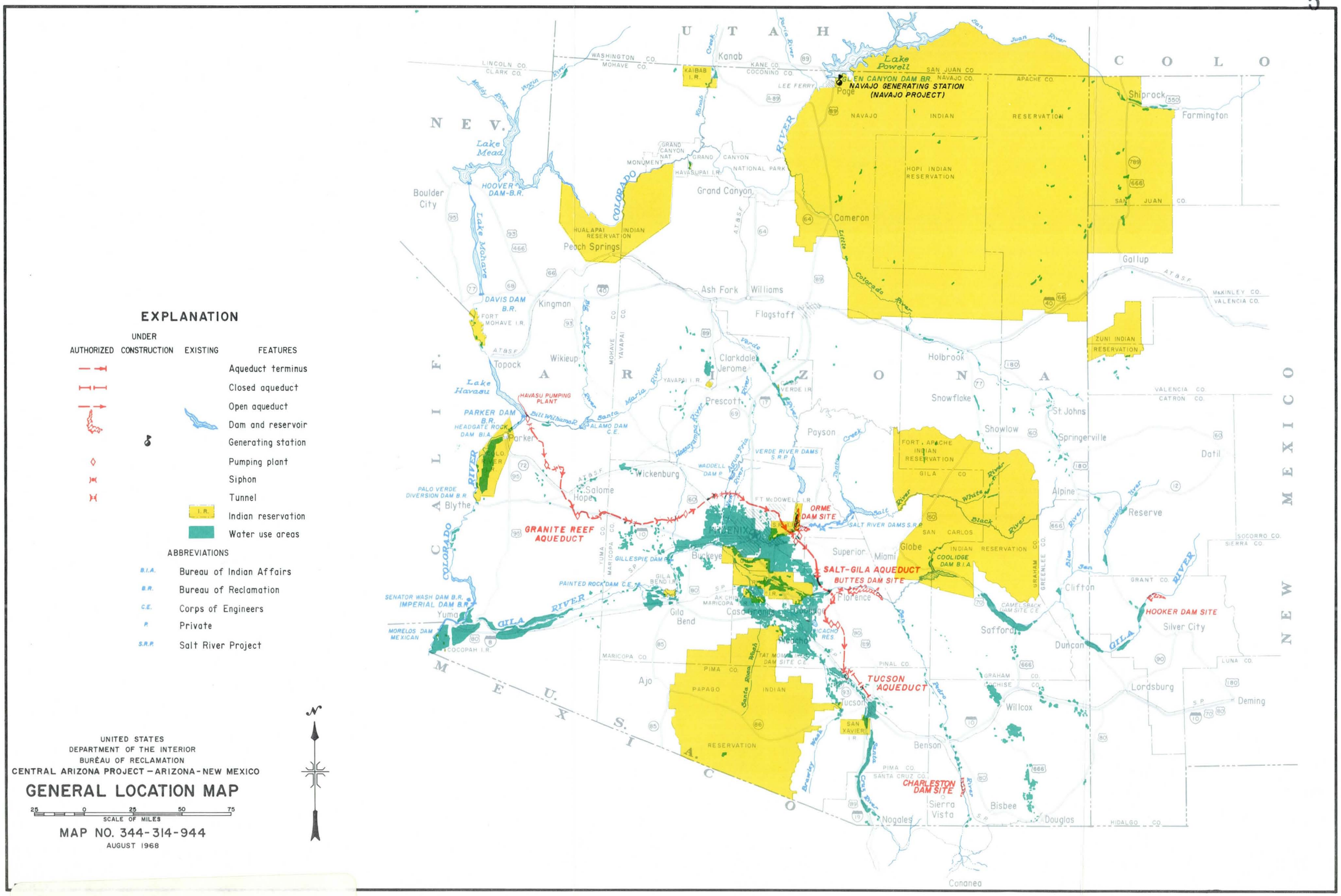
In general, the area of principal benefit from the CAP is the basin of the Gila River and its major tributaries from above Painted Rock Dam to the river's upper reaches in southwestern New Mexico. This area includes the metropolitan areas of Phoenix and Tucson and the large agricultural complex located in Maricopa, Pinal, and Pima Counties in central Arizona. Direct delivery of Colorado River water will be made by the CAP into these areas. Also, communities and agricultural areas located in and adjacent to the Gila River watershed will receive additional water through water exchange agreements between the Project and central area water users in Arizona.

The major features of the Central Arizona Project as authorized are shown in Figure 1. Table 1 gives the status of each major CAP feature.

The Central Arizona Water Control Study (CAWCS) centers on the flood control and regulatory storage functions of the proposed Orme Dam and Reservoir which would be located in Maricopa County, Arizona, approximately 20 miles east of Phoenix, at the confluence of the Salt and Verde Rivers. Orme Dam would be operated in coordination with the existing Salt River Project storage system and with diversions from the Colorado River delivered through the Granite Reef Aqueduct, another CAP feature. Orme Dam would provide operational flexibility to the Granite Reef Aqueduct by allowing the storage of Colorado River diversions during low water demand periods or during aqueduct shutdowns. In addition to providing regulatory storage, Orme Dam would offer a high degree of flood protection to the Phoenix metropolitan area and provide for conservation of flows from the Salt and Verde Rivers. Regulatory storage also would facilitate diversions to the Salt-Gila Aqueduct when maintenance is scheduled for the Granite Reef Aqueduct, during periods of high water demands or under emergency conditions.

In May 1976, the Water and Power Resources Service (formerly the Bureau of Reclamation) published a draft environmental statement for Orme Dam and Reservoir. Public response to this environmental impact statement

Figure 1



On April 18, 1977, the Administration recommended that the Central Arizona Project be modified to eliminate Orme, Hooker, and Charleston Dams.

Table 1

Central Arizona Project Features

Authorized Features	Status
DAMS AND RESERVOIRS	
Orme	*
Buttes	Advance Planning
Charleston	*
Hooker	*
AQUEDUCTS	
Granite Reef	Under Construction
Salt-Gila	Advance Planning
Tucson	Advance Planning
POWER GENERATION	
Navajo Generating Station	Existing

The Project also includes various electrical power transmission lines, communications systems, distribution systems to Indian and non-Indian lands, and drainage facilities.

* Recommended for elimination from the Project by President Carter in his Statement on the Water Projects Review, April 1977.

identified major concerns among some agencies and many residents of Arizona. In particular, concerns regarding the inundation of the Fort McDowell Indian Reservation, inundation of riparian habitat, and inundation of the habitat of the endangered bald eagle were expressed. Also, the safety aspects of the proposed dam, deleterious effects upon regional water quality, destruction of historical and archeological resources, and conversion of recreational use of the Salt River from tubing and picnicking to lake-oriented recreation were questioned. Additionally, the feeling was expressed that more information should be presented on the alternatives to the proposed Orme Dam.

These concerns and others caused the Water and Power Resources Service to reassess the merits of Orme Dam and to delay the preparation of a final environmental statement and initiation of the construction of this feature. In April 1977, President Carter, as a result of the Administration's Water Projects Review, recommended that Orme Dam be eliminated.

By this time, the situation had become increasingly problematic as the CAP was under construction and a decision on regulatory storage was needed. In addition, the Salt and Gila Rivers frequently flood the Phoenix area causing widespread damage and destruction. Orme Dam, planned and authorized to resolve both problems, had been deemed inappropriate by President Carter. The Water and Power Resources Service renewed its search for an alternative solution and found that other plans may be feasible, although additional study and analysis is required.

This PLAN OF STUDY presents a preliminary analysis of alternative elements made since President Carter's decision in April 1977, and also presents a plan for gathering additional information concerning these alternatives upon which the Agencies (Water and Power Resources Service and Corps of Engineers) will base their decision as to which alternative plan should be implemented. The report is divided into two sections. The section immediately following this introduction is titled STAGE I STUDY RESULTS and briefly describes a preliminary analysis of alternatives for regulatory storage and flood control. The final section of this report, PLAN OF STUDY, presents the plan which will be followed to determine the most suitable alternative for implementation.

Authority for the CAWCS is derived from the Lower Colorado River Basin Project Act (Public Law 90-537), signed into law September 30, 1968. This act authorizes construction of Orme Dam and Reservoir, or a suitable alternative, by the Water and Power Resources Service (formerly the Bureau of Reclamation). The study of "suitable alternatives" is precisely the purpose of this Report. The Flood Control Act of 1944 (Public Law 78-534) assigns to the Corps of Engineers responsibility to prescribe

regulations for use of storage allocated for flood control at all reservoirs constructed with federal funds. Based on this authority, the Corps of Engineers will assist the Water and Power Resources Service by formulating and evaluating alternative plans for flood control.

A Memorandum of Understanding between the Agencies that defines the respective responsibilities was signed by the Regional Director of the Lower Colorado Region and the Los Angeles District Engineer on January 3, 1979.

MEMORANDUM OF UNDERSTANDING
BETWEEN

CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

AND

BUREAU OF RECLAMATION
DEPARTMENT OF THE INTERIOR NO. 9-07-30-X0057

PERTAINING TO A STUDY OF ALTERNATIVES
FOR CONTROL OF FLOODS ALONG THE SALT AND GILA RIVERS
AND REGULATION OF CENTRAL ARIZONA PROJECT WATERS

THIS MEMORANDUM OF UNDERSTANDING, entered into this 15th day of December, 1978, between the Corps of Engineers of the Department of the Army, hereinafter referred to as the "Corps," and represented by the District Engineer, Los Angeles District, and the Bureau of Reclamation of the Department of the Interior, hereinafter referred to as the "Bureau," and represented by the Regional Director, Lower Colorado Region together hereinafter termed the "Agencies." This is entered into under the authority of the Act of June 20, 1932, as amended (47 Stat. 382) which is commonly known as the "Economy Act."

WITNESSETH THAT:

WHEREAS, the Central Arizona Project (CAP) was authorized by Public Law 90-537 on September 30, 1968, "for the purpose of furnishing irrigation water and municipal water supplies to the water-deficient areas of Arizona. . . control of floods. . ." and to consist. . ." of the

following principal works: . . . (2) Orme Dam and Reservoir and power-pumping plant or suitable alternative . . . ; and

WHEREAS, the President in his Statement on Water Projects dated April 18, 1977, recommended that the CAP be modified by eliminating Orme Dam which would have provided flood control along the Salt and Gila Rivers and regulation of CAP waters; and

WHEREAS, the Council on Environmental Quality Guidelines for Preparation of Environmental Impact Statements pursuant to the National Environmental Policy Act (NEPA) require the responsible agency to study, develop, and describe all reasonable alternatives, including those not within the existing authority of the responsible agency; and

WHEREAS, the Interagency Task Force on Orme Dam Alternatives was unable to make a recommendation on a suitable alternative to Orme Dam, but concluded in its final report, dated May 5, 1978, that further work needs to be done and it now appears possible to select a realistic number of alternatives for detailed analysis; and

WHEREAS, the Resolution by the United States Senate Committee on Public Works, dated July 31, 1973, directed the Board of Engineers for Rivers and Harbors to conduct the Phoenix Urban Study which addresses, among other things, flood problems on the Salt River; and

WHEREAS, the Agencies agree that a multipurpose plan to accomplish the goals of flood control along the Salt and Gila Rivers in the metropolitan Phoenix area and regulation of CAP waters to be imported from the Colorado River is urgently needed.

NOW, THEREFORE, we the undersigned, recognizing the importance of developing a multipurpose plan resulting from a Study of Alternatives for the Control of Floods along the Salt and Gila Rivers and the Regulation of Central Arizona Project Waters, hereinafter referred to as "the Study," hereby agree as follows:

I. Objectives:

A. Development of viable alternative plans for flood control and regulation of CAP waters;

B. Identification of other needs including, but not limited to, water-based recreation, fish and wildlife, hydropower, ground-water recharge, and environmental protection and enhancement;

C. Obtaining of technical, environmental, economic, and social data required for the formulation and evaluation of alternative plans;

D. Fulfillment of the requirements of NEPA regarding the preparation of an environmental impact statement from which the appropriate administrative or legislative action can be taken;

E. Maintenance of a high degree of public and other agency involvement to insure clear and accurate two-way exchange of information on the plans, the decision-making process, and other major study areas of interest.

II. General Provisions:

A. The Agencies shall assign the highest priority to the Study consistent with other responsibilities.

B. The applicable elements of the Principles and Standards for Planning Water and Related Land Resources adopted by the Water Resources Council shall be applied.

C. The applicable elements of President Carter's Water Policy message of June 6, 1978, shall be used in the conduct of the Study.

D. All information developed by the Study or other applicable studies shall be available to each Agency.

E. The Agencies recognize the need to enter into contracts to procure outside services. The Bureau will contract for services involving a public involvement program, and for environmental, social, and economic demographic studies. Other contract services will be procured by either Agency as required; however, procurement of contract services by the Corps will be coordinated with the Bureau.

F. The Agencies will prepare a Plan of Study, describing the specific tasks to be accomplished, responsibilities for the tasks, the schedule, a public involvement program, and other pertinent information. Upon completion and agreement by both Agencies on the Plan of Study, such Plan of Study will become a part of this Memorandum of Understanding.

III. Responsibilities:

The Bureau will have full responsibility for accomplishing the Study. The Corps will provide input as agreed to in the Plan of Study. The Corps input will meet Corps survey report standards for flood control planning.

IV. Program Management:

The Agencies will each name an agency manager to assure continual coordination and adherence to a program schedule. The agency managers shall:

A. Coordinate with their respective agencies to assure adherence to study scope, logic, and schedules, as defined in the Plan of Study.

B. Maintain a study schedule showing tasks to be accomplished by the Agencies, other agencies, and contractors; funding requirements, and personnel needs and services to assure that study objectives are being met.

C. Solicit, as needed, assistance and cooperation from other agencies and the public.

D. Assure adequate public involvement.

E. Prepare periodic progress reports to the Agencies and the public involvement groups.

V. Funds:

Funds for the Study will be those authorized for appropriation by Public Law 90-537 or other applicable law. Should Congress fail to provide the funds required, the Memorandum may be terminated by either Agency.

VI. Modification:

Modification of the Memorandum, consistent with its purpose and within its general scope, may be accomplished by written agreement between the Agencies either by exchange of letters or in the form of an amendment.

VII. Duration:

This Memorandum shall continue in force through September 1982, unless terminated earlier by either of the Agencies by the giving of sixty (60) days notice in writing. It may be extended by written agreement between the Agencies either by exchange of letters or in the form of an amendment.

Dated: 21 Dec 78

District Engineer
Corps of Engineers

Dated: Jan 3, 1979

Regional Director
Bureau of Reclamation

II. STAGE I STUDY RESULTS

II. STAGE I STUDY RESULTS

Description of the Study Area

The area under study encompasses portions of the Salt, Verde, Gila, and Agua Fria River drainage basins and is shown in Figure 2. Specifically, the Study area includes:

a. The Salt River drainage basin from Roosevelt Lake to Granite Reef Diversion Dam.

b. The Salt River floodplain from Granite Reef Diversion Dam to its confluence with the Gila River.

c. The Verde River drainage basin from the vicinity of Tangle Creek to its confluence with the Salt River.

d. The Gila River floodplain from the Salt River confluence to Painted Rock Reservoir.

e. The Agua Fria River drainage basin from Lake Pleasant to its confluence with the Gila River.

f. Portions of the Gila River upstream from the town of Florence surrounding the Buttes and Florence Dam sites.

g. Portions of the Santa Rosa Wash area surrounding the Tat Momolikot Dam site and Lake St. Clair.

This complex of rivers and floodplains lies mostly within Maricopa County, Arizona, but includes western Pinal County, portions of extreme southern Yavapai County, and western Gila County. In addition, analyses of flood control and flood frequencies of necessity would have to consider the influence of drainage areas lying upstream of the primary CAWCS area.

The CAWCS area was established after consideration of several factors relating to flood control and CAP regulatory storage. Primary flood damage areas in the Phoenix metropolitan area are included since local protection works, such as channels, will be considered to reduce flood damages. Upstream dams also might reduce these damages, so potential damsites are included. Preliminary analysis indicates that the effectiveness of a flood control dam is greatly reduced if it is located too far upstream of Phoenix. More specifically, a flood control dam upstream of the existing Roosevelt Dam on the Salt River or a flood control dam upstream of Tangle Creek on the Verde River would be ineffective; therefore,

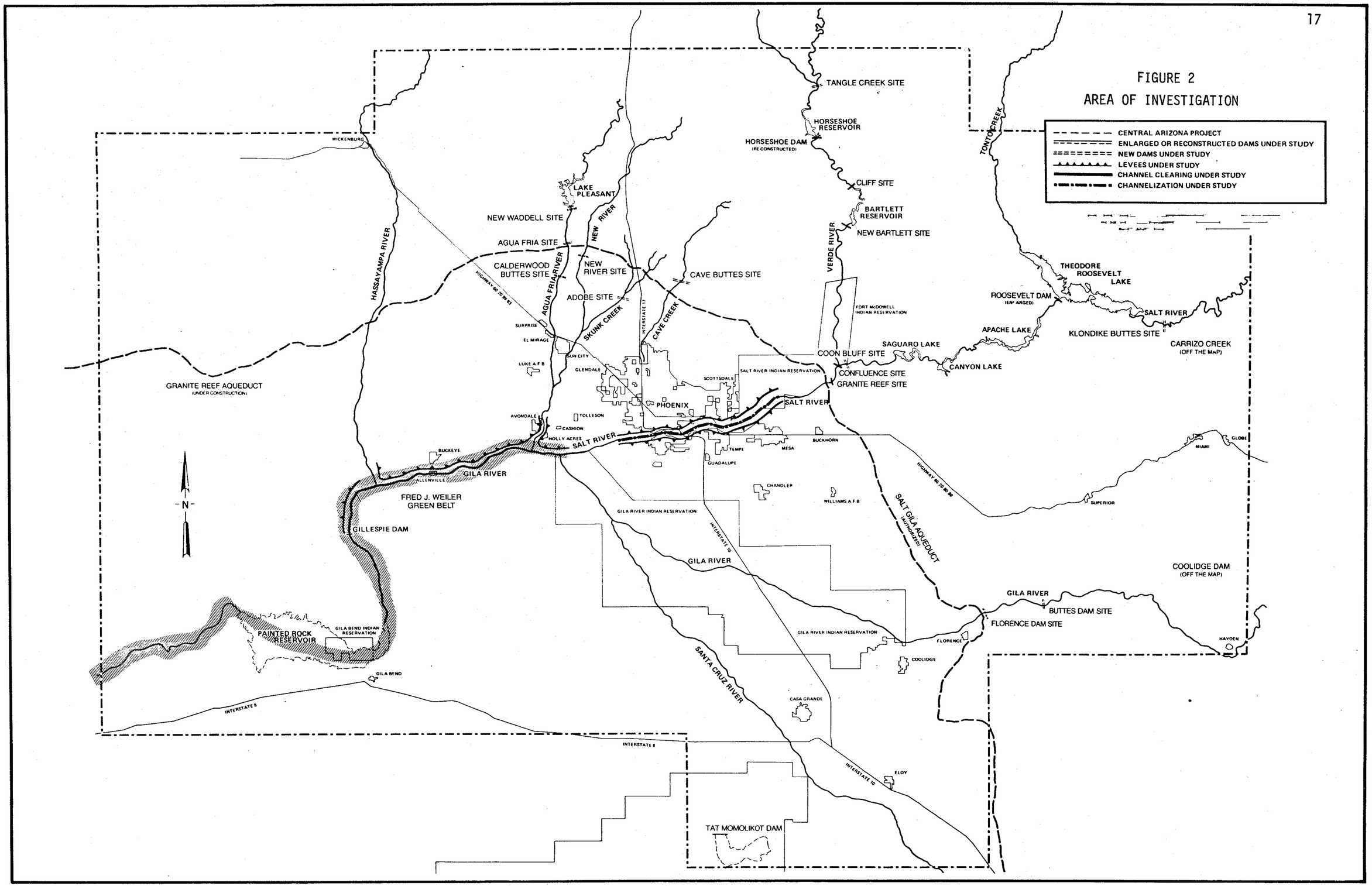


FIGURE 2
AREA OF INVESTIGATION
CENTRAL ARIZONA PROJECT
ENLARGED OR RECONSTRUCTED DAMS UNDER STUDY
NEW DAMS UNDER STUDY
LEVEES UNDER STUDY
CHANNEL CLEARING UNDER STUDY
CHANNELIZATION UNDER STUDY
TANGLE CREEK SITE
HORSESHOE RESERVOIR
HORSESHOE DAM
(RECONSTRUCTED)
CLIFF SITE
BARTLETT RESERVOIR
NEW BARTLETT SITE
VERDE RIVER
TONTO CREEK
THEODORE ROOSEVELT LAKE
ROOSEVELT DAM
(ENLARGED)
SALT RIVER
KLONDIKE BUTTES SITE
CARRIZO CREEK
(OFF THE MAP)
APACHE LAKE
SAGUARO LAKE
CANYON LAKE
COON BLUFF SITE
CONFLUENCE SITE
GRANITE REEF SITE
FORT McDOWELL INDIAN RESERVATION
SALT RIVER INDIAN RESERVATION
WICKENBURG
LAKE PLEASANT
NEW WADDELL SITE
NEW RIVER
AGUA FRIA SITE
CALDERWOOD BUTTES SITE
NEW RIVER SITE
AGUA FRIA RIVER
ADOBE SITE
SKUNK CREEK
CAVE BUTTES SITE
CAVE CREEK
HASSAYAMPA RIVER
HIGHWAY 60 70 80 93
INTERSTATE 17
SURPRISE
EL MIRAGE
SUN CITY
LUKE A.F.B.
GLENDALE
SCOTTSDALE
PHOENIX
SALT RIVER
AVONDALE
TOLLESON
CASHION
HOLLY ACRES
BUCKEYE
ALLENVILLE
GILA RIVER
TEMPE
MESA
BUCKHORN
GUADALUPE
CHANDLER
WILLIAMS A.F.B.
GRANITE REEF AQUEDUCT
(UNDER CONSTRUCTION)
FRED J. WEILER GREEN BELT
GILLESPIE DAM
GILA RIVER INDIAN RESERVATION
INTERSTATE 10
SALT GILA AQUEDUCT
(AUTHORIZED)
HIGHWAY 60 70 80 89
MIAMI
GLOBE
SUPERIOR
COOLIDGE DAM
(OFF THE MAP)
BUTTES DAM SITE
FLORENCE DAM SITE
FLORENCE
COOLIDGE
HAYDEN
PAINTED ROCK RESERVOIR
GILA BEND INDIAN RESERVATION
GILA BEND
INTERSTATE 8
SANTA CRUZ RIVER
CASA GRANDE
ELOY
TAT MOMOLIKOT DAM
N

the CAWCS area was limited to these points.

