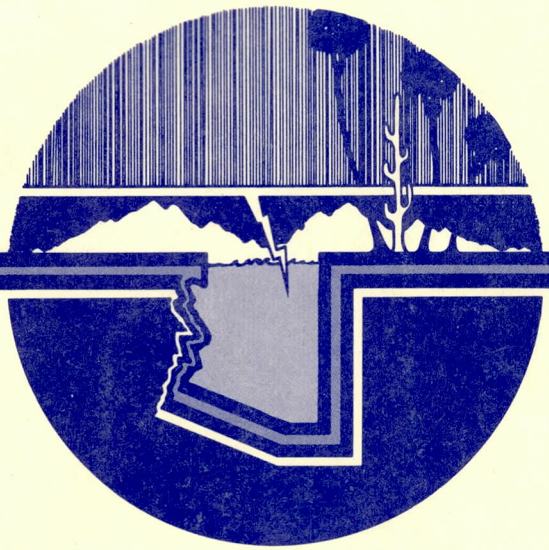
FINAL

ENVIRONMENTAL IMPACT STATEMENT

REGULATORY STORAGE DIVISION
CENTRAL ARIZONA PROJECT

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

LOWER COLORADO REGION



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FINAL

ENVIRONMENTAL IMPACT STATEMENT

REGULATORY STORAGE DIVISION
CENTRAL ARIZONA PROJECT

Maricopa, Pinal, and Gila Counties, Arizona

U.S. DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION

As Lead Agency in Cooperation With

U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, TONTO NATIONAL FOREST

This Environmental Impact Statement describes six alternatives for the proposed construction and operation of the Regulatory Storage Division of the Central Arizona Project (CAP). The alternatives described provide for CAP Regulatory Storage, flood control for the Salt and Gila Rivers through the Phoenix metropolitan area, and concurrent and coincident aspects of the Safety of Dams program. A No Action alternative is also described. This EIS also fulfills the requirements of Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands), and the requirements of the Nationwide Permit in accordance with the provisions of Section 404 of the Clean Water Act.

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PREFACE

Response to public comments on the Draft Environmental Impact Statement (EIS) and continuation of planning on the Proposed Action have resulted in several revisions that are reflected in the Final EIS. These changes include:

- A new plan (Plan 9) was formulated in response to public comments requesting a plan that did not include Cliff Dam. This decision has been incorporated throughout this EIS.

- The decision was made to modify existing Roosevelt and Stewart Mountain Dams rather than construct new dams. The summary of the document has been changed to show this decision; and it has been discussed in Section II.D. of the main EIS. The remaining references in the text of the main document to New Roosevelt and Stewart Mountain Dams have not been revised.

- A mitigation plan for Plan 6 was developed based on updated construction and operation data.

- An environmental commitment section has been added.

- A final Fish and Wildlife Service Coordination Act Report has been included in Appendix G.

Maps for the elements provided with the Draft EIS should be retained for reference. The maps for the Verde River Dams Modifications element of Plan 9 are bound in the EIS.

SUMMARY

I. PURPOSE AND NEED FOR THE ACTION

A. Background

This environmental impact statement (EIS) describes and evaluates the proposed construction and operation of the Regulatory Storage Division of the Central Arizona Project (CAP). Construction of the CAP Regulatory Storage Division was authorized by Section 301(a)(3) of the Colorado River Basin Project Act (P.L. 90-537) of 1968. This feature of the CAP is being investigated under