For water conservation purposes, an ideal reservoir site should be reasonably close to the CAP Aqueduct system and areas which will receive the water it delivers. A site on the Agua Fria River that meets these criteria was included, while sites further west along the aqueduct were found to be less effective. Damsites such as Florence, Buttes, and Tat Momolikot may meet these criteria if appropriate connecting canals are included.

A. Physical Characteristics

Geology. The area is generally within the Basin and Range physiographic province, which is typified by geologic faulting and tilting. This tectonic activity has formed numerous northwest-southwest trending mountain ranges separated by broad alluvial basins. Despite the prevalence of faults throughout the area, the earthquake hazard in the Study area is not considered severe. While several major earthquakes have occurred in California and northern Mexico, few quakes of consequence have centered in central Arizona. In general, the rock types within the Basin and Range province are crystalline igneous and metamorphic rocks in the mountains and sedimentary in the basins. The crystalline rocks are frequently volcanic flows covering ancient granite and schists. Detritus from these units are deposited in the basins to depths in excess of 1,000 feet and comprise the principal source of ground water in the state.

Elevations. Elevations in the Study area vary from about 500 feet above sea level at Painted Rock Dam to about 2,150 feet above sea level at Roosevelt Dam. Mountains in the Study area rise to over 7,000 feet above sea level. Elevations in the Salt River watershed upstream of the CAWCS area rise to 11,590 feet above sea level on Baldy Peak in eastern Arizona and 12,670 feet above sea level on Humphrey Peak near Flagstaff. Most of the population of the Study area resides in metropolitan Phoenix. Elevations in metropolitan Phoenix range from 890 feet at Buckeye to 1,380 feet above sea level east of Mesa, with mountains in or near the urban area reaching 4,000 feet above sea level. Slopes in the Study area are, by and large, gentle, although steep gradients 10 percent or greater) occur in the mountains.

Climate. The climate of the Study area is arid and marked by extreme heat and low rainfall. In summertime, daily high temperatures average over 100°F, with lows averaging in the 70°F. During the winter months, highs average in the upper 60°F, with lows about 40°F. Temperature in higher elevations tend to be lower in both summer and winter. Precipitation amounts in the Study area range from less than 6 inches per year in the desert to in excess of 20 inches in the surrounding

mountains. Elevations above 3,000 feet experience occasional snowfall. Snow accumulates in substantial amounts in the watersheds above 5,000 feet and is a major factor in the hydrology of rivers in the Study area. Snow rarely occurs in the desert and generally melts upon hitting the ground.

Precipitation in the CAWCS area occurs in two distinct seasons. Winter rains are usually the result of cyclonic disturbances originating over the Pacific Ocean. These storms bring light widespread precipitation. The arrival over Arizona of moist tropical air from the Gulf of California in midsummer signals the start of the "monsoon" or summer rainy season which extends from July to September and occasionally October and is marked by scattered, often heavy thunderstorms. These storms can result in periods of high wind, severe blowing dust, and flashflooding.

B. Biological Characteristics

Vegetation in the Study area varies considerably and correlates directly with elevation, available moisture, and temperature. The desert plains in the western portion of the CAWCS area support only the hardiest plantlife, such as creosote bushes and catclaw. Stands of mesquite, palo verde, and ironwood are found along intermittent creeks, washes, and rivers. Lusher riparian vegetation occurs along flowing streams. Much desert and riparian plantlife, however, has been lost through agricultural development and urbanization of metropolitan Phoenix. In the higher elevations of the CAWCS area, up to about 4,000 feet, greater rainfall and rugged terrain support lush desert vegetation marked by large cacti, dense chaparral and where there is sufficient subterranean water, palo verde, ironwood, and mesquite trees. Stands of oak and pine are found in the well-watered mountains and drainage regions of the Study area.

In historic times, non-native crops supported by intense irrigation were introduced into the Salt and Gila River Valleys. Leading agricultural products include seed crops (cotton, milo, barley, sorghum, and alfalfa), vegetables, fruit (citrus and grapes), and nut crops.

Wildlife in the CAWCS area is typical of that found in desert and foothill regions of the Southwest. The Study area includes a perrenial watercourse which supports a substantial riparian habitat. Numerous species of birds, mammals, fish, amphibians, and reptiles thrive in undeveloped portions of the CAWCS area. Some of the species include the bald eagle, the Yuma clapper rail, the gray fox, the mule deer, the desert cottontail rabbit, and the beaver. For the most part, however, native fauna has disappeared from urban and agricultural portions of the CAWCS area and has been replaced by livestock and other domestic animals.

C. Socio-Economic Profile

Cultural Background. In prehistoric times, much of the Study area was inhabited by an agricultural people known as the Hohokam. They diverted water from the Salt River and developed an extensive network of irrigation canals. About 1450 AD, the Hohokam deserted their villages and for approximately the next 3 centuries the area remained largely uninhabited. In historic times the Pima and Papago Indians, possible cultural descendants of the Hohokam, moved into the Salt River Valley.

During the mid-1860's, settlers began diverting water from the Salt River and irrigating farmland. Later in the decade, Phoenix was established and in the 1870's it became the leading commercial center in the Valley. Construction of the Arizona Canal north of the Salt River and other canals to the south of the Salt River and the arrival of branchline railroads connected to transcontinental routes resulted in expansion of agriculture with the subsequent growth of Phoenix and development of a number of sattelite communities during the 1880's and 1890's.

Destructive floods in 1891 and 1905 together with a drought which began in the 1890's and lasted into the early 20th century, caused farmers and townspeople in the Study area to seek a dependable source of water. Their efforts resulted in construction of Theodore Roosevelt Dam, the first multipurpose dam authorized under the National Reclamation Act of 1902. Completed in 1911, this structure provided both irrigation water and hydroelectric power. In the 1920's and 1930's, three more dams were built on the Salt River to conserve water and generate hydroelectric power. Two dams were constructed on the Verde River as well.

During World War II, the Salt River Valley was the site of a number of military airfields and defense plants. After the war, the Study area entered into a sustained period of urbanization and industrialization. The development of air conditioning made life in metropolitan Phoenix comfortable the year round. People and businesses continue to be attracted by the dry climate and increasing economic opportunities.

Population. Almost all of the CAWCS area lies within rapidly growing Maricopa County. With over 1,340,000 inhabitants as of 1978, it is the most populous of Arizona's 14 counties. Portions of Yavapai, Pinal, and Gila Counties are also in the CAWCS area. Most of the CAWCS area's population resides in the Salt River Valley, leaving much of the region either sparsely settled or uninhabited. Phoenix, with a population of 682,000, is the principal community of the CAWCS area. Other prominent towns include Scottsdale, Tempe, Mesa, Glendale, Buckeye, Gila Bend, Florence, Coolidge, and Casa Grande. Five Indian reservations are also

included: the Fort McDowell Reservation on the lower Verde River, the Gila River Reservation, the Salt River Reservation north of the Salt River east of Phoenix, the Ak-Chin Reservation and two portions of the Papago Reservation including the northern portion near the Tat Momolikot Dam, and the Gila Bend Unit along the Gila River near Painted Rock Dam. For population statistics of the CAWCS area, see Tables 2-4.

Housing. Housing in the CAWCS area focuses on the single family structure. A 1977 inventory indicated that 518,000 dwelling units existed in metropolitan Phoenix. Single family houses accounted for 329,400 of these, with apartment units numbering 105,900, and townhouses and mobile homes numbering 83,000. Occupancy rates averaged 97 percent. Over 40 percent of homes in the Phoenix area were less than 10 years old. Housing conditions on the Indian reservations in the CAWCS area generally are considered substandard, although improvements have been made in recent years.

Education. According to 1977 estimates, 21 percent of adults in Phoenix over age 25 had less than a high school education; high school graduates accounted for 35 percent and 13 percent were college graduates. The median educational level for the CAWCS area is 12.8 years.

Income. In 1977, the median household income for metropolitan Phoenix was estimated at $14,011. Median household incomes were under $10,000 in the inner city, while many families in the north Phoenix, Scottsdale, and Paradise Valley areas earned over $35,000. Indian reservations in the CAWCS area have family incomes which are quite low. In 1970, the median ranged from $946 on the Gila River Indian Reservation to $4,780 on the Fort McDowell and Salt River Indian Reservation.

Economy. The CAWCS area is a major center for economic activity in the Southwest. Leading factors in the area's economy are manufacturing (principally high technology products), tourism, retail trade and services, and government. Industrial development is centered in metropolitan Phoenix, with agricultural districts extending to the west, southwest, and southeast of the urban area. Within the past 20 years, manufacturing has replaced agriculture as the main source of income in Maricopa County, although the county still leads the state in agricultural production. Agriculture in the CAWCS area is expected to continue to decline as the urbanization of metropolitan Phoenix increases.

Transportation. The CAWCS area is connected to the rest of Arizona and the nation by two interstate highways, two railroads, and 10 commercial air carriers. The major factor in transportation in metropolitan Phoenix, however, is the motor vehicle. Over 100 transcontinental, interstate, and intrastate trucking companies and two

Table 2

Population Growth and Racial
Distribution; Arizona, Maricopa County and Pinal County

Population[1]

Year		Arizona	Maricopa County	Pinal County
1960	(census)	1,302,160	663,510	62,700
1965		1,584,000	852,000	
1970	(census)	1,755,400	971,230	68,600
1975		2,212,000	1,209,800	83,900
1976		2,270,000	1,260,500	86,300
1977		2,364,000	1,292,000	87,200
1980	(projected)	2,610,000	1,431,000	92,500
2000	(projected)	3,939,000	2,181,000	127,700

Racial Distribution[2]
(July 1, 1977)

Race	Arizona	Maricopa County	Pinal County
White	1,702,600	1,041,500	43,700
Spanish Heritage	442,300	190,500	32,900
Indian	131,000	15,500	8,400
Negro	70,900	44,400	4,000
Other	16,800	8,100	700
Total	2,363,600	1,300,000	89,700

[1] Census year data from the Bureau of the Census. Others from the Arizona Department of Economic Security.

[2] Valley National Bank, Arizona Statistical Review, 1978.

Table 3

Populations of CAWCS Area Communities (July 1, 1977)[1]

Avondale	6,900
Buckeye	3,525
Casa Grande	16,425
Cashion	4,280
Chandler	22,800
Coolidge	7,275
Florence	3,175
Fountain Hills	2,000
Gila Bend	2,000
Gilbert	3,975
Goodyear	2,650
Glendale	75,175
Guadalupe	4,400
Litchfield Park	3,100
Luke Air Force Base	7,350
Mesa	115,000
Peoria	11,500
Phoenix	682,200
Scottsdale	82,000
Tempe	103,000
Tolleson	3,750

[1] Valley National Bank, Arizona Statistical Review, 1978.

Table 4

Populations of Indian Reservations in the CAWCS Area

(July 1, 1977)[1/]

Ak-Chin Indian Community	336
Fort McDowell Mohave-Apache Indian Community	348
Salt River Pima-Maricopa Indian Community	2,950
Gila River Indian Community	8,600
Papago Indian Community	
Gila Bend Unit	357
Sif Oidak District	650
Total	13,241

[1] Valley National Bank, Arizona Statistical Review, 1978 and U.S. Department of the Interior-Bureau of Indian Affairs, Final Environmental Impact Statement - Vekol Hills Project, Papago Indian Reservation - Pinal County, Arizona, 1978.

transcontinental bus lines serve the area. Maricopa County also leads Arizona in motor vehicle registrations, with 646,006 passenger cars, 100,194 commercial vehicles, and 95,893 noncommercial trucks registered in 1977. The large number of motor vehicles has increased traffic congestion in Phoenix. Efforts to implement mass transit and car pooling have met with limited success.

Four major freeways are found in the CAWCS area. Interstate 17 enters metropolitan Phoenix from the north and connects with Interstate 10, an important east-west link in the Interstate Highway System. The Superstition Freeway (Arizona State Route 360) connects the communities of Tempe and Mesa with Interstate 10. Interstate 8 comes from the west and connects with Interstate 10 just south of Casa Grande.

Sky Harbor International Airport is the major air terminal in the CAWCS area. It serves in excess of 4,500,000 passengers annually. In addition, there are 22 other civilian airfields and two airbases in Maricopa County which handle an increasing volume of private and military traffic.

Land Use. The CAWCS area contains one of the fastest growing urban regions in the United States. In recent years rapid population increases have resulted in urbanization of much of the Salt River Valley. Growth is expected to continue, particularly to the west, southwest, northwest, and southeast. A large area of undeveloped land north of Phoenix, presently owned and administered by the State of Arizona, is another potential region for urban expansion. Indian reservations in the southern and eastern portions of Maricopa County may limit urbanization in these directions. For statistics on land ownership and use in Maricopa and Pinal Counties, see Tables 5, 6 and 7.

D. Water Resources Profile

The major streams in the CAWCS area are the Salt, Verde, Agua Fria, and Gila Rivers. Their tributaries in the Study area include New River, Skunk Creek, Cave Creek, Indian Bend Wash, Sycamore Creek, the Santa Cruz River, and Santa Rosa Wash, as well as several smaller arroyos and washes. With the exception of the perennial Salt and Verde Rivers above Granite Reef Diversion Dam and the Gila River above Ashurst-Hayden Diversion Dam, these streams are ephemeral. The relatively light winter rainfall usually is insufficient to produce sustained major surface flows along the tributaries, although winter and spring runoff from rainfall and/or melting snow from the watersheds may cause significant flows on the larger streams. Intense summer thunderstorms occasionally result in flooding along tributary streams but not normally along the major water courses.

Table 5

Status of Land Ownership, Maricopa and Pinal Counties, Arizona, 1978[1]

	Maricopa County	Pinal County
U. S. Forest Service	12%	7%
U. S. Bureau of Land Management	31%	16%
Indian Reservations	5%	16%
State of Arizona	10%	36%
Individual or Corporate	27%	25%
Other*	15%	--

[1] Valley National Bank, Arizona Statistical Review, 1978

* Includes lands administered by the National Park Service, Department of Defense, U. S. Fish and Wildlife Service, Bureau of Reclamation, and other county, state, and federal agencies.

Table 6

Existing General Land Use, Maricopa County, Arizona, 1973[1]

Land Use	Area in Square Miles	% Total Co. Area
Urban Development	323	3.5
Agricultural	882	9.6
Major Park and Recreation Areas	1,305	14.1
Airports and Military Reservations	1,260	13.7
Mountains and Desert	5,456	59.1
Total County Area	9,226	100.0

[1] Maricopa County Planning Department, "A Report Upon Future General Land Use for Maricopa County, Arizona, Part Three of the Comprehensive Plan," 1975

Table 7

Predominant Land Use, Pinal County, Arizona, 1967[1]

Predominant Use	Area in Acres	Percent (of total)
National Forest	234,240	6.0
Indian Reservations	561,280	16.0
Irrigated Agriculture		
Private	345,600	10.0
State Lease	53,500	1.5
Grazing (State Lease)	1,177,000	34.0
Rights-of-Way (State)	30,000	0.9
U.S. Contracts	1,500	-
Urban	38,400	1.0
Balance	1,000,400	30.0
	3,441,920	100.0

[1] Pinal County - 1980 Development Plan, Pinal County, Arizona, June, 1967.
NOTE: These are the most current figures available at this time.

The Salt and Verde Rivers are controlled by six dams, four on the Salt (Steward Mountain, Mormon Flat, Horse Mesa, and Roosevlet) and two on the Verde (Bartlett and Horseshoe). These structures which, along with the operating agency, are known as the Salt River Project, impound reservoirs which provide irrigation and domestic water for metropolitan Phoenix, and were not designed, nor authorized, for flood control even though they provide significant flood damage reduction. At Granite Reef Diversion Dam, waters from the Salt and Verde are channeled into canals which serve the Phoenix area. The Agua Fria River is impounded by Waddell Dam, forming Lake Pleasant. This reservoir supplies water to Maricopa County Municipal Water Conservation District No. 1. The Gila River is impounded by Coolidge Dam and San Carlos Reservoir. Water from the Gila River is diverted at the Ashurst-Hayden Diversion Dam for use by the San Carlos Project, a project which serves both Indian and non-Indian water users. The amount of surface water available from these last two systems are far less in quantity and not as reliable as that from the Salt-Verde system.

In the Arizona Water Commission's Phase I - Arizona Water Plan (1975), the average annual consumptive use of water in the Salt River Valley Basin is estimated at 1,563,000 acre-feet, while the average annual supply is only 931,000 acre-feet. The ground-water reserves are being overdrafted at the rate of 632,000 acre-feet per year to supplement the dependable surface supply. Comparable figures for the entire state show that average annual consumptive use in Arizona is 4,800,000 acre-feet while the average annual supply is 2,800,000 acre-feet. The state-wide ground-water overdraft of more than 2,000,000 acre-feet per year is indicated by the difference in these numbers.

Problems and Needs

The settlement, development, and economic growth of central Arizona has been predicated on the location and availability of water resources. Prehistoric and early historic settlers relied on surface flowing streams, springs, and rivers. Since the early 20th century, however, dependence on readily available ground water has increased. Growth has far outstripped the area's renewable water resources, resulting in massive overdrafting of ground-water supplies. Despite this imbalance between water demands and renewable water reserves, the area continues to be plagued by periodic flooding. This section highlights the problems and needs of the Study area and their interrelationship with the CAWCS.

A. Water Supply

The maintenance of an adequate water supply in the CAWCS area for agricultural, municipal, and industrial purposes is a major problem. A satisfactory solution to the water supply problem is being sought by

the State of Arizona through the Arizona Water Commission. While a comprehensive analysis of water supply and demand issues is properly a responsibility of the State, this Study will address the issues of water conservation, importation of water, and conservation of floodflows as measures which could contribute toward a solution of the water supply problem.

1. Water Conservation

President Carter, in his Water Policy Message of June 6, 1978, placed a new national emphasis on water conservation and directed the Water Resources Council to add conservation as an economic and environmental objective of Federal water projects. Because of the long history of water scarcity in central Arizona, this aspect of the President's policy takes on added importance.

As of 1970, agriculture accounted for 89 percent of water depletions in Arizona. Mining consumed 3 percent, and fish and wildlife interests used a little over 1 percent. Urban uses (municipal and industrial) amounted to less than 7 percent of the depletions. Although urban uses have increased since 1970, agriculture still consumes the largest amount of water. Arizona's farmers and ranchers are generally efficient in their application of water to the land, although the most common irrigation application remains flood irrigation. Implementation of advanced techniques such as sprinkling, drip irrigation, laser leveling, row shortening, and irrigation management services could result in additional water savings through greater efficiency. These techniques, however, would probably require costly investments by farmers. Urban water conservation measures also become increasingly important as more and more cropland is converted to commercial, residential, and industrial uses.

Water conservation will continue to be an important facet of central Arizona's overall water picture, and measures to improve water conservation need to be explored. Although conservation alone will not resolve the CAWCS area's water problems, it can supplement other measures designed to balance the region's water budget.

2. Importation of Water

The CAP should deliver a long-term average of 1.1 million acre-feet of Colorado River water per year to central Arizona. It is estimated that with regulatory storage this delivery could be increased 10-15 percent annually. With regulatory storage, the CAP Aqueduct system could have more operational flexibility and water deliveries could better meet the seasonal water demand patterns. The need to provide regulatory storage is one of the primary questions to be answered by the Study.

3. Conservation of Floodflows

Large quantities of floodwaters flowing through normally dry river channels in the Phoenix area result not only in flood damages, but also in the loss of a portion of these waters for beneficial use. Because these floodflows are presently unregulated, a great deal of water which could be obtained for beneficial use is permanently lost outside the CAWCS area (water which arrives at Painted Rock Dam is lost for beneficial use). This water collected behind Painted Rock Dam has been assigned a value, as CAP irrigation water, of $42.91. Not all of the floodflows reach Painted Rock Dam, however. It is generally assumed that a portion of the floodwaters percolates into the ground and eventually reaches the ground-water table. Although much of the specific data regarding ground-water recharge in the CAWCS area has not yet been generated, some general information is available. The actual amount of water reaching the ground-water table is presently unknown. It has been determined, however, that some of it reaches areas where ground-water recharge is not beneficial. Some of the water entering ground-water basins can be recovered and some cannot. These losses can be attributed to such factors as ground-water perching, vados zone saturation, and/or lateral migration within the aquifers. It is evident, therefore, that substantial losses to the system have been accrued as a result of these unrecovered floodwaters. It is interesting to note that the value of the water lost during floods in 1978 roughly approximates the estimate of damages caused by floodwaters.

For instance, damages sustained on the Salt and Gila Rivers during the March 1978 flood have been estimated at $31.4 million. During that flood, approximately 600,000 acre-feet of water flowed past Phoenix in the Salt River. If floodwater were assigned a value equal to the estimated direct annual benefits of CAP irrigation water ($42.91 per acre-foot), it would be valued at $25.7 million. The existence of CAP regulatory storage and flood control storage capacity would increase the opportunity to store portions of floodflows for later beneficial use either through direct water deliveries or ground-water recharge. Preliminary studies indicate that a dam in the vicinity of the confluence of the Salt and Verde Rivers could conserve a significant amount of water. The amount of water available for beneficial use would vary greatly from year to year depending on storage capacity, precipitation in the Salt-Verde watershed, and other factors.

As a means of providing a partial solution to central Arizona's water supply problems, conservation of floodflows needs to be explored and incorporated into the Study's other water resource planning efforts.

B. Flood Control

Flooding along the Salt River has been recorded since the arrival of pioneer settlers in central Arizona in the 1860's (see Table 8). The most serious of the early floods occurred in February 1891, when an estimated peak flow of 300,000 ft^3/s overtopped the Arizona Dam, which at that time diverted water from the Salt River into the Arizona Canal, and washed out other downstream diversion dams and irrigation works. Floodwaters inundated much of downtown Phoenix, reaching the intersection of Jefferson Street and Central Avenue. This event shifted the general growth pattern of the city away from the river toward the northern mountains.

Since 1891, a number of less extreme, though significant, floods have occurred in the CAWCS area. In 1905 and 1906, several periods of severe flooding again took place on the Salt River. The peak flow came in November 1905 when over 200,000 ft^3/s was recorded near Phoenix. Warm rains melted a heavy snowpack in the high mountains causing a flow on the Salt River of 120,000 ft^3/s on January 19-20, 1916, and 105,000 ft^3/s on January 29-30, 1916. This flow was exceeded by the flood of February 1920, which produced a peak flow of 130,000 ft^3/s. Another serious flood on the Salt River occurred in March 1938, producing a peak flow of 95,000 ft^3/s. In 1941, a large storm relieved near-drought conditions and resulted in a flow of 40,000 ft^3/s.

For the next 24 years there were no seriously damaging floodflows in the Salt River through Phoenix, but several damaging floods have occurred in recent years. The 1965-1966 flood, with a peak discharge of 67,000 ft^3/s at Granite Reef Diversion Dam, caused damages to business and residential properties, feed lots, sand and gravel operations, street crossings, bridges, agricultural acreage, irrigation works, and utilities. Fourteen of 17 street crossings over the Salt River were washed out. Sky Harbor, the main airport in the CAWCS area, sustained considerable damage when 2,600 feet of runway were inundated. Damage to a number of sewage oxidation ponds resulted in the discharge of raw sewage into the Salt and Gila Rivers. Total damages along the Salt River from this flood amounted to about $6,000,000, or about $12,000,000 measured in 1978 dollars.

In 1973, an extensive snowpack in the higher elevations of the Salt-Verde watershed melted, creating a continuous flow through the reservoir system and into Phoenix from February 21 through May 29 (with the exception of 7 days). A maximum flow of 22,000 ft^3/s was experienced along the Salt River. This flow caused damages to sand and gravel operations and forced the closure of several street crossings for an extended period. Monetary losses from this flood, however, were not excessive.

Table 8

Historical Floods on the Salt River*

Date	Flood Peak (ft^3/s)
February 1891	300,000
April 1905	115,000
November 27, 1905	200,000
January 19-20, 1916	120,000
January 29-30, 1916	105,000
February 1920	130,000
March 1938	95,000
March 1941	40,000
December 1965 - January 1966	67,000
February 21-- May 29, 1973	22,000
March 2, 1978	122,000
December 19, 1978	140,000
January 19, 1979	88,000
March 29, 1979	67,800

* Data for early floods obtained from the Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, U. S. Army Corps of Engineers, Los Angeles District, 1957, and from "Floods of November, 1965/January, 1966 in the Gila River Basin, Arizona and New Mexico, and Adjacent Basins in Arizona," U.S. Geological Survey, Water Supply Paper 1850C, 1970.

Data for recent floods obtained from the U.S. Geological Survey, measured at 48th Street and the Salt River (figures are preliminary and subject to revision).

In March 1978, a flood occurred with an estimated peak flow of 122,000 ft^3/s through the Phoenix area and caused an estimated $33,138,000. in damages (see Table 9). Approximately 95 percent of this damage occurred on the Salt and Gila Rivers ($24.9 million and $6.9 million, respectively). Once again, snowmelt influenced the flow and contributed to the flood.

In December 1978, warm, moist air from the Pacific Ocean and the resulting precipitation caused another snowpack to melt. The resultant peak flow of 140,000 ft^3/s on the Salt River was slightly larger than the March flood. Damages occuring as a result of the December 1978 flood were somewhat higher in the CAWCS area than those occuring in March 1978. Damage estimates for the latter flood are: $28.1 million on the Salt River, $7.3 million on the Gila River, and $3.9 million on the Agua Fria River--a total of $39.3 million on the three river systems.

The most severe flood than can reasonably be expected to occur in a region based on its meteorologic and geographic characteristics is called a "Standard Project Flood" (SPF). In the case of the CAWCS area, this hypothetical flood has been established and, coincidentally, has a peak flow almost identical to the 1891 flood.

The SPF overflow boundary exceeds the banks of the normally dry Salt River bed by 800 feet to 2½ miles at various reaches along the river. From its beginning at Granite Reef Diversion Dam, the boundary broadens to a total river width of about 2 miles at Gilbert Road in Mesa. As the boundary approaches the Mill Avenue bridge in Tempe, it narrows to a width of about 1/3 mile. The boundary broadens again in the reach from Mill Avenue in Tempe to 19th Avenue in Phoenix to a maximum width of 2½ miles. In the reach from 19th Avenue to 83rd Avenue, just upstream from the Salt and Gila confluence, the boundary is relatively constant at a width of about 2 miles.

Should the SPF occur, the following are just some of the anticipated conditions: (1) the Sky Harbor International Airport would be inundated, (2) all of the existing bridges within the SPF boundary would be impassable, (3) the 91st Avenue and 23rd Avenue sewage treatment plants would be inundated (4) several communities on both sides of the Salt River would be isolated, and (5) portions of downtown Phoenix south of Washington Street, including the Southern Pacific Railroad yards at 16th Street, would be inundated. The Corps of Engineers estimates that property damages in excess of $252,000,000. would result from the SPF on the Salt River. Such an event, with an approximate frequency of once every 200 years, would have a peak flow of 290,000 ft^3/s.

Table 9

March 1978 Flood Damage Summary, Maricopa County, Arizona
(1,000's of dollars)

	Physical Damages	Business and Emergency Losses	Total
Agricultural	$3,909	$122	$ 4,031
Residential	2,806	312	3,118
Commercial	686	59	745
Industrial			
Sand and Gravel	2,254	240	2,494
Other Industrial	5,148	188	5,336
Public			
Roads and Bridges	12,508	391	12,899
Other Public	3,412	11	3,423
Other	1,085	7	1,092
Total - All Damages	$31,808	$1,330	$33,138

The Salt River is regulated by six water conservation reservoirs on the Salt and Verde Rivers. These reservoirs greatly reduce peak flows along the Salt River although water conservation is their primary objective. During some years, the reservoirs are filled to capacity toward the end of the annual runoff season; consequently, there is no dedicated or designated space available in the existing Salt River Project reservoir system for flood control purposes. Some reservoirs were constructed since the large floods of the early twentieth century and would have reduced those flows. Table 10 summarizes the capacities of the Salt River Project reservoirs. The total watershed served by these reservoirs is approximately 13,000 square miles and is nearly equally divided between the Salt and Verde Rivers. The available storage capacity, however, is not so evenly divided, as 85 percent of the 2,063,948 acre-foot storage serves only the Salt River. As might be expected with this imbalance, a disproportionate share of the water from recent floods has emanated from the Verde River.

These flood problems interrelate with physical limitations of releases through Gillespie Dam and with the operation of Painted Rock Dam further downstream. Gillespie Dam was constructed to provide head works for irrigation canals similar to the function of Granite Reef Diversion Dam. It has negligible storage capacity and is filled with sediments accumulated since its construction in 1921. Although river flows pass over the crest of the dam without endangering the structure itself, the dam has a very limited outlet capacity. As a result, water is backed up behind the dam inundating lands upstream, depositing sediments and stimulating growth of salt cedar and other phreatophytes.

Painted Rock Dam, constructed by the Corps in 1959, provides efficient flood protection for downstream areas. The maximum release from Painted Rock following the floods of 1978 and 1979 has been 3,000 ft^3/s, or 2½ percent of the peak inflow to Painted Rock. The water stored in Painted Rock, however, has very limited use from that point downstream. It represents a liability to the agricultural lands downstream, even at flow rates of 3,000 ft^3/s or less, due to interruption of transportation and aggravation of saline ground-water problems.

In summary, severe flood hazard conditions on the Salt River have been confirmed by the floods in 1978 and 1979, and a need exists to formulate and implement a plan to reduce flood damages. The CAWCS will address this need as one of its primary objectives.

Table 10

Salt River Project Dams

Dam	Reservoir Capacity (acre-feet)	Percent of Total	Year Completed
Salt River			
Roosevelt	1,381,580		1911
Horse Mesa	245,138		1927
Mormon Flat	57,852		1925
Stewart Mountain	69,765		1930
Granite Reef Diversion	negligible		1908
Total: Salt System	1,754,065	85%	
Verde River			
Horseshoe	139,238		1946
Bartlett	178,477		1939
Total: Verde System	317,715	15%	
Total: Salt & Verde Systems	2,071,780	100%	

C. Energy Conservation and Production

In recent years, energy demands and costs have risen dramatically. Substantial efforts are being made by power utilities in the CAWCS area to meet the demand, and in particular, to reduce demand during peak-power periods. The plan developed by the CAWCS will influence and should be influenced by the energy picture in several ways.

If additional reservoir storage space is developed for either regulatory storage or flood control purposes, it may provide additional hydroelectric generating capability. This power might be provided on a continuous basis, thus augmenting base load power capacity, or it could be provided only during periods of peak demand. Peak power generation might involve operation on a pump-back basis in conjunction with existing Salt River Project facilities.

The addition of storage space or more efficient use of existing space might allow the capture and use of water that would otherwise be wasted, and could reduce the amount of water delivered by the Granite Reef Aqueduct from the Colorado River. This would result in obvious savings in the power required for pumping from the ground or the Colorado River.

Finally, if regulatory storage is provided, the CAP would be operated so as to reduce its own peak power demand by pumping whenever possible during low demand periods. This could be done without affecting the ability to meet immediate water demands. Without regulatory storage, however, this method of saving energy would be severely restricted.

Each of these aspects of energy conservation will be taken into consideration in the course of the CAWCS. Particular attention also must be given to close coordination with the Salt River Project.

D. Water Quality

Throughout the nation there is a growing concern for the quality of the country's waters, and this concern has extended into the CAWCS area. The classic differentiation of water into surface and subsurface categories, and of pollutants into point and non-point sources, may aid in the understanding of water quality concerns.

Ground-water quality varies greatly throughout the Study area from low quality with total dissolved solids in excess of 4,000 mg/l to high quality of less than 200 mg/l. Other constituents, such as fluorides, nitrates, chromium, arsenic, sulfates, hardness, lead, and radioactivity cause problems in certain localities. While causes of such pollution are not completely understood, in a number of instances (e.g. fluorides),

the problem seems to be caused solely by natural processes. In other instances, man seems to have influenced the problem through generation of pollutants from point sources which percolate into ground-water basins. Non-point sources of pollution also affect water quality, particularly as water management practices come into play. For instance, the continuous application of irrigation water may lead to a concentration of salts to the extent that the underlying ground water is no longer useful for most purposes.

Surface water quality also varies in the region. For the most part, pollutants in surface water consist of dissolved salts and are from natural non-point sources. There are few significant point sources of pollution that affect surface water in the CAWCS area.

Man has influenced the concentration of dissolved salts in surface water through management practices. In general, surface water quality improves during periods of high flows and deteriorates as flows decrease. Floodwater is of the highest quality in terms of dissolved solids. For instance, floodflows collected in Painted Rock Reservoir after the March 1978 flood contained concentrations of 318 mg/l of total dissolved solids on April 18, 1978, while water delivered through the CAP is expected to contain about 755 mg/l. Under natural conditions, floodwater escapes the area quickly, but the construction of the Salt River Project facilities allowed much of this higher quality water to be captured for use, with the net effect of improving water quality. However, long-term surface storage tends to lower water quality as evaporation concentrates the dissolved solids. Since regulatory storage will influence the amount of CAP water delivered, it will also influence the importation of dissolved solids. The location of regulatory storage may influence surface water quality in other respects. Salt River water has an average concentration of 620 mg/l of total dissolved solids below Stewart Mountain Dam, while the Verde River average is 260 mg/l. The average for the Salt-Verde system is 470 mg/l. The regulatory storage site and delivery method will determine the extent to which these waters of various qualities are intermingled. If additional floodwater is captured for future use, it would be of a higher than average quality. If CAP water were stored in ground-water reservoirs, it could also influence water quality there.

In summary, water quality will be influenced in many ways by the plan developed by the CAWCS. The extent of this influence should be estimated, understood, and considered during the CAWCS.

E. Vegetation and Wildlife

All of the structural alternatives to be considered by the Study could impact habitat of significance to birds and mammals of the region. While relatively few animals would die outright as the result

of a specific project, the disruption of their habitat would lead to declines in population and possible local extinction of certain species within the Study area. The rapid growth of agriculture and urbanization in large portions of the CAWCS area already has reduced substantially, the amounts of land and water available for wildlife habitat. Of particular interest to the CAWCS are regions of riparian vegetation. Such growths exist in the CAWCS area along the lower Verde River; the Salt River above and immediately below Granite Reef Diversion Dam; and the Salt-Gila River from the 23rd Avenue treatment plant in Phoenix to Gillespie Dam. All, or a portion of these stands of riparian vegetation could be impacted by flood control projects.

A dam and reservoir at or upstream of the confluence of the Salt and Verde Rivers could reduce the habitat for local animal population in the area. The mule deer, javelina, gray fox, and coyote would decrease if habitats diminished and recreational uses and development occurred. Bird species nesting in the area could also be affected adversely. Nesting areas for black hawks and the endangered bald eagle could be adversely affected, and eagles in the region would suffer from a reduction of stream feeding habitat. In addition most species of reptiles and amphibians at the confluence site would be impacted.

Not all effects of flood control projects are negative. If ground-water recharge is successfully incorporated into a project, it may improve riparian habitat and thus have a very beneficial impact. Dams, reservoirs, and other alternatives would have similar impacts upon vegetation and wildlife in the immediate area. The consequence of taking no action for regulatory storage and flood control purposes would also have positive and negative impacts on the vegetation and wildlife. These impacts must be addressed during the CAWCS as well as ways of improving habitat and aiding in the recovery and conservation of endangered species.

F. Recreation

Because the desert climate permits year-round enjoyment of outdoor activities, a strong demand exists in the CAWCS area for recreational facilities and programs. The population growth experienced by metropolitan Phoenix in the decades after World War II, together with a general increase in income levels and leisure time, has produced an unprecedented demand for recreation of all types. The steadily rising cost of gasoline has, at the same time, caused residents of the CAWCS area to orient their activities toward easily accessible facilities.

Local suppliers of recreational programs and facilities, both public and private, have been unable to keep up with the demand. Existing facilities receive heavy, often excessive, use from residents and visitors to the area. The resulting overcrowding not only diminishes the quality of the recreational experience for individual users, but also causes deterioration of the recreation resource itself. Both facilities and settings suffer, thereby reducing the resource's original carrying capacity. The original problem of an insufficient and overtaxed supply is exacerbated further. This produces a cycle of overuse-deterioration-reduced capacity (supply)-overuse, that is difficult to break.

Recreational use of the few watercourses in the CAWCS area provides an example of this demand/supply problem. During hot summer months, the flowing streams and man-made lakes on the Salt, Verde, and Agua Fria Rivers are used for water-based recreation such as fishing, boating, swimming, water skiing, and floating; while the lakeshores and riverbanks serve as sites for picnicking, hiking, and other activities. Overuse of these resources caused so many adverse effects to this area that management policies have been adopted which restrict the number of visitors to some reservoirs and certain reaches of the individual rivers. The U.S. Forest Service is considering additional management plans to facilitate the enjoyment of this resource while, at the same time, protecting it. Arizona's Comprehensive Outdoor Recreation Plan, proposed by the Arizona Outdoor Recreation Coordinating Commission, estimates that by 1985, existing lakes in Maricopa, Pinal, and Gila Counties will be able to supply only 25 percent of the demand for boating and water skiing, and only 15 percent of the demand for boat ramps. Similar strains are expected for other heavily used facilities such as hiking and riding trails. The flowing streams in the CAWCS area represent a unique and irreplaceable resource. The opportunity to tube down the river is particularly attractive to people in the area who cannot afford or are not interested in flat-water recreation. A larger and more diversified stock of land and water-based recreational facilities needs to be developed for the use of Phoenix area residents. This need will be addressed as part of the CAWCS.

G. Social Considerations

In the upstream portion of the CAWCS area, major social concerns involve the quality of life and preservation of the culture of the Indians on the Fort McDowell and Salt River Reservations. At present, the inhabitants of these reservations are faced with such problems as low incomes, inadequate housing, and illiteracy. At the same time, they are a proud people with great respect for their land and environmental issues in general. A dam at the Salt-Verde River confluence would affect the Indian people in many ways. It might require extensive relocation of the Fort McDowell residents, thus placing further strains

on their social fabric and jeopardizing the preservation of their culture. A reservoir at this site might improve economic conditions for some Indians. The CAWCS must include extensive coordination with the Fort McDowell and Salt River Indians and must respect their views and values.

Due to the unique recreational use of the Salt River that has developed over the years, elimination of this "tubing" resource would represent a significant social change in the lives of some of the residents of the area. Creation of different forms of recreation would likewise affect social life.

Downstream, in metropolitan Phoenix, the CAWCS faces a different set of social concerns. Many essential services for the city of Phoenix are located north of the Salt River. Severe floods close most river crossings, isolating south Phoenix from vital agencies and imposing hardships on commuters who must cross the river. The social concerns of residents of the CAWCS area south of the Salt River will be taken into consideration by the CAWCS.

Further downstream, very intensive flooding in the communities of Holly Acres, Allenville, and other areas west of Phoenix, causes social problems to residents. Personal hardship, financial losses, and threat to life caused by the floods are factors that must be considered.

H. Cultural Resources

Rapid urbanization over the past three decades has placed increasing pressure on the archeological and historical resources and in some cases obliterated many sites of cultural importance.

Because most of the prehistoric inhabitants of the CAWCS area practiced irrigated agriculture, the remains of their cultures tend to be located along or near major water courses. As a result, many archeological sites could be impacted by flood control and regulatory storage alternatives on the Verde, Salt, Gila, and Agua Fria Rivers.

Historical sites along the major streams also could be impacted by flood control and regulatory storage projects. The remains of old Fort McDowell and the cemetery on the Fort McDowell Indian Reservation might be affected by a dam and reservoir at the confluence site. A sheep bridge spanning the Verde River near its confluence with Tangle Creek which is included on the National Register of Historic Places might be impacted The modification of Roosevelt Dam on the Salt River also would involve a structure on the National Register of Historic Places.

The CAWCS will take into consideration the value of such cultural artifacts as the prehistoric and historic sites in the Study area, and if possible, will develop plans for their preservation.

I. Water Rights

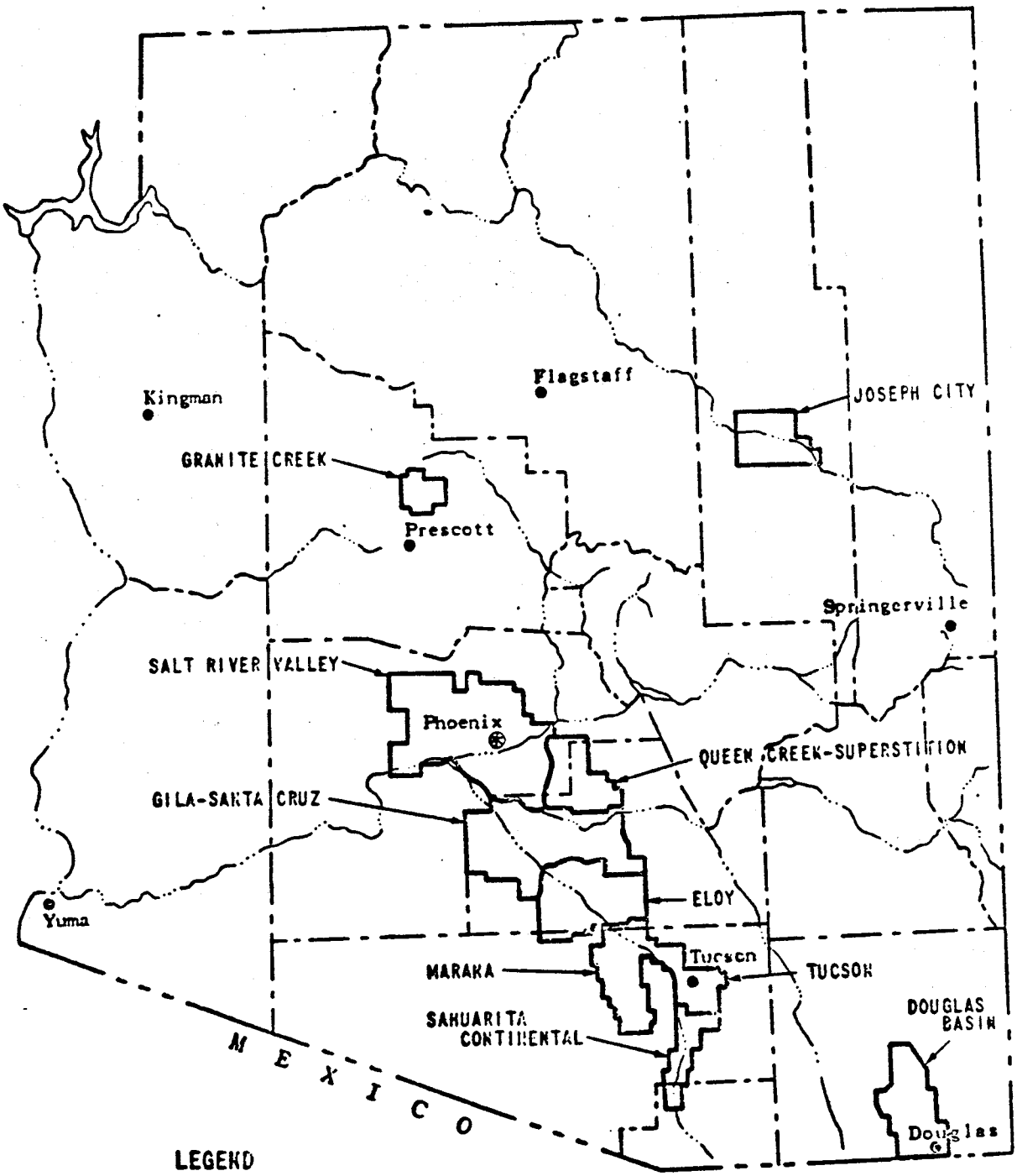
1. Indian Water Rights

As increasing amounts of western land were reclaimed during the late nineteenth and early twentieth centuries, conflicts arose between Indian and non-Indian water users over water rights. Non-Indian water rights in the West are based on state systems of prior appropriation. Indian water rights are based on judicial precedent. The earliest determination by the courts of Indian water rights was the 1908 Supreme Court decision in Winters versus United States; the origin of the term "Winters Doctrine." "The Court in 'Winters' concluded that the Government, when it created the Indian Reservation, intended to deal fairly with the Indians by reserving for them the waters without which their lands would have been useless."[1] Through the years, judicial decisions have expanded Indian water rights to reservations created either by treaty, acts of Congress, or executive orders. The Arizona versus California Supreme Court decision of 1964 was a strong reaffirmation of the basic "Winters Doctrine." This doctrine and in some instances, the doctrine of prior appropriation, forms the basis for Indian water claims in central Arizona.

In 1975, representatives of the Fort McDowell and Salt River Indian Reservations were among a group of Arizona Indian tribes presenting water rights claims before the Committee on Interior and Insular Affairs of the United States Senate. They protested the proposed allocation of CAP water as being too low. Several tribes throughout Arizona have filed lawsuits against other water users which in general alle misappropriation of water which rightfully should be available to Indians. A number of bills have been introduced in the Congress which would have more water made available to central Arizona Indians. Since the water supply is so limited, there would undoubtedly be impacts on the non-Indian water users.

In this region, settlement of Indian water rights is a pressing matter which would have traumatic impact if a major reapportionment of surface and ground-water rights occurred. It is generally accepted that negotiation of an acceptable solution to Indian water rights is by far preferable to litigation. The United States Government

1/ Arizona versus California, 373, U. S. 546 (1963)



LEGEND

COUNTY LINE

DESIGNATED CRITICAL GROUNDWATER BASINS

DESIGNATED CRITICAL GROUNDWATER BASINS

ARIZONA WATER COMMISSION
PHASE I PLAN 1975

* Taken from U.S. Army Corps of Engineers, Los Angeles District, Draft Institutional Inventory, June, 1977.

and Salt River Project are both currently involved in such negotiations. One of the keys to successful water rights negotiations is the availability of a new source of water to negotiate. CAP water, sewage effluent, and floodwater that might be controlled by the plan developed through this Study are examples of additional water sources.

There appears to be no direct role for CAWCS in the settlement of Indian water rights issues. However, the CAWCS will influence to some extent, the amount of water available. The need for coordination during the CAWCS with those agencies involved in negotiations is also recognized.

2. Ground-water Rights

Early water law in the Southwest was based on the principle of "first in time, first in right," which mandated a chronological hierarchy among appropriators. Little thought, however, was given to subsurface water rights. It was not until 1904, in the case of Howard versus Perrin, that the Supreme Court of the Territory of Arizona ruled that underground waters were the property of the landowner, not subject to appropriation, but contingent on beneficial use. The Arizona Legislature, in 1919, adopted a water rights permit system for surface water, but was vague regarding the status of ground water.

The depletion of the state's ground-water supplies prompted the Arizona Legislature to adopt the Groundwater Code of 1948. This code provided for the establishment of critical ground-water areas in basins not having sufficient ground water to provide an adequate long-term supply for the irrigation of cultivated lands in the basin at the then current rates of withdrawal. Much of the CAWCS area lies within these critical ground-water basins (see Figure 3). Drilling of new wells within the critical area for irrigation of land not in cultivation when the designation was made was prohibited by the code. The code, however, did not control the extent of pumpage of wells already in existence, nor did it prohibit the drilling of new wells for purposes other than irrigation At present, 10 critical ground-water areas have been designated by the State Land Department, one of which is the Salt River Valley.

In May 1977, an emergency ground-water bill was signed into law by the Governor. This act established a 25-member Groundwater Management Study Commission to draft a ground-water management plan which will become law in 1981 if the legislature fails to enact a new ground-water code by that date. The emergency law also put a 4-year freeze on designation of new critical ground-water areas and prohibited injunctions to stop transfers of water from already designated areas.

The potential for more extensive conjunctive use of ground and surface waters is frequently mentioned. Ground-water recharge measures and ground-water storage for regulatory storage purposes have been suggested, yet the existing ground-water law discourages those measures inasmuch as the right to exclusive use of water is lost when it is placed in underground reservoirs.

The CAWCS needs to recognize the limitations imposed by existing ground-water laws and must monitor the progress of the Ground-water Management Study Commission.

J. Safety of Dams

The construction of a dam anywhere and particularly upstream of a major metropolitan area always involves consideration of the safety of the structure. The recent catastrophic failures in our nation have prompted increased emphasis on dam safety. In the wake of recent interest in dam safety, Congress enacted Public Law 92-367 to assign responsibilities for dam safety.

A review of the safety of existing dams in the Study area has resulted in concern regarding three structures: Bartlett Dam on the Verde River and Stewart Mountain and Roosevelt Dams on the Salt River. Officials of the Water and Power Resources Service (formerly the Bureau of Reclamation) and the Salt River Project have frequently pointed to the need for immediate attention to this issue and the need for early corrective action. The Water and Power Resources Service (WPRS) is analyzing the safety aspects of these three structures in its Engineering and Research Center; but that analysis is outside the scope of this Study. There is a relationship, however, between this program and the CAWCS as it applies to Roosevelt Dam and New Bartlett Dam, both of which are being considered as alternatives. The CAWCS must consider and coordinate the design for modifying and/or constructing the dams for safety purposes along with modifications for flood control.

The CAWCS is certainly intended to be responsive to the various needs of the area as described in this section, and it should be done expeditiously. Extreme care must be taken to consider the safety aspects of existing and proposed structures.

Previous Studies and Current Plans

Several local, state, and federal agencies have studied Salt-Gila flood control, regulatory storage, and related issues. This section identifies these studies by agency and highlights any interrelationship with the current Study.

A. Water and Power Resources Service (WPRS) (formerly the Bureau of Reclamation)

Lower Colorado Region Comprehensive Framework Study, 1971.

The WPRS played a major role in this study prepared by the Lower Colorado Region, State-Federal Interagency Group. A framework is presented for development and management of water and related land resources of the Lower Colorado Region, which includes the area covered in this Study. Many problems considered in the current Study (e.g., water supply, flood control, and water quality) are addressed, but on a regional basis. It also contains much useful background information and will serve as a source document.

Central Arizona Project Studies, 1972-1979.

The implementation of the Colorado River Basin Project Act (Public Law 90-537) has resulted in several studies of the CAP as a whole and of its individual features. A partial listing of published studies will give an idea of their relevance to the scope of the current Study. Of particular interest are the Final Environmental Statement on the entire CAP, which puts the regulatory storage issue in context, and the Draft Environmental Statement on Orme Dam. (See *)

* Final Environmental Statement, Central Arizona Project, Department of the Interior, FES, 72-35, Boulder City, Nevada, 1972.

Final Environmental Statement, Navajo Project, Department of the Interior, FES 72-1, Boulder City, Nevada, 1972.

Final Environmental Statement, Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel, Department of the Interior, FES 73-2, Boulder City, Nevada, 1972.

Final Environmental Statement, Granite Reef Aqueduct, Department of the Interior, FES 74-5, Boulder City, Nevada, 1974.

Final Environmental Statement, Granite Reef Aqueduct Transmission System, Department of the Interior, FES 75-66, Boulder City, Nevada, 1975.

* Draft Environmental Statement, Orme Dam and Reservoir, Department of the Interior, DES 76-17, Boulder City, Nevada, 1976.

CAP Geology and Groundwater Resources Report, Maricopa and Pinal Counties, Arizona, Phoenix, Arizona, 1976.

Draft Environmental Statement, Salt-Gila Aqueduct, Department of the Interior, DES 79-1, Boulder City, Nevada, 1979.

Other studies related to the CAP are the Tucson Aqueduct study and the Indian Distribution System study, both of which are scheduled to publish draft environmental statemer in 1980. The Buttes Dam and Reservoir Draft Environmental Statement is scheduled for completion in 1981.

Dam Safety Program

The analysis of safety aspects of Bartlett, Stewart Mountain, and Roosevelt Dams is being conducted by the WPRS Engineering and Research Center in Denver, Colorado, under the authority of the Reclamation Safety of Dams Act of 1978. The analysis of Roosevelt Dam is underway and centers on several areas of common interest to this Study: integrity of abutment geologic formations, spillways and outlet capacity, safety of the highway which crosses the top of the dam, and flood hydrology. This dam safety study and the current Study must be closely coordinated and will share certain technical data. The dam safety study has no firm schedule for completion.

Final Report Interagency Task Force on Orme Dam Alternatives, 1978.

In 1977 and 1978, the WPRS worked with the Interagency Task Force on Orme Dam Alternatives which addressed issues similar to the ones in this Study. Due to a lack of information on the alternatives which were considered, the Task Force was

unable to reach a conclusion on a preferred alternative. However, the Final Report is an invaluable collection of data on alternative solutions to the problems of interest, and represents a point of departure for the CAWCS.

B. Corps of Engineers

Interim Report on Survey For Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, 1957.

The Corps studied the Salt-Gila system flood problems in the 1950's, and published this report which resulted in authorization of a project to reduce flood damages. The project was never implemented because of subsequent authorization of the CAP and Orme Dam. The study contains valuable background and technical information and will be used as a resource document.

General Design Memorandum - Design Memorandum No. 2 - General Design for Santa Rosa Wash (Tat Momolikot Dam and Lake St. Clair), 1971.

The Santa Rosa Wash Project, which was completed in 1974, was a coordinated effort of the Corps, the Bureau of Indian Affairs, Pinal County, and the Papago Indian Council. The project includes a multi-purpose dam and lake, the Vaiva Vo irrigation works downstream from the dam, and fish and wildlife recreational facilities. This project is being considered as a possible CAP regulatory storage facility.

General Design Memorandum - Phase I, Plan Formulation For Indian Bend Wash, 1973.

This document describes a unique flood control project which incorporates multiple use of the floodplain along with structural and non-structural flood control measures. Conceptually, it is similar to the Rio Salado plan for the Salt River, and will be useful as background information. Indian Bend Wash enters the Salt River in the CAWCS area, making it imperative that hydrological information presented in this report be taken into account.

Gila River, New River and Phoenix City Streams, Design Memorandum Phase I, Plan Formulation, 1976.

This document describes a flood control project in the Phoenix area. The project, which is under construction, affects the

area hydrology to some extent by the construction of four dams (Dreamy Draw, Cave Buttes, Adobe, and New River) and a diversion channel.

Painted Rock Dam Operation Study, Information Brochure, 1977.

Painted Rock Dam is located on the Gila River at the western edge of the CAWCS area. The operation of this facility currently is under study and various operational schemes are described. Problems associated with operation of Painted Rock Dam should be taken into account during this Study.

Phoenix Urban Study

The Corps is in the final stages of this study which addresses flood control, water quality, and water conservation; areas of interest common to the current Study. Although the final draft will not be submitted to the Division Engineer, South Pacific Division, Corps of Engineers until September 1979, the following interim and draft reports are pertinent.

Groundwater Recharge, February 1977.

This working paper presents a conceptual plan for artificial ground-water recharge of floodwaters in the Salt River. The principles of operation of this plan will be analyzed more carefully in the current Study.

A Plan of Study for a Demonstration Recharge Project in the Salt River Valley, October 1978.

This working paper, prepared for the Corps by the University of Arizona, describes many facets of artificial ground-water recharge and recommends comprehensive study of the concept through a demonstration project. A report has not yet been approved or released by the Corps, but the concepts presented are of interest to the CAWCS.

Draft Final Plan, 208 Water Quality Management Program, December 1978.

This plan, prepared by the Corps for the Maricopa Association of Governments (MAG), presents an areawide water quality management plan to meet the requirements of Section 208, Public Law 92-500. Water quality problems in much of the Study area are described and will be taken into account in the current Study.

Draft Nonpoint Sources of Groundwater Pollution, Water Quality Management Program, November 1978.

This portion of MAG's 208 plan is a comprehensive description of ground-water quality problems and contains a plan to gain better understanding of the causes of the problems. Data contained in the report will assist in the assessment of ground-water quality impacts associated with plans being considered by the current Study.

Draft Environmental Assessment and Impact Statement on Point-Source Metro Phoenix Alternatives, November 1978.

This environmental document addresses water quality in the heart of the CAWCS area. It not only provides water quality management data, but also contains considerable environmental setting information.

Rio Salado, Phase III, 1978.

This report, prepared for the Corps by the Research and Service Foundation, College of Architecture, Arizona State University; describes various flood control channel configurations in the Salt River. The Rio Salado concept envisions multiple use of the natural channel by open space, greenbelts, recreation, commercial operations, and flood control facilities. Rio Salado will be defined further by the CAWCS.

C. Other Federal Agencies

1. U.S. Geological Survey (USGS)

The USGS conducts several programs of particular interest to the CAWCS. Their annual report on water flows and water quality will be used as a basic data source. The USGS has recently undertaken a thorough study of ground-water aquifers which will develop information pertinent to ground-water recharge and storage. The USGS is also involved in the analysis of hydrological data from the recent floods.

2. U.S. Soil Conservation Service (SCS)

The SCS has conducted numerous studies of flood control projects in the Study area, e.g., the Buckhorn-Mesa and White Tanks projects. To the extent that these studies affect local hydrology, they will be considering during the CAWCS.

3. U.S. Forest Service

This agency controls much of the land adjacent to the Salt and Verde Rivers. Current planning efforts by the Forest Service directed at management of recreation along the Salt River will be of interest to the CAWCS. A Draft Environmental Statement, Lower Salt River Recreation Area (R3-78-02) was published in January 1979, discussing this planning.

4. U.S. Fish and Wildlife Service

Fish and Wildlife Coordination Act Advance Planning Report for the Central Arizona Project, June 1976.

This report provides an assessment of environmental concerns related to the CAP that should be carefully considered.

D. State Agencies

1. Arizona Water Commission

Phase I - Arizona State Water Plan, Inventory of Resources and Uses, July 1975, and Phase II - Arizona State Water Plan, Alternative Futures, February 1977, and Phase III - Part 1, Arizona State Water Plan - Water Conservation, June 1978, are all valuable to the CAWCS for their presensentation of data on water supply and uses. Subsequent parts of phase III, an evaluation of potential water resource management plans, are under preparation. The Water Commission has primary responsibility to recommend CAP water allocations to the Secretary of the Interior. The amount of water available for allocation (as it is influenced by availability of regulatory storage) will be of interest to the Arizona Water Commission. The Water Commission also is assigned primary responsibility for flood control matters by the Governor.

2. Groundwater Management Study Commission

This agency is involved in preparation of a ground-water management plan for Arizona, to be incorporated into state law in 1981. The staffs of the Agencies have conferred with the Commission in the past and will continue to do so. The eventual plans may affect feasibility of ground-water storage and artificial recharge.

3. Office of Economic Planning and Development (OEPAD)

OEPAD is conducting studies related to secondary economic benefits of channelization as a part of the Rio Salado concept. Preliminary indications are that the benefits are substantial. Inasmuch as an assessment of the primary benefits (i.e., prevention of flood damages and reduction of business losses) has indicated a lack of economic justification for channelization, the OEPAD conclusions will be of great interest.

4. Office of the Governor

Governor Babbit has appointed a 28-member Community Advisory Board to advise him (and the Agencies) on the best plan for Salt-Gila flood control and CAP regulatory storage. This Board will play a key role in the Study, as is described in the next section of this report.

E. Local Agencies

1. Flood Control District of Maricopa County (FCDMC)

The FCDMC acts as the local sponsor for flood control projects in the county. Its interest and input to this CAWCS is obvious, particularly in relation to local cost-sharing requirements. This agency also is conducting a study of the feasibility of channel clearing on the Gila River in the general vicinity of Buckeye, the results of which will be of interest to the CAWCS; however, there is no established schedule for completion.

2. Maricopa Association of Governments (MAG)

This voluntary association of cities in Maricopa County and the County itself has been designated as the responsible agency for water quality planning as required by Public Law 92-500. With assistance from the Corps, MAG has

prepared the areawide plan required by Section 208 of that law. MAG has published two reports on the Rio Salado Plan (Phase I in 1972 and Phase II in 1974), and maintains continuing interest in that project. MAG has primary responsibility for transportation planning and will be concerned with eventual flood control plans as they might affect access across the Salt River. MAG also is involved in air quality planning which will be of secondary interest in the CAWCS.

3. Salt River Project (SRP)

The SRP currently is studying a wide range of proposals to provide peak electrical power through a system of pump-back storage. SRP is the focal point during periods of flooding on the Salt River inasmuch as it operates extensive snowpack and runoff gaging stations, predicts floodflows, and maintains a system of six storage reservoirs on the Salt and Verde Rivers. Its continuous study of methods to improve operating procedures will benefit the Study. The SRP also is involved in the negotiation and litigation of Indian water rights with six tribes in the Salt-Verde watershed. The availability of CAP and flood waters will be of interest to SRP in this regard.

4. City of Tempe

The City of Tempe has probably been the most active proponent of the Rio Salado concept. Their planning staff maintains a continuous effort to promote the concept. Tempe's plan will be considered during the CAWCS.

Stage I Public Involvement

Stage I public involvement has been conducted to insure that public perceptions, concerns, ideas, and preferences are understood so as to structure the CAWCS appropriately. Fortunately, a great deal of information has been accumulated.

A. Public Response

The responses to the Orme Dam Draft Environmental Statement (1976) provide a great deal of insight to public attitudes. The concerns expressed in these responses include:

Alternative means of controlling floods along the Salt and Gila Rivers

Conservation of local floodflows

Regulation of CAP water supplies

Reduction of ground-water overdraft

Archeological and historical impacts

Social impacts

Economic impacts

Endangered species

Vegetation and wildlife habitat

Ground-water recharge

Impacts on Indian communities

Water and air quality

Dam safety

Recreation

Fish and wildlife enhancement

B. Interagency Task Force on Orme Dam Alternatives

Based on the responses to the Orme Dam Draft Environmental Statement, the WPRS reassessed alternatives to Orme Dam. The Interagency Task Force on Orme Dam Alternatives was formed in April 1977 to identify and evaluate primary-purpose alternatives for CAP regulation and flood control. The Task Force consisted of individuals with varying viewpoints and backgrounds. A Technical Work Group was organized, which in turn was divided into Flood Control, Regulatory, and Environmental/Socio-economic Subcommittees. The Task Force suspended work following a September 30, 1977, memorandum from the Lower Colorado Regional Director of the Water and Power Resources Service that no further funds be expended on Orme Dam or any confluence structure. Activities were resumed after

clarification was received indicating that Congress had not intended to prohibit the study of alternatives at the confluence site. On May 5, 1978, the Task Force submitted a final report which stated that a consensus recommendation could not be made because of the complexity of the issues involved, a shortage of time and resources, and the divergent opinions of the Task Force members. Opinions expressed in response to the final report are valuable to the current Study and constitute a primary source of information for identification of alternatives to be evaluated further in this Study.

C. The Community Advisory Board

In 1978, Governor Babbit organized the Community Advisory Board, Salt-Gila Flood Control and CAP Regulation Study, to review and advise on the identification and selection of a viable alternative for flood control and CAP regulatory storage. The Board is composed of community leaders representing a wide range of constituencies and interests. The interest in expediting the CAWCS has been continually expressed by the Board and they will be an extremely important group for providing feedback as the Study progresses and eventually in helping to mold a community-wide consensus for the selected plan.

Three public meetings on the Study of Alternatives for Salt-Gila Flood control and Regulation of Central Arizona Project Waters (now CAWCS) were held at: The Buckeye High School Auditorium, January 30, 1979, 7:00 p.m., with 188 persons filling out attendance cards; the Maricopa County Supervisor's Auditorium, Phoenix, January 31, 1979, 10:00 a.m., with 57 persons filling out attendance cards; and the Centennial Building, Mesa, January 31, 1979, 7:00 p.m., with 52 persons filling out attendance cards. The first meeting was chaired by John Hawley, Mayor of Buckeye; William A. Lavell, Field Solicitor for the Department of the Interior in Phoenix, chaired the second meeting; and Wayne C. Pomeroy, Mayor of Mesa, moderated at the third meeting. Representing the Water and Power Resources Service at these meetings were Dick Shunick, Projects Manager for the Arizona Projects Office, his assistant Des Chappelear, Stephen Magnussen, Chief of Advance Planning, and Herb Dishlip, Agency Manager for the Study. Present for the Corps of Engineers were Colonel Gwynn Teague, District Engineer, Los Angeles District; Lieutenant Colonel Verne Doyle, Special Assistant to the District Engineer; Joe Dixon, Agency Manager, and Will Worthington, Urban Studies Chief.

Each of these meetings began with slide presentations describing the issues of Salt-Gila flood control and regulation of CAP waters and briefly summarized the alternatives under study by the WPRS and Corps. The Study (now CAWCS) process and schedule which the Agencies will follow also were discussed. The public information brochure was also distributed.

The meetings were then open to public questions and statements. The representatives of the WPRS and Corps made responses to these questions and comments whenever appropriate.

Fourteen persons made comments at the Buckeye meeting. In general, these involved: Concern over the length of time of the Study, lack of adequate bridges over the Salt and Gila Rivers from 91st Avenue to Gillespie Dam, impaired access to Rainbow Valley, need for channel clearing or channelization of the Salt and Gila Rivers from 91st Avenue to Gillespie Dam, environmental impacts of upstream structures, channel clearing or channelization, concern for the Fort McDowell Indians, operation and safety of Painted Rock Dam, linking downstream flood control (as it relates to the CAWCS) with CAP regulatory storage, criticism of Salt River Project during the recent floods, and support and criticism of Orme Dam.

Specifically, it was suggested that:

1. The Agencies recognize there is no alternative to channel clearing or channelization between 91st Avenue and Gillespie Dam.

2. Gates be installed at Gillespie Dam to lower the height of the structure so that a channel through the Arlington area can be made.

3. The Agencies assist in a local program which would be established to prepare an environmental assessment for channel clearing.

4. The Salt River Project's operations be reoriented to provide greater flood control.

5. The Agencies' priorities be shifted to provide flood protection for downstream areas in advance of any decision on CAP regulatory storage or upstream flood control measures.

6. The potential for water conservation and storage should be studied in order to develop plans to protect the area from the damaging effects of droughts.

At the Phoenix meeting, 12 persons made comments regarding the need for clearing the Gila River channel in the CAWCS area, support for and opposition to Orme Dam or any structure at or near the Salt-Verde confluence, danger to riparian habitat and wildlife posed by some alternatives, concern for Fort McDowell Indians, support of non-structural solutions to flood control and CAP regulatory storage needs, adequate bridges over the Salt River, both criticism and support of the Salt River Project's operation during the floods of 1978-1979, and concern over safety of Stewart Mountain and Roosevelt Dams.

Specifically, it was suggested that:

1. Channelization or channel clearing is needed below the 91st Avenue wastewater treatment plant even if Orme Dam or alternative upstream flood control structure is built.

2. Ground-water recharge be thoroughly investigated as an alternative for CAP regulatory storage.

3. Renewed consideration be given to regulatory storage damsites on the Agua Fria and Gila Rivers.

4. San Carlos Lake be investigated for CAP storage.

5. Floodplain regulation be strictly enforced.

6. The Salt River Project's responsibilities should include specific flood control duties.

7. Improved flood warning systems are needed.

Twenty persons made comments at the Mesa meeting. In general, these comments concerned: The length of time of the Study (now CAWCS), cost of the Study, costs of Orme Dam and Reservoir and of channelization of the Salt River, operating criteria for any proposed upstream flood control structure, criticism of the Salt River Project's operation during the 1978 floods, the effects of proposed structural alternatives on riparian habitat and eagle nesting areas, the need for non-structural alternatives for both flood control and regulatory storage, the safety of Stewart Mountain and Roosevelt Dams, concern for the Fort McDowell Indians, the need for channels and bridges along the Salt River, and support for and opposition to Orme Dam and Reservoir, as authorized.

Specifically, it was suggested that:

1. The Salt River Project provide increased flood control through modification of existing regulations or restructuring of the Board of Directors.

2. Water exchanges with the Salt River Project be accomplished to provide CAP storage.

3. Bridges, channels, and floodplain regulation be examined as more economical solutions to flood protection.

4. Ground-water recharge be promoted as an alternative for CAP regulatory storage and flood control.

5. Improved flood warning systems be developed.

6. The Agencies recognize that construction of any new upstream structure or modification of existing structures may endanger important archeological sites and critical riparian habitat.

E. Public Review and Comment

Numerous comments and suggestions were received by the Agencies in addition to the statements made at the public meetings. Several letters and telephone calls were received in response to brochures. A number of comments were included the mailback postcards. Letters containing suggestions and points of view were received as a result of newspaper articles and television coverage of the flood events. Letters written to the newspaper editors often contained information relevant to this Study. Many specific public comments on the PLAN OF STUDY were provided by members of the Technical Agency Group and the Community Advisory Board. These groups were furnished early drafts of this report so that their ideas and comments could be incorporated into the final report.

The Agencies have chosen to reply to these comments through revisions, corrections, and additions in the text rather than by a separate comment/ response section. The direct incorporation of public comments into this document is intended to make the public viewpoint an integral part of the CAWCS.

Stage I Element Identification

The planning process for this Study involves a series of steps to be repeated several times until a preferred system of alternatives can be recommended. The alternative elements presented were identified in Stage I of this Study. Examination of the elements has been conducted to determine the extent of further study needed.

An initial level study would involve:

1. Preliminary analysis of water supply or flood control level of effectiveness.

2. Area-capacity calculations.

3. Literature review of geological information.

4. Preliminary cost estimates.

5. Field reviews by engineers and geologists.

A feasibility level study would involve:

1. More detailed analysis of water supply or flood control as determined by operation studies or flood routing studies.

2. Geotechnical investigations, including a drilling program to determine geological conditions below the ground and to determine sources of construction materials.

3. Site specific engineering design and cost estimates.

4. Studies of environmental, social, economic, demographic, and other relevant non-engineering factors.

Most of the elements have received at least initial levels of study during Stage I. However, during the public meetings, several additional alternative elements were suggested which require an initial level of study. These elements will be included in the Stage II analysis.

After further study each element will be combined into systems and plans and their impacts and effects analyzed. Those systems which are determined most acceptable will be studied at an increased level of detail until a preferred plan or plans can be recommended. At each decision point the public will be involved to a great extent.

Reducing the number of alternatives in order to allow concentration on the most promising is essential if the Study is to remain on schedule. A description of each alternative and a recommendation by the WPRS and the Corps for further study is included in this summary.

While several sites may be appropriate for such primary reasons as recreation or ground-water recharge, the alternatives presented are primarily for flood control and CAP regulatory storage. These recommendations were based largely on three factors: (1) geology, (2) location, and (3) economics. Geological problems related to foundation preparation and particularly to the prevention of seepage at the storage sites are often referred to as geotechnical problems. Because of the number of elements and the complexity of the Salt River system, a computer model (HEC 1)[1/] was used to estimate on a preliminary basis, the economic and hydrologic performance of alternatives systems for flood control. The model has two methods of evaluating the alternative systems:

1/ Corps of Engineers: The Hydrologic Engineering Center, "Optimal Sizing of Urban Flood Control Systems," Technical Paper No. 42, March 1974

1. Unconstrained Optimization. In this method, the system (an element or combination of elements) that produced the maximum net economic benefits was derived. Maximum net economic benefits are the benefits derived from the system; in this case, flood damage reduction minus the annualized cost to build the system.

2. Constrained Optimization. In this method, the alternative system was constrained to meet a specified performance level. In this case, the constraint was to reduce the Standard Project Flood and 100-year flood through Phoenix to 50,000 ft^3/s and, at the same time, to produce maximum net economic benefits.

Both methods were used in screening the alternative systems. It was determined from this screening that several of the elements were justified, either singly or in combination with other elements. The location of a site should be able either to interface with the CAP aqueduct system effectively or control the water to prevent flooding downstream.

Ideally, the most appropriate solution would solve problems of both regulatory storage and flood control. The determination of the desired amount and degree of water control is an important consideration in analyzing the alternatives. Generally, flood control studies are geared to protect against the Standard Project Flood (SPF). The Standard Project Flood is intended to represent a flood that would be exceeded in magnitude only on rare occasions, thus providing a standard for design of structures offering a high degree of protection. In most cases the SPF should equal or approximate the flood that would result if the most critical storm of record in the region would occur over the drainage area. The flood waters can be controlled to a prescribed "acceptable flow", such as 100,000 ft^3/s, or if enough reservoir space were provided, they could be eliminated entirely. The studies of CAP regulatory storage are also subject to a determination of the appropriate and desired amount of reservoir capacity. As the Central Arizona Water Control Study progresses, the issue of degree of control will be addressed and will rely significantly on public impact.

A. Description of Alternatives

The Study area was established after consideration of several factors relating to flood control and CAP regulatory storage. For easier understanding, this review will divide the alternatives into 4 sections: (1) Verde River; (2) Salt River above Granite Reef Dam; (3) Agua Fria River, New River, Skunk Creek and Cave Creek; and (4) Gila River, Santa Cruz River, and Santa Rosa Wash.

B. Verde River Alternatives

There were only four geotechnically feasible elements to be considered on the Verde River which would serve the main purpose of flood control. Possibilities may exist for additional water conservation through the use of water exchange between the CAP and the Salt River Project which would allow these structures to be used in a CAP regulatory role.

1. Tangle Creek

The Tangle Creek Dam site is located on the Verde River seven miles upstream from the present Horseshoe Reservoir. This dam would provide limited control over Verde River floodflows, but greater flood control could be obtained in a combination with other plans. A dam and reservoir at Tangle Creek could impact bald eagle and other wildlife habitats along the river. A sheep crossing bridge which is on the National Register of Historic Places could also be affected. Surface geological investigations utilizing aerial photographs and field geological mapping indicates the site contains potentially serious geotechnical problems Hot springs have been found which would underlie the proposed embankment. These springs flow along the contact or juncture between the granite and the volcanic bedrock in the area and could render the embankment unstable. At this time, no feasible method is known of effectively controlling the springs. In addition, foundation material underlying the proposed left abutment is relatively soft and potentially permeable under a sustained reservoir.

Recommendation: No further study is warranted because of geotechnical problems.

2. Modified Horseshoe Dam

Horseshoe Dam is located on the Verde River downstream of the Tangle Creek Dam site. Enlarging the existing structure could provide both flood control and water storage. This modification of Horseshoe Dam could adversely impact bald eagle habitat as well as archeological sites. Though further geological studies are required, preliminary investigations indicate foundation seepage problems which may render the site unsuitable.

Recommendation: A further feasibility study is warranted.

3. Cliff Dam

The Cliff Dam site is located on the Verde River, immediately upstream from Bartlett Reservoir. Bald eagle and other wildlife habitats could be affected. Further study is needed on the archeological, social, and historical impacts. Though further geological studies are required, preliminary investigations indicate this to be a feasible dam site.

Recommendation: A further feasibility study is warranted.

4. New Bartlett Dam

The existing Bartlett Dam cannot be easily modified, but a new and higher dam could be built immediately downstream. The larger reservoir created would be used primarily for flood control with some water storage possible. The bald eagle and other wildlife habitats could be disturbed. The archeological, historical, and social impacts have not been fully assessed. Preliminary geological investigations indicate this to be a feasible dam site.

Recommendation: A further feasibility study is warranted.

C. Salt River Above Granite Reef Dam Alternatives

Sites to be considered in this area are primarily suited for flood control, except at the confluence site where regulatory storage can also be provided. Possibilities may exist for additional water conservation at other sites through the use of water exchange between the CAP and the Salt River Project.

1. Carrizo Creek Dam

The Carrizo Creek Dam would be located on the Salt River below the confluence of the Black and White Rivers near Alkali Canyon and east of Roosevelt Lake. The purposes of this dam and reservoir would be to improve the quality of the Salt River water and allow for the diversion of water to Gila River to augment the natural inflow to the San Carlos Reservoir. Carrizo Creek Dam would be too far upstream to offer effective flood control for the Phoenix area, and it cannot be used for regulatory storage.

Recommendation: No further study is warranted because the site meets neither flood control nor regulatory storage needs.

2. Klondike Buttes Dam

Klondike Buttes Dam is located on the Salt River just above Roosevelt Lake and its primary feature would be flood control of the upper portion of the river. It is not suitable for CAP storage. A dam and reservoir at this site would vegetation along the stream and would encroach upon a proposed Wild and Scenic Rivers area. A dam at this site would not control Tonto Creek, a major tributory to Roosevelt Lake, thus leaving a large uncontrolled area downstream. Klondike Buttes Dam would have the capacity to store 550,000 acre-feet of water for flood control purposes and would cost approximately $90 million. In comparison, modification of Roosevelt Dam (see below) would provide storage of 558,000 acre-feet of water and would cost $23 million.

Recommendation: No further study is warranted because the site does not meet regulatory storage needs. Also, the cost of a dam at this site would be prohibitive.

3. Modified Roosevelt Dam

Roosevelt Dam could be enlarged primarily for flood control, though increased storage is possible. Estimates of 20 additional feet are the maximum without requiring major design changes. Some archeological sites would be adversely impacted, and Roosevelt Dam is on the National Register of Historic Places. This site has no identified geological problems.

Recommendations: A further feasibility study is warranted.

4. Coon Bluff Dam

The Coon Bluff Dam is located on the Salt River 1 mile upstream from its confluence with the Verde River. While the site has only been analyzed for regulatory storage, flood control could be an alternative use. Wildlife and bald eagle habitat could be adversely affected as would archeological and historical sites and flowing stream recreation. Serious geotechnical problems are present at this site. Abutments and foundation drilling indicate the foundation is comprised of weakly to non-cemented, sandy, and silty gravel grading to gravelly silt and sand toward the right abutment. This formation extends to depths of at least 356 feet. Material of these types are considered permeable. Blanketing of the foundation and reservoir area to reduce seepage volume and velocity is probably not practical because of the large reservoir area and local topography. If remedial measures were undertaken at this site, they would be extremely costly. It is, however, considered possible to design a dam that would seep at this

site degrading its value as a storage reservoir. The risk of failure of such a dam from piping, due to increased pressures caused by a reservoir coupled with the easily erodable foundation material may be significant.

Recommendation: No further study is warranted because of the geotechnical problems.

5. Confluence Site (Orme Dam)

This site is located at the confluence of the Salt and Verde Rivers and provides storage for the CAP in addition to flood control from both streams. The impact on wildlife and bald eagle habitats, flowing stream recreation, archeological and historical sites, as well as the flooding of significant portions of the Fort McDowell and Salt River Indian Reservations are major concerns. Smaller structures at this site will also be studied and some adverse impacts may be reduced. However, a loss in flood control and/or regulatory storage capacity would result. A small structure may be used in combination with other plans.

Recommendation: A further feasibility study is warranted.

6. Granite Reef Dam

The Granite Reef Dam would be constructed 4 miles downstream from the confluence of the Salt and Verde Rivers, providing a large amount of CAP storage capacity in addition to flood control. This earthen dam would require twice the length needed at the confluence site, and similar environmental and social impacts would result from its construction. Particularly, the wildlife habitats and flowing stream recreation opportunities would be affected. Portions of the surrounding Indian Reservations would be flooded.

Recommendation: A further feasibility study is warranted.

7. Rio Salado Low Dams

The Rio Salado Low Dams would consist of three earthen structures on the Salt River between Mesa and Phoenix and could provide minimal CAP storage. Site geology is alluvial fill which is considered permeable. Storage losses would be severe and would require reservoir lining. Surface regulatory storage does not appear to be feasible since these dams themselves may require upstream protection from flooding and silting. No archeological, environmental, or historical impacts have been identified.

Recommendation: No further study is warranted because of

geotechnical problems and because the site meets neither flood control nor regulatory storage needs.

D. Agua Fria, New River, Skunk Creek, and Cave Creek Alternatives

Sites in this area were primarily evaluated as regulatory storage sites. Hydrologic studies indicate that floodflows from the Agua Fria River contribute only a small portion of the total volume of floodwaters on the Gila River. Based on this information, it has been determined that the analysis of sites for primary purpose flood control is not warranted on the Agua Fria River. Advance planning and construction are currently under way to provide flood control on New River, Skunk Creek, and Cave Creek by way of the Corps of Engineers New River and Phoenix City Streams Project.

1. Lake Pleasant Storage

Lake Pleasant is located on the Agua Fria River behind Waddell Dam. It is an alternative which would require no dam enlargement but would use the available vacant space behind the existing dam for CAP water storage. This vacant space is available in years when the Agua Fria River runoff is low. A canal would be needed to connect Granite Reef Aqueduct with Waddell Dam. Waddell Dam was constructed in 1928 by the Maricopa County Municipal Water Conservation District No. 1. Since this dam is not a Water and Power Resources Service structure, it would have to be carefully analyzed to determine if it would meet criteria and standards for water storage.

Recommendation: A further feasibility study is warranted.

2. New Waddell Dam

The New Waddell Dam would be located on the Agua Fria River immediately downstream from the existing Waddell Dam which impounds Lake Pleasant. The primary purpose of this earthen dam and reservoir enlargement would be to provide additional space for CAP storage. The reservoir would be directly connected to the Granite Reef Aqueduct by means of a canal and pumping plant.

Geological investigations are currently underway to determine the most feasible dam and spillway locations and to determine if seepage from the reservoir is a problem.

Recommendation: A further feasibility study is warranted.

3. Agua Fria Dam

The Agua Fria Dam would be located about 5½ miles downstream of the existing Waddell Dam where the Granite Reef Aqueduct crosses the Agua Fria River. This site, considered primarily for CAP storage, would have a long narrow basin limiting storage capacity. Environmental impacts are expected to be minimal, but several archeological sites would be affected. Examination of the Agua Fria site geology indicates an unconfined reservoir basin. The foundation, left abutment and reservoir areas are all sited on alluvial materials. Depth of alluvium exceeds 400 feet. This data correlated with geologic data recently developed for CAP's Agua Fria River Siphon indicates the high probability of severe seepage losses from the reservoir area to the New River drainage. These losses are likely since no bedrock separation between the two channels has been found. Extensive foundation treatment would be necessary to reduce the underflow to a rate which would preserve the integrity of the structure. To reduce the loss of imported CAP water to the adjoining basin, the reservoir area would have to be sealed or lined. It appears lining material in the quantities required are not available; so the cost of remedial measures at this site could be prohibitive. Without remedial measures at this site, yields are expected to be extremely poor.

Recommendation: No further study is warranted because of geotechnical problems.

4. Calderwood Butte

The Calderwood Butte Dam would be a mile-long earthen dam located about 3 miles downstream from the Granite Reef Aqueduct on the Agua Fria River. This site would be primarily used for CAP storage. Pumping would be necessary to return reservoir water to the aqueduct. No serious environmental impacts have been identified, although several archeological sites would be impacted. A field review of the site indicate similar surface geology as that of the Agua Fria site 4 miles upstream. That is largely unconfined alluvium. The depth to bedrock is unknown at the dam axis, but surrounding geologic formations, when correlated with the geologic information at the upstream site, indicate that bedrock could be too deep to allow a suitable foundation design. The reservoir area would have to be lined or sealed to reduce seepage losses of the type encountered at the Agua Fria site. Without significant remedial measures at this site, yields are expected to be extremely poor. No significant flood control for the CAWCS area would be provided.

Recommendation: No further study is warranted because of geotechnical problems.

5. North Phoenix Flood Control Dams (for CAP)

The Corps of Engineers is currently constructing three dams: Cave Buttes Dam on Cave Creek; New River Dam on New River; and Adobe Dam on Skunk Creek. These dams will protect much of Phoenix from floods on those streams, but they will not protect from flooding on the Salt and Gila Rivers. Neither will they provide water storage. Enlarging these dams to store CAP water has been suggested, but the topographical conditions at these sites would preclude the larger reservoir.

If converted to regulatory storage, these dams would lose their flood control effectiveness. Conversion of the dams could also impact archeological sites.

Recommendation: No further study is warranted because of conflicting requirements between regulatory storage and flood control.

E. Gila River, Santa Cruz River, and Santa Rosa Wash Alternatives

The alternative elements in this area have received limited attention as possibilities for CAP storage. They have no potential for flood control in the Phoenix area. As a result of suggestions received from the public, these alternatives, except for Coolidge, will receive an initial level of study.

1. Coolidge Dam

Coolidge Dam is located on the Gila River within the San Carlos Indian Reservation about 60 miles east of the town of Florence. Historically, San Carlos Reservoir behind Coolidge Dam has rarely filled, and therefore extra storage space has been available. However, to use this space for CAP regulatory storage would require a 60 mile pipeline and a series of pumping plants to connect the reservoir with the Salt-Gila Aqueduct. Construction of such a pipeline would be difficult and the costs would be prohibitive. Some water exchanges may be possible and are being studied in connection with the operation of Buttes Reservoir.

Recommendation: No further study is warranted because this site meets neither flood control nor regulatory storage needs.

2. Florence Dam

The Florence Dam is located on the Gila River about 4 miles below Ashurst-Hayden Diversion Dam and 6 miles east of the town of Florence. If Florence Dam were constructed, the Ashurst-Hayden structure would be inundated, thus backing water up to the proposed Buttes Dam. CAP water would have to be pumped from the Salt-Gila Aqueduct

to the reservoir for the regulatory storage. As presently envisioned, a dam and reservoir at the Florence site would provide no downstream flood control on the Gila River. Environmental impacts along the river may be limited since the site is partly located on a dry wash. Four prehistoric sites would be affected. The geology of the area is a problem and seepage losses from the storage pool could occur. Additional geological analysis is needed.

Recommendation: More initial study is warranted.

3. Buttes Dam

Buttes Dam and Reservoir is an authorized CAP feature located 7 miles upstream from the Florence Dam site. A canal would be required to connect the Salt-Gila Aqueduct with Buttes Reservoir for CAP regulatory storage. Impacts on mineral resources and on wildlife habitat along the river could result.

Recommendation: More initial study is warranted.

4. Tat Momolikot

Tat Momolikot Dam is an existing structure located on Santa Rosa Wash on the Papago Indian Reservation. Constructing a 30-mile feeder canal from the Salt-Gila Aqueduct to Tat Momolikot could provide CAP water storage. However, seepage of water out of the reservoir basin is a major concern. If converted to regulatory storage, this dam would lose its flood control effectiveness. Environmental impacts are expected to be minimal since the Santa Rosa Wash is dry.

Recommendation: More initial study is warranted.

5. Painted Rock Dam

Painted Rock Dam and Reservoir are located on the Gila River near the town of Gila Bend. It has been proposed that flood waters stored there be put to beneficial uses in other parts of Arizona. Unfortunately Painted Rock Reservoir's downstream location creates a problem in delivering that water to the major agricultural and metropolitan areas.

Recommendation: No further study is warranted because the site meets neither flood control nor regulatory storage needs in the Phoenix metropolitan area.

F. Channels

Several channel configurations were analyzed for flood control purposes. They included rectangular concrete, trapezoidal concrete, and soft-bottom with revetted side-slopes. The preliminary costs per mile in million dollar (in 1978 dollars) increments for the three channel configurations are as follows:

Design Q.	Rectangular Concrete	Trapezoidal Concrete	Earth Soft-bottom
20,000 ft^3/s	.3	3.5	2.6
50,000 ft^3/s	6.6	5.5	3.3
150,000 ft^3/s	14.3	11.5	6.9
250,000 ft^3/s	21.0	17.4	10.4

Of the three, the soft-bottom type appears to be the most cost effective for flood control. An economic benefit/cost analysis was performed for channels between Granite Reef Diversion Dam and Gillespie Dam. These studies indicate that a continuous system of channels is not justified. Of the three sections studied, those between Granite Reef Diversion Dam and Country Club Drive and between 35th Avenue and Gillespie Dam do not incur enough flood damages to justify annual costs. The economic analysis for these two sections is as follows:

SECTION	DESIGN Q (ft^3/s)	LENGTH (miles)	AVERAGE ANNUAL DAMAGES	CONSTRUCTION COST (million)	ANNUAL COST (million)
Granite Reef Diversion Dam to Country Club Drive	50,000	11.6	$ 212,000.	$38.3	$ 2.6
35th Avenue and Gillespie Dam	50,000	46	$1,500,000.	$152.	$10.5

Recommendations:

1. Granite Reef Diversion to Country Club Drive: No further study is warranted because of poor economic justification. The benefit/cost ratio for flood control is estimated at 0.08.

2. Country Club Drive to 35th Avenue: A further feasibility study is warranted.

3. 35th Avenue to Gillespie Dam: No further study is warranted because of poor economic justification. The benefit/cost ratio is estimated at .14.

G. Levees

A continuous system of flood control levees which would create a floodway has been analyzed. This alternative would not provide CAP water storage. Controlled water releases from upstream reservoirs may require some easements on lands which would be flooded. Levees should be considered in combination with reservoirs to reduce easement requirements.

Levees can be constructed with or without a supplementary concrete or soft-bottom low-flow channel. They are constructed to accommodate either the Standard Project Flood or a 100,000 ft^3/s flow. The preliminary costs per mile in million dollar increments are as follows:

	Without Low-flow	Concrete Low-flow	Soft-bottom Low-flow
Standard Project Flood	5.1	7.8	6.2
100,000 ft^3/s	5.0	7.6	6.1

Levees along the Salt-Gila Rivers do not appear to be economically justified as a total solution to the flood problem. Specifically, the sections between Granite Reef Diversion Dam and Country Club Drive and 35th Avenue to the Salt-Gila River confluence do not incur enough flood damage to justify the annual costs associated with construction of levees. The economic analysis for levees in these two reaches appears below. Because they are most cost effective, calculations for levees without low flow channels were used in this economic analysis.

SECTION	DESIGN Q (ft^3/s)	LENGTH (miles)	AVERAGE ANNUAL DAMAGE	CONSTRUCTION COST (million)	ANNUAL COST (million)
Granite Reef Diversion Dam to Country Club Drive	290,000	11.6	$148,000.	$59.2	$4.1
35th Avenue to Salt-Gila River Confluence	290,000	10.7	$313,000.	$54.	$3.6

Recommendations:

1. Granite Reef Diversion Dam to County Club Drive: No further study is warranted because of poor economic justification. The benefit/cost ratio is estimated at 0.04.

2. Country Club Drive to 35th Avenue: A further feasibility study for two-sided levees is warranted.

3. 35th Avenue to Salt-Gila River Confluence: No further study is warranted because of poor economic justification. The benefit/cost ratio is estimated at 0.09.

4. Salt-Gila River Confluence to Gillespie Dam: A further feasibility study is warranted for a single-sided levee along the north side of the river.

H. Channel Clearing

The overgrowth of salt-cedar and other such desert shrubs has obstructed the Gila River channel in many areas. Clearing a swath through this growth has been suggested as a means to allow flood flows a path to follow. Several methods, including chaining and controlled burning, could be used to accomplish the clearing. The Maricopa County Flood Control District is presently investigating a plan to provide a 1,000-foot wide clearing on the Gila River. Furthermore, the Corps of Engineers has an authorized flood control project (1957 Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona) which includes clearing the riverbed to create a 2,000-foot floodway from Gillespie Dam to Granite Reef Dam.

Recommendation: A further feasibility study is warranted.

I. Water Exchanges

Water exchanges for CAP regulation are possible only with systems in Central Arizona having surface-water sources and storage reservoirs.

Only three systems of this kind exist: The Salt River Project on the Salt and Verde Rivers, the San Carlos Project on the Gila River, the Maricopa County Municipal Water Conservation District No. 1. on the Agua Fria River (Lake Pleasant).

Exchanges could be accomplished as follows:

1. Vacant storage space is available in a reservoir at the same time that CAP needs the storage.

2. The exchanging organization would agree to trade its water for an equal amount of CAP water.

3. The exchanging organization would later trade the exchange water in partial satisfaction of its CAP allotment or deliver on demand the exchanged water to the aqueduct system.

Recommendation: A further feasibility study is warranted.

J. Salt River Project Operation for Flood Control

The existing reservoir system on the Salt River would be operated so as to gain optimal flood control. The concept may include any or all of the following:

1. Sophisticated runoff forecasting capability.

2. Improved monitoring of watershed conditions.

3. Designated flood control space which would vary according to season and watershed conditions.

4. Additional water outlets to the existing system.

Use of this concept would decrease downstream releases of water from the system, lessen flood damages, and increase utilization of the Salt River floodplain. Impacts on flood control, water conservation, hydropower generation, recreation, and fish and wildlife habitat must be evaluated.

Recommendation: A further feasibility study is warranted.

K. Floodplain Management Measures

The alternatives for flood control may include any or all of the following:

1. Floodproofing - alteration of existing and future development by such means as floodwalls, small levees, temporary closures on openings, raising structures, and removal of structures and/or their contents.

2. Floodplain acquisition - purchase and removal of existing structures from the floodplain.

3. Floodplain regulation - use of regulations to lessen flood damage.

4. Flood warning techniques - use of advance warning of impending flooding to remove people and damageable property.

5. Bridge construction - construction of bridges of sufficient capacity to pass floodflows to reduce traffic delay costs experienced during floods. NOTE: Since such a large portion of recent flood damages were transportation-related, an extra effort will be made to evaluate both nonstructural and traditional structural methods of protection against damages incurred as a result of traffic delays.

These measures do not pertain to the regulatory storage question and will not completely solve flood problems, but might be justified in combination with other alternatives.

Recommendation: A further feasibility study is warranted.

L. Ground-water Recharge

Ground-water recharge has been suggested as an alternative associated with both flood control and CAP regulatory storage. The concept, used in connection with upstream control, would call for controlled infiltration of water into the ground to raise the water table and store surplus water for later use. In order for this concept to be used for flood control, water must be taken out of an above-ground reservoir during the winter season and placed underground. This underground water storage could be used in exchange for space behind existing dams during the times of flooding. Pumping would be required to recover the ground water when it is needed. For CAP purposes, proposals have been made that surplus Colorado River water be stored underground for recovery at a later time. This concept differs from the seasonal storage idea envisioned from regulatory storage, but it may be valuable for longer term storage.

The type of information needed to analyze ground-water recharge and recovery in Arizona is quite limited. Also conflicts of water ownership could arise unless provisions are made for such a scheme under Arizona's ground-water laws.

M. No Action Alternative

A "No Action Alternative" is an element where none of the proposed elements in the CAWCS area are implemented. The "No Action Alternative" will assume operation of the CAP Aqueduct and Buttes Dam and Reservoir without additional regulatory storage and federal flood protection. Future development of the Salt River floodplain also would be limited under the "No Action Alternative" in accordance with Federal Insurance Administration regulations.

The purpose and status of each alternative discussed is displayed on the following table.

TABLE 11
SPECIFIC STUDY FEATURES

Element	Purpose		Further Study		
	Flood Reduction	CAP Regulatory Storage	Warranted		Unwarranted
			Initial	Feasibility	
VERDE RIVER					
Tangle Creek	●	●			●
Modified Horseshoe	●	●		●	
Cliff Site	●	●		●	
New Bartlett	●	●		●	
SALT RIVER					
Carrizo Creek	●				●
Klondike Buttes	●				●
Modified Roosevelt	●	●		●	
Coon Bluff		●			●
Confluence	●	●		●	
Granite Reef	●	●		●	
Rio Salado Low Dams		●			●
AGUA FRIA RIVER AND TRIBUTARIES					
Lake Pleasant		●		●	
New Waddell		●		●	
Agua Fria Siphon		●			●
Calderwood Butte		●			●
North Phoenix Flood Control Dams (for CAP)		●			●
GILA RIVER AND SANTA ROSA WASH					
Coolidge		●			●
Florence		●	●		
Buttes		●	●		
Tat Momolikot		●	●		
Painted Rock Reservoir		●			●
CHANNELS					
Granite Reef Diversion to Country Club Road	●				●
Country Club Road to 35th Avenue	●			●	
35th Avenue to Gillespie Dam	●				●
LEVEES					
Granite Reef Diversion to Country Club Road	●				●
Country Club Road to 35th Avenue	●			●	
35th Avenue to Salt-Gila Confluence	●				●
Salt-Gila Confluence to Gillespie Dam	●			●	
CHANNEL CLEARING	●			●	
WATER EXCHANGE		●		●	
SALT RIVER PROJECT OPERATION AND FLOOD CONTROL	●			●	
FLOODPLAIN MANAGEMENT	●			●	
GROUNDWATER RECHARGE	●	●		●	
NO ACTION				●	

PLAN OF STUDY

III. PLAN OF STUDY

The Stage I Study Results section just concluded described observations made and work accomplished prior to publication of this report. From this point forward, a Plan of Study will be presented which is designed to resolve the stated problems and needs, taking into account previous studies, current plans, desires expressed by the public, and preliminary assessments of the most feasible alternatives.

Planning Objectives

The Water and Power Resources Service assisted by the Corps of Engineers (the Agencies) are guided by Principles and Standards for Planning Water and Related Land Resources, prepared in 1973 by the Water Resources Council under authority of the 1965 Water Resources Planning Act. These guidelines require that federal and federally-assisted water and related land planning have "National Economic Development" and "Environmental Quality" as equal national objectives.

To meet this requirement, therefore, plan formulation will be directed toward meeting current and projected needs and solving problems identified by the public in such a manner that progress can be made toward achieving society's preferences for national economic development and environmental quality. Also, a system of public information accounts will be established that displays beneficial and adverse effects on regional development and social well-being and provides a basis for comparing alternative plans.

The Principles and Standards as applied to the CAWCS require that all monetary, environmental, and other costs and benefits of the alternatives will be considered. Planning objectives specific to the CAWCS will be consistent with national objectives so that each alternative can be measured against the same standards.

Initially, 12 planning objectives have been adopted subject to review and modification through the public involvement process. It should be noted that the authority for the CAWCS is derived from Public Law 90-537, which authorizes construction of Orme Dam and Reservoir or a suitable alternative. Therefore, plans developed during this Study should provide for the purposes of CAP water storage and flood control to the maximum extent feasible.

Study Objectives:

A. Increase efficiency of the Central Arizona Project by providing regulatory storage capacity in central Arizona.

B. Decrease flood damages along the Salt and Gila Rivers between Granite Reef Dam and Painted Rock Dam.

C. Increase conservation of waters emanating from the Salt, Verde, Agua Fria, and Gila watersheds.

D. Maximize energy efficiency as it relates to water resources, especially in regard to ground-water and CAP pumping requirements.

E. Develop and illustrate opportunities for hydroelectric power production associated with structural and nonstructural alternatives.

F. Take advantage of opportunities to protect and/or improve the quality of certain natural or cultural resources or ecological systems.

G. Take advantage of opportunities to enhance the social well-being of Indian Communities.

H. Develop plans for recreational facilities in urban areas (such as those proposed in the Rio Salado concept) as well as in rural/natural areas to provide opportunities for recreational enhancement at both upstream and downstream locations in the CAWCS area.

I. Improve water resource management by encouraging implementation of conservation measures such as advanced irrigation techniques and reduced household water consumption.

J. Take advantage of opportunities to improve the management and protection of open space and to increase its extent by maintaining existing wildlife areas and studying the potential for development of greenbelt floodways and multipurpose projects such as the Rio Salado concept.

K. Improve management and preservation of unique archeological and historical resources in the CAWCS area.

L. Conserve and enhance fish and wildlife resources by taking such measures as creating minimum pools for bass fisheries and developing cottonwood seeding programs.

The Planning Process

In order to conduct the CAWCS efficiently, a three-stage process has been established by the Agencies.

STAGE I PLAN OF STUDY. STAGE I efforts include identification of problems and needs in the CAWCS area, establishment of broad planning objectives,

delineation of public concerns, and formulation of a management program for conduct of the CAWCS. A wide array of plans is developed. Following a preliminary assessment, decisions are made and unsuitable alternatives are eliminated from further study. A PLAN OF STUDY, is published at the conclusion of STAGE I, it contains alternatives warranting more detailed evaluation and it describes the Plan of Study to be followed, including estimated cost and schedule.

STAGE II DEVELOPMENT OF INTERMEDIATE PLANS includes detailed assessments of geology, foundations, hydrology, hydraulics, costs, structural designs, and institutional analyses. More detailed environmental assessments and social and economic studies are also conducted. Non-viable plans are eliminated in STAGE II and a limited number of plans are recommended for further detailed study in STAGE III. STAGE II concludes with a thorough review of findings by the Agency staffs and the general public.

STAGE III DEVELOPMENT OF DETAILED PLANS includes modification of plans and designs based on economic, engineering, environmental, and social concerns disclosed during STAGE II review. Emphasis is placed on a more thorough evaluation of proposed plans and upon implementation arrangements. Near the end of STAGE III, draft planning reports and environmental statements are published and circulated for review and comment. Finally, the Regional Director of the Water and Power Resources Service recommends a plan for adoption. Final planning reports and environmental statements are then submitted to the appropriate authorities for implementation.

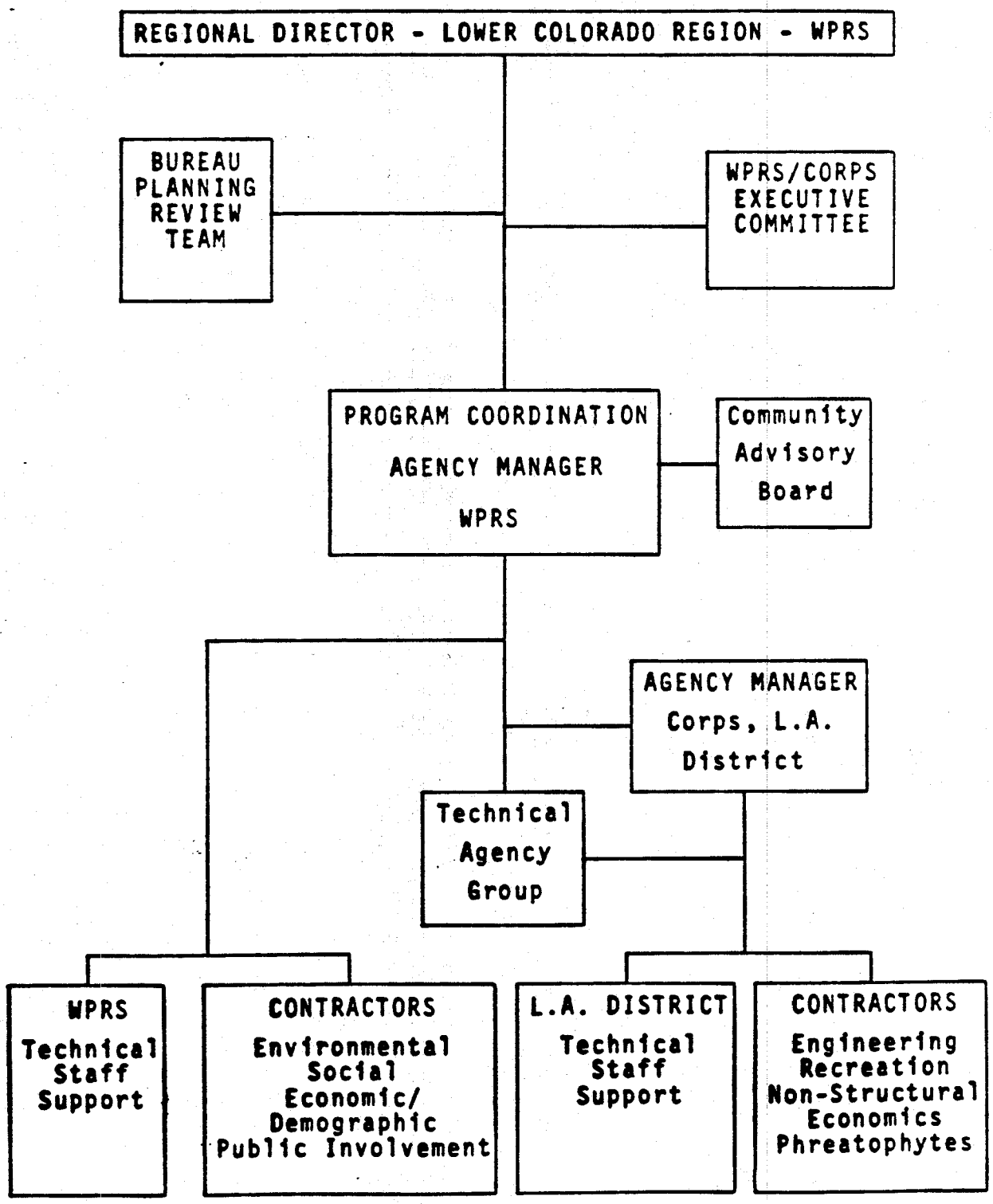
Numerous public laws (P.L.) and federal regulations guide the Water and Power Resources Service and the Corps of Engineers in project planning. The Agencies will conduct their Study activities in accordance with all applicable laws, regulations, and criteria.

Study Management

The CAWCS will be accomplished by personnel of the Water and Power Resources Service's Arizona Projects Office with assistance from the Corps of Engineers Los Angeles District Office, contractors, a Technical Agency Group (see Public Involvement section for membership listing), and other Agency staffs such as the WPRS Engineering and Research Center and the Corps Hydrologic Engineering Center. Information developed by the CAWCS will be presented to the WPRS Regional Director and the Corps District Engineer for review. The Community Advisory Board will also comment. In the final analysis, however, the Regional Director of the Water and Power Resources Service is accountable to the Executive Branch and Congress for funds made available to the CAWCS. Figure 4 shows these relationships schematically.

FIGURE 4

STUDY ORGANIZATION CHART



The CAWCS involves several levels of management, both internal and external to the two Agencies involved. The Water and Power Resources Service maintains primary responsibility for policy, technical studies, and designs for water conservation components or structures. The Corps of Engineers responsibilities encompass these same factors in relation to flood control measures. Coordination between the Agencies will occur at the local level to assure continuity and adherence to the program schedule.

An Agency Program Manager has been designated by each Agency to control internal processes and effect coordination between local offices.

Responsibilities of the WPRS Program Manager with assistance from the Corps Program Manager are:

A. Prepare work schedules and task assignments; identify deadlines, funding requirements, and personnel needs; and monitor costs.

B. Conduct public involvement program.

C. Solicit assistance and cooperation from other agencies.

D. Coordinate Agency activities to assure adherence to established schedules.

E. Identify appropriate tasks for outside contractors and insure that work performed under contract is satisfactory.

F. Prepare progress reports for the WPRS, Technical Agency Group, and Community Advisory Board.

The Lower Colorado Region, Water and Power Resources Service and the Los Angeles District, Corps of Engineers will provide policy guidance for conduct of the CAWCS consistent with the Memorandum of Understanding.

In addition to coordination between the Agencies, technical coordination will be required with many other federal, state, and local organizations. A Technical Agency Group (TAG) has been formed for interagency cooperation and coordination. The function and membership of the TAG are discussed under Public Involvement.

Contractors will be retained by either Agency as required. The Contract Officer for each contract will be designated by the originating Agency; contract scopes will be structured to serve the needs of both Agencies where feasible. For example, the WPRS will award a contract for environmental assessments required by both Agencies, and the Corps will award a recreation planning contract to meet the needs of both Agencies.

Study Scope

The CAWCS will follow a three-stage planning process as previously described. The first stage, PLAN OF STUDY, is concluded with the publicatior of this report. The remainder of the CAWCS consists of STAGE 2 DEVELOPMENT OF INTERMEDIATE PLANS and STAGE 3 DEVELOPMENT OF DETAILED PLANS. The following section briefly describes the various engineering, environmental, socio-economic, and institutional analyses to be undertaken during Stages 2 and 3.

A. Technical Studies - Water and Power Resources Service

1. Hydrologic and Hydraulic Studies

Required Tasks:

a. Determine flood runoff characteristics.

b. Determine peak discharge and sediment production.

c. Determine inflow design flood.

d. Review and evaluate existing data.

e. Develop hydraulic design data.

2. Survey and Mapping

Required Tasks:

a. Set control for topographic mapping.

b. Develop topographic maps for all damsites.

3. Geotechnical Investigation

Required Tasks:

a. Review and evaluate existing data.

b. Location and evaluation of embankment materials.

c. Exploratory boring to determine foundation suitability.

d. Geologic mapping.

e. Seepage evaluation.

4. Economic Studies

Required Tasks:

a. Develop benefit/cost ratio for alternative plans.

b. Update benefit values to current levels.

c. Assist in arraying National Economic Development alternative.

5. Contract Studies

Required Tasks:

a. Environmental Studies.

The WPRS has awarded a contract to Dames and Moore, Inc., to perform a wide variety of environmental studies. Dames and Moore has separated the work into the following catagories:

(1) Biology

(2) Geology/Soils

(3) Water Resources

(4) Air Quality

(5) Acoustics

(6) Archeology

(7) Historical Resources

(8) Land Use

(9) Recreation

(10) Visual Quality

(11) Regional Seismicity

Tasks to be performed include several iterations of gathering baseline information, determining impacts of a proposed alternative analyzing the effect of that impact, and suggesting ways to eliminate or mitigate the effects. Dames and Moore will aid the Agencies in planning for the Environmental Quality objective and preparing the Environmental Quality accounts.

b. Social Studies.

Dames and Moore, through a subcontract with Abt Associates Inc., will perform a variety of studies dealing with social factors and social impacts and effects of proposed alternatives. They will aid the Agencies in the preparation of the Social Well-Being accounts.

c. Economic/demographic studies.

Abt Associates Inc., through a subcontract with Dames and Moore, will evaluate the direct and indirect impacts of alternativ plan development. These impacts may be seen in changes in population distribution or employment and income characteristics.

d. Design and aid in conduct of public involvement program.

Dames and Moore will assist the WPRS in conducting the public involvement program. Included in the work plan is:

(1) Opening a public information office and establishing a CAWCS phone number (Address: CAWCS, Suite 666, Security Center, 234 North Central Avenue, Phoenix, Arizona, 85004. Phone: (602) 271-0915).

(2) Monthly newsletters.

(3) Establish Indian community liaison.

(4) Plan and conduct public meetings and workshops.

(5) Coordinate with the activities of the Community Advisory Board.

6. Design and Estimates

Required Tasks:

a. Develop design data package.

b. Preliminary design of features.

c. Preliminary cost of features.

d. Feasibility design of features.

e. Feasibility cost of features.

7. Operation Studies

Required Tasks:

a. CAP operation studies.

b. Water exchange studies.

c. Hydroelectric power generation potential studies.

d. Water conservation studies.

B. Technical Studies - Corps of Engineers

1. Hydrologic Studies

Required Tasks:

a. Review and evaluation of previous hydrology studies on the Salt and Gila Rivers and documentation.

b. Determine meteorological and flood runoff characteristic for the Salt River, the Gila River from its confluence with the Salt River to Painted Rock Dam, and major tributaries to the Salt and Gila Rivers in the CAWCS area.

c. Determine peak discharge, volume frequencies, and estimate of sediment at damsites.

d. Determine Standard Project Flood (SPF) and probable maximum floods at damsites and downstream areas.

e. Determine flood routings under existing conditions and under various alternatives; determine residual flows with various alternatives.

f. Determine water conservation yields for various dam alternatives on the Verde River.

g. Coordination with the Water and Power Resources Service and other agencies.

2. Hydraulic Studies

Required Tasks:

a. Analysis of existing channel capacities.

b. Delineation of overflow areas.

3. Engineering Design and Cost Studies

Required Tasks:

a. Structural design of flood control features, including dams, channels, levees, and greenbelts.

b. Determine quantity and cost estimates for all flood control features.

c. Engineering design and cost studies for nonstructural alternatives.

d. Delineate required rights-of-way.

e. Determine costs of rights-of-way, easements, severence, and damages.

NOTE: Engineering design and cost studies will determine separate costs for all flood control features.

4. Surveying and Mapping

Required Tasks:

a. Limited surveys to obtain overflow data.

b. Limited surveys for reservoir design.

5. Geotechnical Investigation

Required Tasks:

a. Provide personnel to oversee and coordinate foundation and materials investigation with the Water and Power Resources Service for damsites under study on the Verde River.

b. Perform geophysical explorations (refractive) of the Verde damsites.

c. Perform foundation and materials investigations for channels, levees, and greenbelts.

d. Design of dam embankment sections and levee sections.

e. Geologic mapping (New Bartlett site).

f. Preliminary exploratory boring to determine foundation suitability (New Bartlett site).

6. Economic Studies of Flood Control Alternatives

Required Tasks:

a. Determine existing and proposed land uses.

b. Evaluate existing and projected values of lands subject to flooding.

c. Determine expected damages from future floods over life of the Project.

d. Assist in identification of the National Economic Development Plan from alternatives.

e. Compute annual charges from first costs and future costs for alternative plans.

f. Estimate annual benefits accruing to alternative plans. (Anticipated benefits include flood damage reduction, savings in cost of fill, location benefits, employment benefits, recreation benefits, and water conservation benefits.)

g. Compute benefit/cost ratios for alternative plans.

h. Manage socioeconomic portion of WPRS contract.

7. Recreation Studies

Required Tasks:

a. Evaluate characteristics of recreation market areas, including present population and population trends.

b. Determine present and probable future recreational use in the CAWCS area.

c. Develop an extensive coordination effort with all governmental agencies and interested private groups which are involved in recreation planning.

d. Preliminary design of recreational facilities for those feasible alternatives that can accommodate recreational development.

e. Determine recreation costs and benefits.
NOTE: The Economic Studies Section, Los Angeles District, Corps of Engineers will be responsible for developing recreation benefits for the CAWCS.

f. Select recreation plans that are consistent with current policy, economically feasible, and desired by local interests.

8. Environmental Studies

Required Tasks:

a. Manage WPRS environmental contract.

b. Coordination with WPRS.

9. Nonstructural Analysis

Required Tasks:

a. Evaluate floodplain regulations.

b. Evaluate floodproofing of existing and future structures in the floodplain.

c. Evaluate relocation of structures out of the floodplain.

d. Evaluate current flood insurance programs.

e. Evaluate existing floodwarning systems and possible improvements to these systems.

f. Evaluate modifying existing bridges to handle larger flows or building new bridges.

g. Evaluate flexible operating criteria for the existing reservoir system or for new reservoirs.

h. Evaluate combinations of structural and non-structural measures.

10. Phreatophytic Growth Assessment on Salt and Gila Rivers

Required Tasks:

a. Document the invasion of the phreatophytes into the CAWCS area.

b. Describe methods of control and clearing of phreatophyte

c. Document the effects phreatophytes have on the rivers' geomorphology.

d. Develop future scenarios of how the phreatophytes will affect or be affected by the No Action Alternative.

C. Study Management Program - Water and Power Resources Service Assisted by Corps of Engineers

Required Tasks:

Project Management - The management of all CAWCS activities includes scheduling, budgeting, work assignments, coordination, and review so that manpower, money, and time are used in an efficient manner. Reporting on the CAWCS progress and briefing of higher authority are a part of this responsibility.

Coordination and Public Involvement - This includes coordinating CAWCS activity with other interested citizens, groups, and agencies. Preparation for and follow-up on public meetings, workshop meetings, and CAWCS presentations to interested groups is a part of this task.

Impact Evaluation - This will require evaluating all significant economic, social, environmental, and institutional changes associated with each alternative plan. It includes evaluating the National Economic Development and Environmental Quality alternatives for each site.

Preparation of Reports - This includes the preparation of texts, tables, plates, graphics, typing, and reproduction of CAWCS documents, such as this PLAN OF STUDY, Stage II documentation, draft planning report, draft environmental statement, planning report, and final environmental statement.

D. Assistance From Other Agencies

In addition to providing consultation and advice, the following two agencies will be asked to provide specific work:

1. Salt River Project

Evaluate hydroelectric power generation potential of each reservoir site.

2. U.S. Fish and Wildlife Service

Review environmental impacts of all plans and recommend appropriate loss prevention, compensation, mitigation, and enhancement measures, and if necessary, provide consultation as required by Section VII of the Endangered Species Act.

E. Unresolved Issues

As technical issues arise during the CAWCS for which the WPRS and Corps have differing criteria, resolution will be at the lowest possible level. For example, the following unresolved issues are discussed below:

Spillway Design. Inflow design floods computed by the WPRS and Corps may vary significantly. The Corps goes through a planning process to derive structural alternatives which eventually may be constructe by the WPRS. A tentative solution is that the Corps design spillways for Verde River dams while the WPRS design Orme, Granite Reef, Roosevelt, and New Waddell Dams.

Discount Rate. The CAP and the Corps Salt River Channel improvements are authorized at a discount rate of 3¼ percent, whereas the current rate for plan formulation is 6 7/8 percent. The CAWCS addresses alternative to both authorized projects, although no decision has been made as to whether the authorized or current rates should be used to evaluate alternatives. It is tentatively planned to display annual costs based on both discount rates.

Authority to Construct. Authorization for the CAP includes Orme Dam or a suitable alternative. The outcome of this Study may propose a plan with features not authorized by the CAP authorizing legislation (P.L. 90-537), such as a dam upstream on the Verde River and channelization of the Salt River. Which Agency would seek funds and authority to implement such a plan remains unclear.

Public Involvement

Public involvement is a term which has many definitions. It is appropriate at this stage in the CAWCS to delineate public involvement objectives and investigate options to implement these objectives.

The major objective of the public involvement program is to provide timely information to the public so that individuals may participate in the planning process. This objective requires that information be generated through the public involvement program in such a manner that the planning process can be responsive to public needs and preferences.

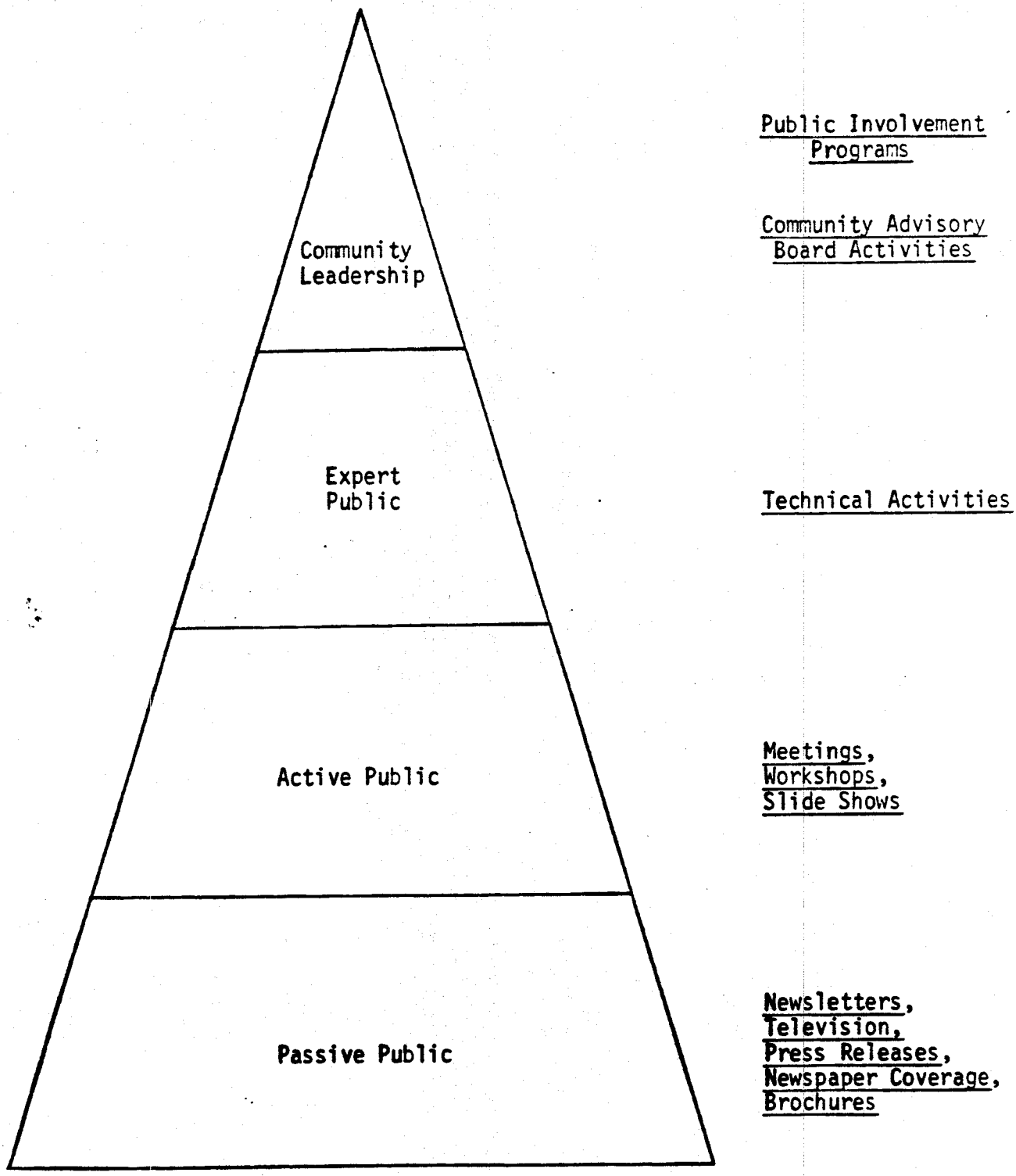
Due to the previous controversy regarding Orme Dam and recent flood problems, a greater level of public interest exists in this Study than in a typical planning study. The public divides itself naturally into four levels of interest according to the way a project is perceived. Certain sectors of the public will be satisfied with an information-educational program. On the lowest interest level people have a "need to know" attitude but feel in many cases that the project will have little effect on them personally. On the next interest level, individuals have definite opinions, especially on issues which directly affect their lives, but they may not have the time or technical expertise to make a contribution to the planning process. Beyond this level is a group of about 100-150 individuals who are professional representatives of Federal, state, and local government agencies whose job responsibilities cover subject areas potentially affected by this Study. This group also includes those with a direct stake in the outcome of the CAWCS, such as water users groups, environmental organizations, recreation clubs, Indian tribes, and landowners. Finally, at the highest interest level are the community leaders. These individuals have a special role in a public involvement program because they are able to focus and articulate needs and concerns of their constituencies. These public involvement levels are shown schematically in Figure 5.

The public involvement program should satisfy information needs at all four levels of public interest. It also should facilitate the involvement of individuals in the CAWCS process.

The lowest interest level or passive public should be approached with information program techniques, including a regular newsletter, brochures, newspaper articles, and television coverage. Since these individuals provide little direct feedback to the CAWCS, the effort expended on these activities should be limited. On the other hand, it is important to remember that media coverage is the only means available to reach some sectors of the public.

FIGURE 5

LEVELS OF PUBLIC INTEREST IN PLAN FORMULATION



The more active public desires involvement in the process and has opinions it wants heard. Interaction techniques, such as organized public meetings and workshops, are effective. Meetings should be timed to coincide with critical decisions and not held too frequently. The following schedule of meetings and workshops has been established:

1. Introductory meetings were held in January 1979 to explain Study (now CAWCS) objectives and encourage participation in the Study process.

2. A series of workshops beginning in November 1979 to focus on problems and needs of the Study area and to review preliminary alternatives and solicit public comment.

3. A public meeting and workshop session near the end of Stage II to focus on intermediate alternative plans and solicit public comment.

4. A public meeting and series of workshops near the middle of Stage III to discuss the preferred plan and to explain the rationale leading to its recommendation.

5. A public meeting following release of the draft environmental statement to explain that document and answer questions.

In addition to meetings and workshops, slide shows will be made available for presentation to interested organizations.

The expert public can provide a great deal of technical information to the Agencies. Governmental bodies and water users groups can produce technical studies useful to the Agencies in areas where they lack expertise or are required by law to coordinate with certain agencies.

The expert public will be organized as the Technical Agency Group (TAG), which will meet periodically during the Study and will interact with the Agencies on a continuous basis. Specifically, the TAG will:

1. Assist in the collection of existing information and develop new data.

2. Review and analyze information.

3. Assist in plan formulation.

4. Participate in public workshops and meetings.

Membership in the TAG will be adjusted by the Agencies during the CAWCS. The TAG may be organized into disciplinary subgroups such as fish and wildlife, recreational and cultural resources, water resources and uses, flood control, and power and engineering. Subgroups could be standing committees or ad hoc, in which case they would organize to perform certain tasks. In general, subgroups would provide data to the TAG as a whole for consideration.

The following agencies have been requested to participate in the Technical Agency Group:

Federal Agencies

Advisory Council on Historic Preservation
Chief, Review and Compliance: Louis S. Wall, Denver, Colorado

Army Corps of Engineers, Los Angeles
District Engineer: Colonel Gwynn A. Teague, Los Angeles, California
Will Worthington, Phoenix, Arizona

Bureau of Indian Affairs
Area Director, Phoenix, Arizona

Bureau of Land Management
State Director, Phoenix, Arizona

Bureau of Mines
Chief of Intermountain Field Operations Center, Denver, Colorado

Department of Agriculture
Soil Conservation Service, Phoenix, Arizona

Department of the Interior
Fish and Wildlife Service, Division of Ecological Services, Phoenix, Arizona
National Park Service, Southern Arizona Group

Department of Energy, Western Area Power Administration
Phoenix District Office
Phoenix, Arizona

Environmental Protection Agency
Arizona Branch Chief: Richard Reavis, San Francisco, California

Federal Highway Administration
Bureau of Public Roads
Division Engineer, Phoenix, Arizona

Interagency Archeological Services
Chief, Heritage Conservation and Recreation Service, San Francisco, CA

Tonto National Forest Service
Supervisor, Phoenix, Arizona

U.S. Geological Survey, Water Resources Division
Arizona District Office, Phoenix, Arizona

Indian Reservations

Fort McDowell Mohave-Apache Tribal Council
President and Community Planner

Gila River Indian Community
Governor, Water Conservation Board Chairman

Salt River Pima-Maricopa Indian Community
Community Manager: Frank Mertely
Planning Director

State Agencies

Arizona Bureau of Mineral and Geology Technology

Arizona Department of Game and Fish

Arizona Department of Health Services

Arizona Department of Transportation

Arizona Outdoor Recreation Coordinating Commission

Arizona State Land Department

Arizona State Parks Board

Arizona Water Commission

County Agencies

Maricopa Association of Governments

Special Districts

Central Arizona Water Conservation District

Flood Control District of Maricopa County

Maricopa County
- Engineering
- Health Services
- Parks and Recreation
- Planning Department

Maricopa County Municipal Water Conservation District No. 1

Local Entities

City of Avondale
Public Works Director

City of Glendale
Manager

City of Mesa
Manager

City of Peoria
Manager

City of Phoenix
Manager

City of Scottsdale
Manager

City of Tempe
Manager

City of Tolleson
Manager

Salt River Project
General Manager

Town of Buckeye
Manager

Town of El Mirage
Manager

Western Area Power Administration
Phoenix District Manager

The community leadership already has been organized with the formation by Governor Babbitt of the Community Advisory Board to advise him on issues addressed by the CAWCS. An analysis of composition of the Board shows it to be a good cross-section of community leadership, which can speak with authority on most Study issues. Representation on the Advisory Board falls into the following categories:

1. Governmental and political.
2. Environmental and wildlife.
3. Development and business.
4. Indian tribes.
5. Media.
6. Labor and citizen groups.

While Board members are generally in leadership roles, they will rely on staff personnel to provide technical expertise.

The Community Advisory Board will aid in identification of problems and needs through complaints and comments received from members' constituencies Their knowledge of other planning issues will help identify ways in which proposed alternatives might affect different projects.

Board members can convey information gained from meetings to their respective organizations to increase the level of communication and input.

The Community Advisory Board may be most helpful to the CAWCS by providing advice on acceptability of alternative plans from political and legal viewpoints. It is anticipated that the Board will offer suggestions concerning compromises and improvements to make alternatives more acceptabl Once the preferred plan is selected, the Board also may aid in demonstratin to the community that all points of view have been considered, resulting in recommendation of the best plan.

While authority for making final decisions on plan formulation and selection rests with the Agencies, advice and recommendations from all four levels of the public will be given serious consideration and will aid the WPRS and Corps in the development of the plan which best serves the public.

Dames and Moore, an environmental and applied earth sciences consulting firm has received a contract from the WPRS to design and implement the CAWCS public involvement program. In addition, this firm will also analyze the environmental, social and economic impacts of the proposed alternatives in the CAWCS.

Study Schedule

A detailed schedule of CAWCS activities has been established and is available separately. A Summary Study Schedule is presented in Figure 6.

Study Cost Estimates

Water and Power Resources Service and Corps of Engineers cost estimates for the Study by fiscal year are provided in Table 12.

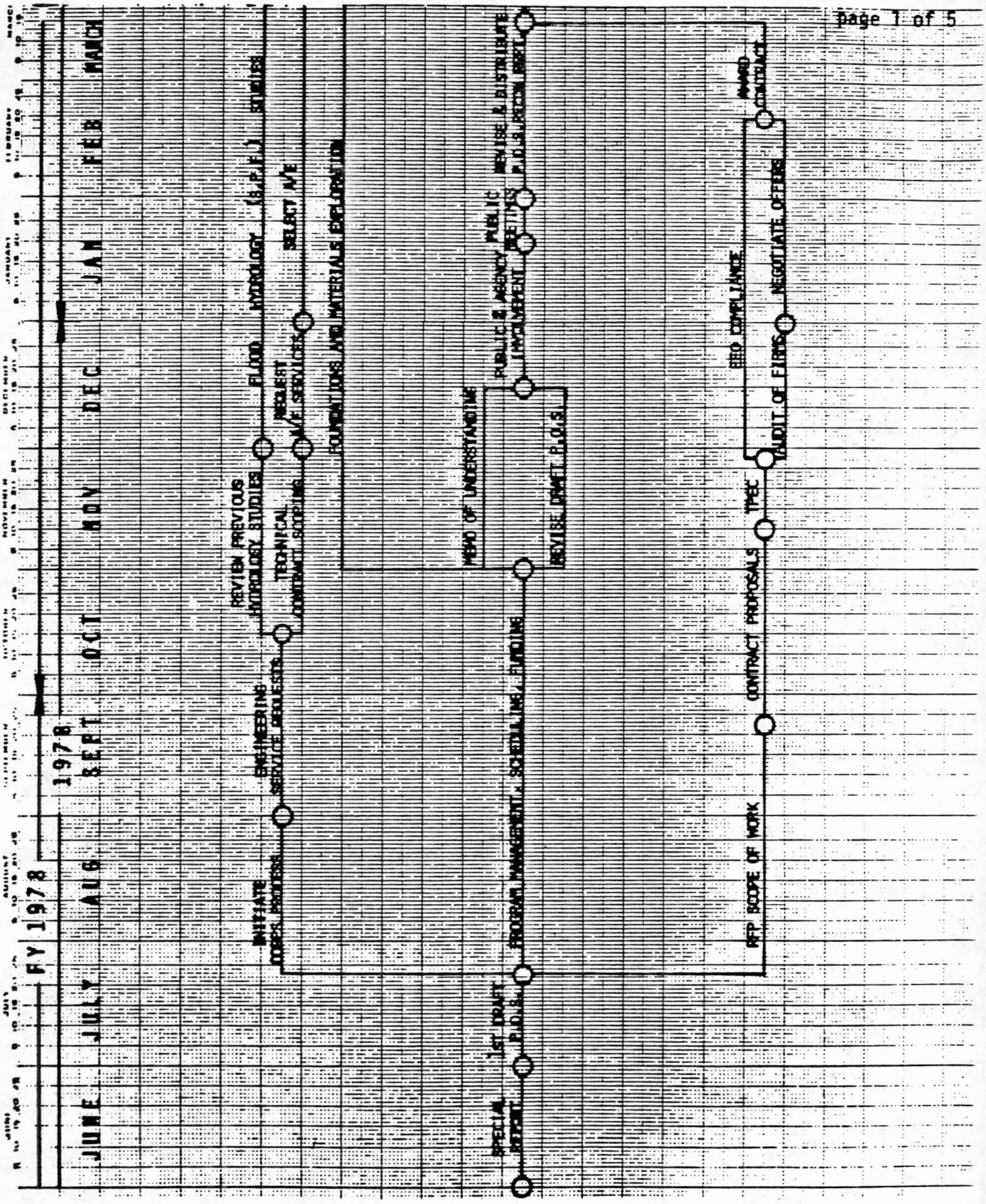
The Corps requirement in FY 79 will be met through the use of $350,000 appropriated for the Corps Phoenix Urban Study and the transfer of funds from the WPRS.

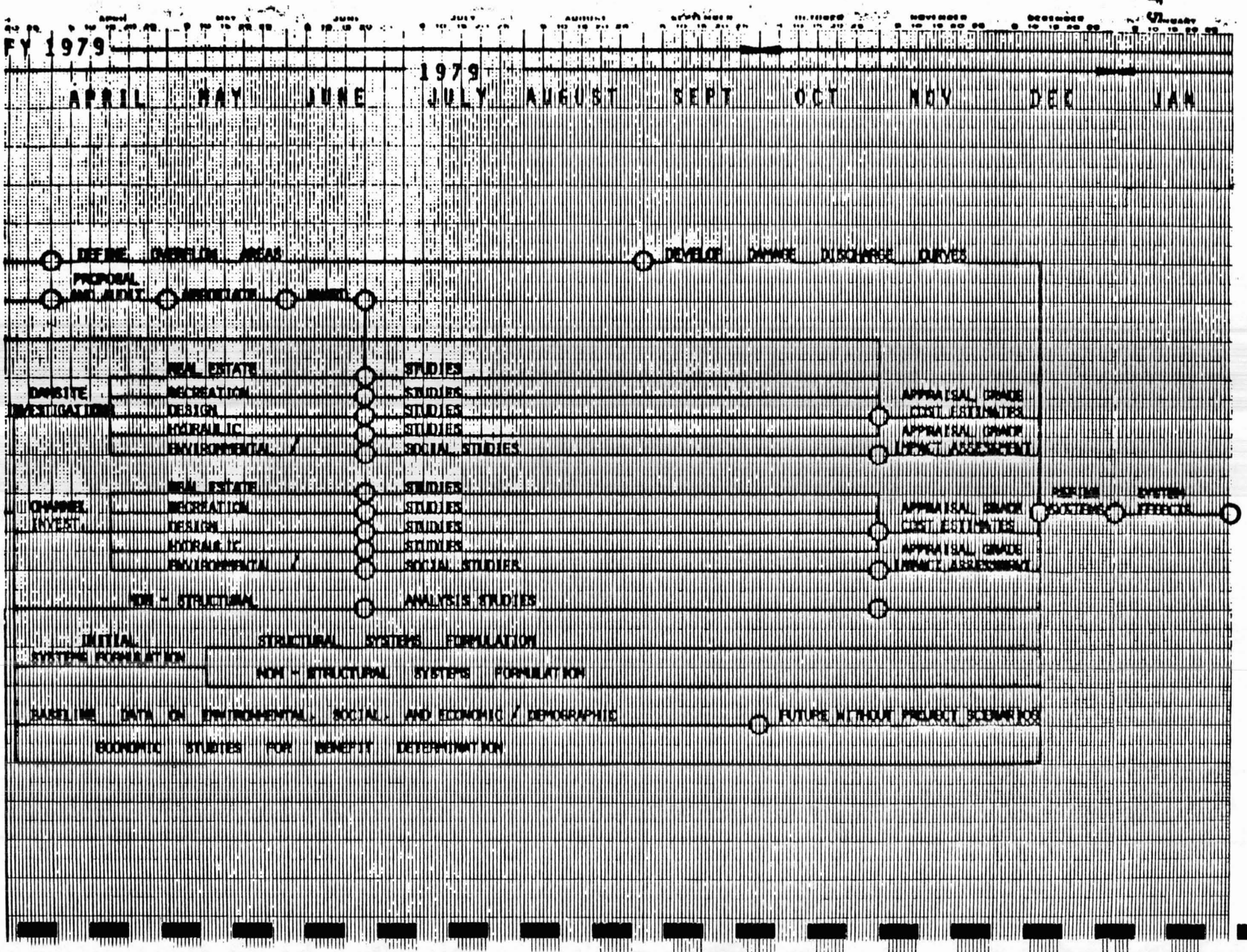
TABLE 12

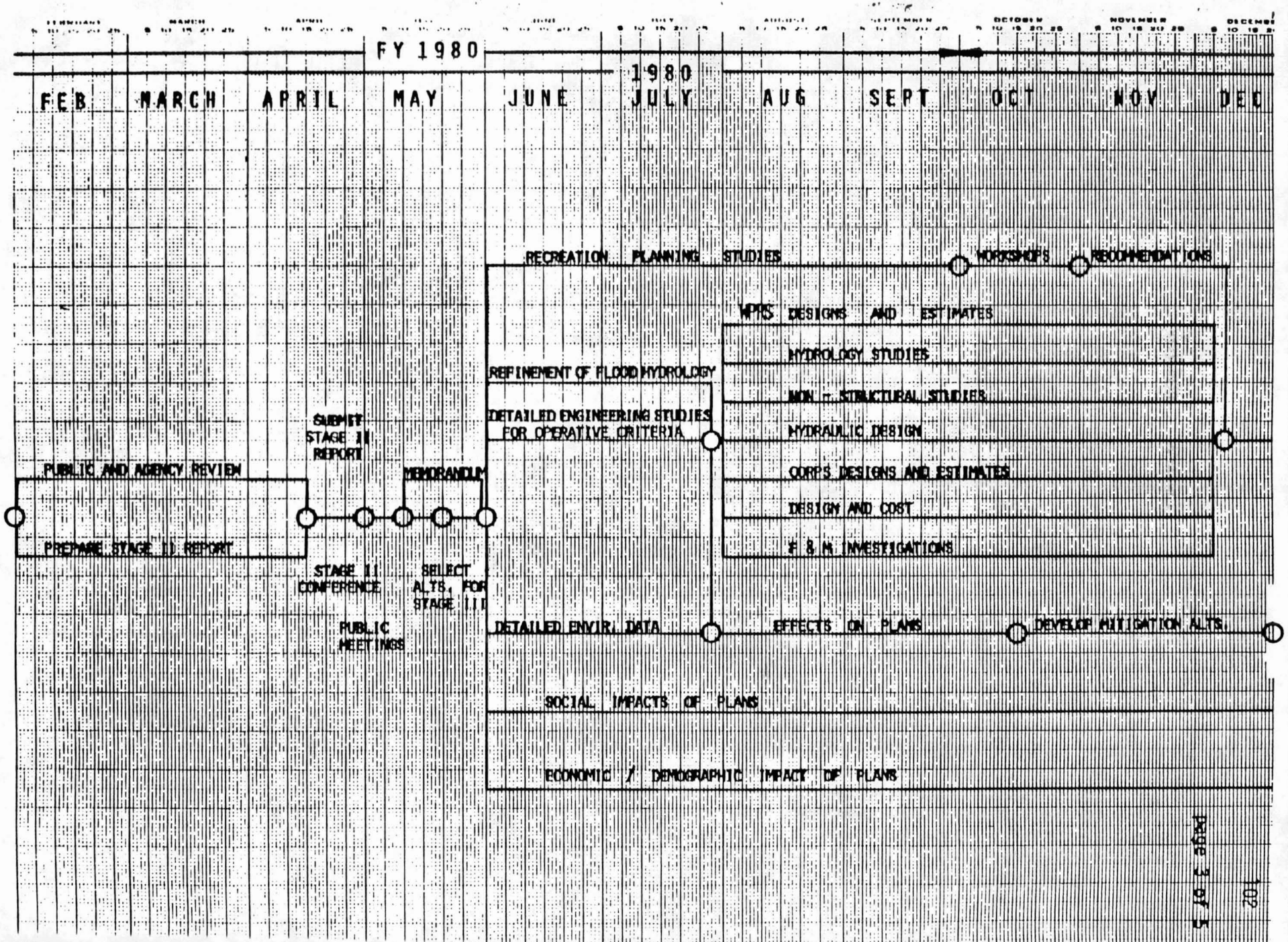
STUDY COST ESTIMATES

	FY 78	FY 79	FY 80	FY 81	FY 82	TOTAL
Corps	50,000	590,000	2,380,000	1,210,000	460,000	4,690,000
WPRS	70,000	1,270,000	1,440,000	970,000	280,000	4,030,000
TOTAL	$120,000	$1,860,000	$3,820,000	$2,180,000	$740,000	$8,720,000

FIGURE 6
SUMMARY STUDY SCHEDULE




FY 1979
1979
APRIL
MAY
JUNE
JULY
AUGUST
SEPT
OCT
NOV
DEC
JAN
DEFINE DEVELOP AREAS
DEVELOP DAMAGE DISCHARGE CURVES
PROPOSAL
DAMSITE INVESTIGATIONS
REAL ESTATE
RECREATION
DESIGN
HYDRAULIC
ENVIRONMENTAL /
STUDIES
SOCIAL STUDIES
APPRAISAL GRADE COST ESTIMATES
APPRAISAL GRADE IMPACT ASSESSMENT
CHANNEL INVEST.
NON - STRUCTURAL
ANALYSIS STUDIES
INITIAL SYSTEMS FORMULATION
STRUCTURAL SYSTEMS FORMULATION
NON - STRUCTURAL SYSTEMS FORMULATION
BASELINE DATA ON ENVIRONMENTAL, SOCIAL, AND ECONOMIC / DEMOGRAPHIC
FUTURE WITHOUT PROJECT SCENARIOS
ECONOMIC STUDIES FOR BENEFIT DETERMINATION
PERTINENT SYSTEMS
SYSTEMS FORMULATION


FY 1980
1980
FEB
MARCH
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
RECREATION PLANNING STUDIES
WORKSHOPS
RECOMMENDATIONS
WPRS DESIGNS AND ESTIMATES
HYDROLOGY STUDIES
NON - STRUCTURAL STUDIES
HYDRAULIC DESIGN
CORPS DESIGNS AND ESTIMATES
DESIGN AND COST
F & M INVESTIGATIONS
REFINEMENT OF FLOOD HYDROLOGY
DETAILED ENGINEERING STUDIES FOR OPERATIVE CRITERIA
SUBMIT STAGE II REPORT
PUBLIC AND AGENCY REVIEW
MEMORANDUM
PREPARE STAGE II REPORT
STAGE II CONFERENCE
SELECT ALTS. FOR STAGE III
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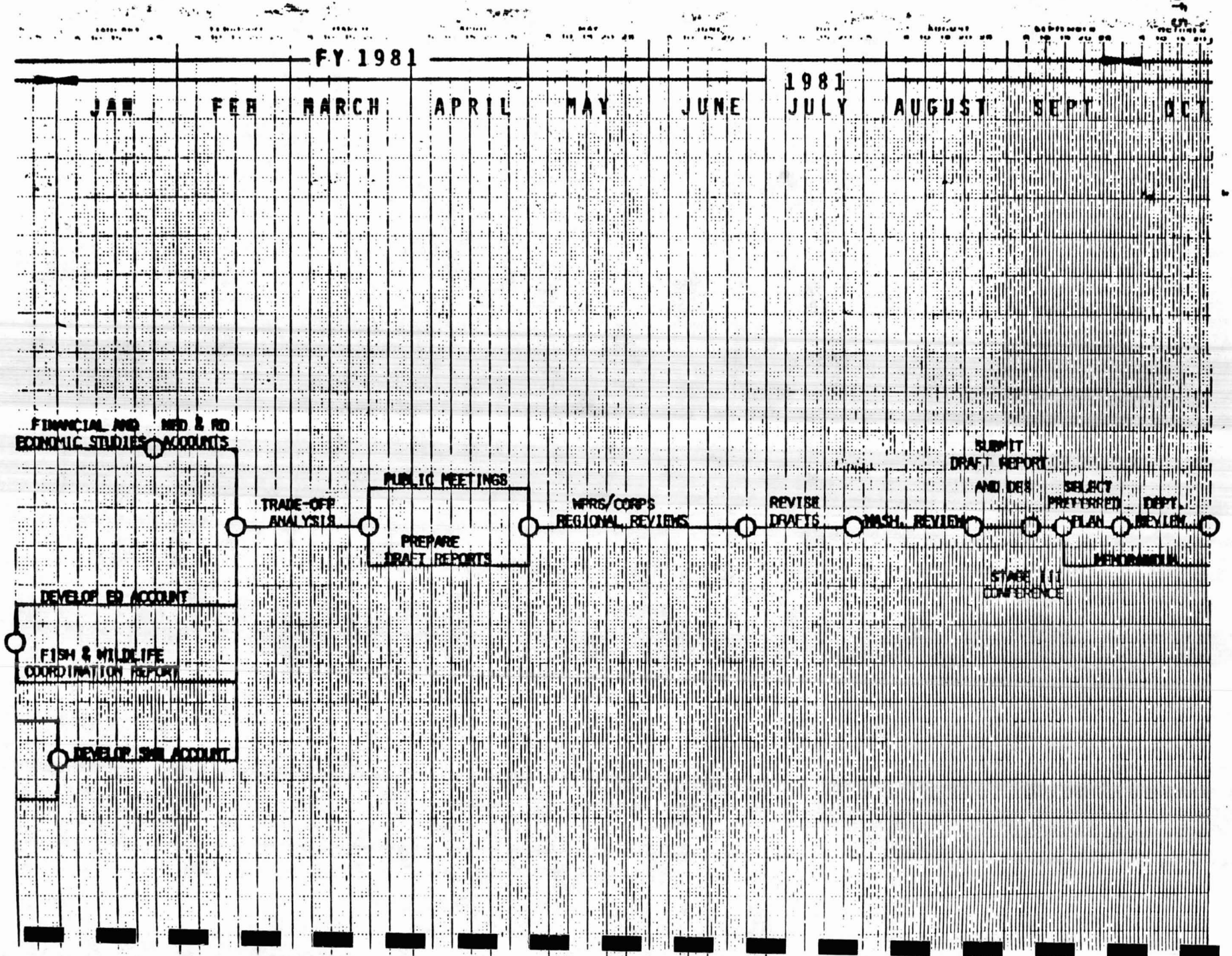
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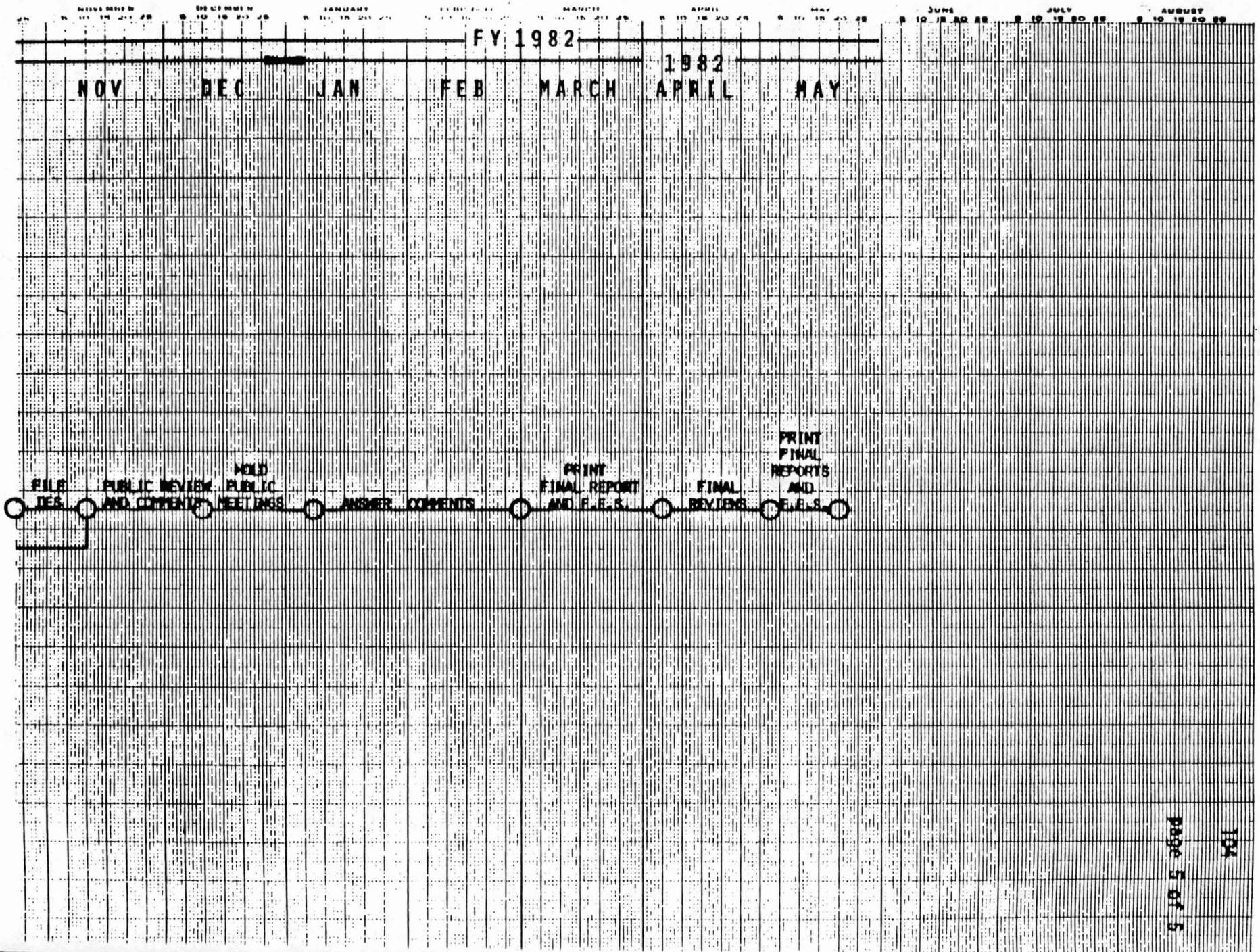
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FINAL REVIEWS
PRINT FINAL REPORTS AND F.E.S.

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JOHN L. LEIBER, V. CH.
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AND
STATE WATER ENGINEER
VICKIE MOONEY
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Arizona Water Commission

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May 7, 1979

Mr. Richard Shunick, Projects Manager
Arizona Projects Office
Bureau of Reclamation
201 North Central Avenue
Phoenix, Arizona 85073

Dear Dick:

Thank you for the opportunity to express the opinion of the Arizona Water Commission on the Plan of Study report relating to alternatives for Salt-Gila flood control and regulation of Central Arizona Project waters. We have reviewed this document and feel that the process outlined is consistent with identification of acceptable alternatives. We must express our continued concern over the time requirements associated with the plan and urge that you continue to attempt to shorten the overall time.

The State of Arizona feels strongly that this study is in the vital interests of our people, and that a high priority should be placed upon its completion. Please feel free to call upon me or the staff of the Water Commission if we can be of assistance to you as the study progresses.

Sincerely,

Wesley E. Steiner
Executive Director

CENTRAL ARIZONA WATER CONSERVATION DISTRICT
SECURITY BUILDING, SUITE 736 • 234 NORTH CENTRAL AVENUE • PHOENIX, ARIZONA 85004 • (602) 258-0745

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Mr. R. E. Shunick, Projects Manager
Bureau of Reclamation
2200 Valley Center
Phoenix, Arizona 85073

May 14, 1979

Dear Dick:

This is in response to Herb Dishlip's verbal request for comments on the April 1979 draft "Plan of Study of Alternatives for Salt-Gila Flood Control and Regulation of Central Arizona Project Waters." After reading the study plan, it appears that the Bureau of Reclamation and Corps of Engineers personnel have prepared a detailed analyses of the problems which must be faced to complete this ambitious program.

However, my main concern is to meet the deadlines established of water storage and regulation for the CAP and to do that we must get on with the program. As Mr. Wuertz stated in his letter of January 4, 1979 to Dr. Lee Thompson, I am "...very frustrated with the plan (for).....a four year study..." but possibly the real issue might be after the study processes are completed. What is the timing for completion of the structures that might be recommended -- and there perhaps the 8-10 year program can be lessened and we can meet the storing and regulation schedule for the Central Arizona Project waters.

I appreciate the opportunity to comment and will look forward to the workshops on the proposed alternatives.

Sincerely,

Elzada

Elzada Darter
Executive Director

ED:pw

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Ecological Services
2934 W. Fairmount Avenue
Phoenix, Arizona 85017

May 3, 1979

Memorandum

To: Projects Manager, Bureau of Reclamation
Arizona Projects Office, Phoenix

From: Field Supervisor, Phoenix (ES)

Subject: Draft Plan of Study for the Study of Alternatives for Salt-Gila Flood Control and Regulation of Central Arizona Project Waters, April 1979

We appreciate the opportunity to review the subject draft statement as well as your earlier draft dated January 22, 1979. We are pleased that the Plan of Study has been modified to reflect many of our previous concerns. However, some concerns remain and are offered for your consideration.

Page 1, second paragraph. It is stated here that "Orme Dam, or a suitable alternative, was authorized to provide a reservoir for seasonal storage and regulation of CAP water upon its arrival in central Arizona." In our opinion, this statement does not accurately reflect authorized project purposes of P.L. 90-537. We believe the authorization provides for storage of water but does not specifically authorize seasonal or regulatory storage. Regulatory storage, as listed on page 66, is a study objective but should not be described as an authorized project purpose.

Page 1, third paragraph. We do not agree that these flows are entirely lost for beneficial use. Both downstream and underground benefits have been recognized as a result of these flows. As you mention later in this document, the feasibility of more efficiently utilizing water impounded in Painted Rock Reservoir should be investigated.

This paragraph implies that the Salt River and Verde River floods were wholly responsible for the federal disaster proclamation. At least in December 1978, floods in other areas (such as Duncan and Safford on the Upper Gila River) were partly responsible for this proclamation.

Page 6, third paragraph. Why is it considered that an impasse had been reached? It seems that such a conclusion could only have been reached if all alternatives had been thoroughly studied and it was found that none were acceptable. The authorizing legislation seems to allow for the deletion of Orme Dam as Orme Dam and Reservoir, or a suitable alternative, was authorized.

Page 50, second paragraph. The sentence, "Since data on environmental and social factors are limited, it would be inappropriate to make judgments on site viability based on those parameters at the present time", in our opinion is not true for the confluence sites. We believe this is substantiated by the final report of the Environmental/Socio-economic Subcommittee prepared for the Interagency Task Force on Orme Dam Alternatives.

Page 52, A. Structural Alternatives - Dams. It is stated that the Coon Bluff, Agua Fria Siphon Site, and Florence alternatives do not warrant further study due to geologic problems. A relatively significant amount of data is provided to substantiate this. It is stated on page 53 that the confluence and Granite Reef sites do not present any serious geologic difficulties; however, no substantiating data is provided. What are the nature of these geologic difficulties (if any) and shouldn't appropriate data be provided?

Page 66, fifth paragraph. We suggest rewriting the last sentence to read as follows: "Therefore, plans developed during this Study must provide for the purposes of CAP water storage and flood control to the maximum extent feasible." Our rationale relates to our comment regarding page 1, second paragraph, and a concern that to say "...must meet the dual purposes..." could imply a predetermined level of water storage and flood control. This is not the case as the actual levels of water storage and flood control provided will not be determined until all evaluation factors have been considered.

Page 67, The Planning Process. We believe that in order to be consistent with Principles and Standards one alternative plan should be formulated in which optimum contributions are made to the National Economic Objectives (NED Plan) and one plan should be formulated which emphasizes the contributions to the Environmental Quality Objectives (EQ Plan).

Page 82. Fish and Wildlife Ecological Service should be changed to Fish and Wildlife Service, Division of Ecological Services, Phoenix, Arizona.

Page 85, last paragraph. Design of the public involvement program should be coordinated with participating numbers of the "Public" as appropriate.

Again, we appreciate the opportunity to review and comment on your Plan of Study and look forward to working with you and the Corps, as well as others, in this planning effort.

Gilbert D. Rhett

cc:
Regional Director, BR, Boulder City
Corps of Engineers, Phoenix
Director, AGFD, Phoenix
Members of the Community Advisory Board
Regional Director, USFWS, Albuquerque (ES, SE)
Area Manager, USFWS, Phoenix

Salt River Project
WATER ◆ POWER

BOX 1980 PHOENIX, ARIZONA 85001

TELEPHONE 273-5900

May 1, 1979

Mr. R. E. Shunick
Projects Manager
Bureau of Reclamation
Suite 2200 Valley Center
201 North Central Avenue
Phoenix, Arizona 85073

Dear Mr. Shunick:

The Salt River Project recognizes the necessity for studying the alternatives for Salt-Gila flood control and regulation of Central Arizona Project waters for the Salt River Valley. The hydrologic events of the past two years--from shortage to over-abundance--have dramatized the Valley's water supply picture.

We have reviewed your Plan of Study. It is comprehensive, ambitious and achievable. Though we are anxious to shorten the study time in any practical manner, we recognize the complexity of the problem.

Salt River Project will continue its full support and cooperation in this effort to solve two of the most important water-related study problems in the recent history of the Salt River Valley-conservation and flood control.

Sincerely,

A. J. Pfister
General Manager

DEW/at

FLOOD CONTROL DISTRICT
of
Maricopa County

3335 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 262-1501

Herbert P. Donald, Chief Engineer and General Manager

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September 18, 1979

Richard E. Schunick, Projects Manager
Arizona Projects Office
Bureau of Reclamation
201 North Central Avenue, Suite 2200
Valley Center
Phoenix, Arizona 85073

Dear Mr. Schunick:

The Plan of Study, dated April, 1979, prepared by your office of alternatives for Salt-Gila flood control and regulation of the Central Arizona Project waters has been reviewed by this office, and we concur that the alternatives selected for further study are realistic and can provide the acceptable degree of flood control on the Salt and Verde Rivers system.

We appreciate the efforts being put forth by the Bureau of Reclamation and the Corps of Engineers conducting this study, and offer our full assistance in its early completion.

Sincerely,

Herbert P. Donald, P. E.

cc: Joe Dixon, Corps of Engineers
Phoenix Office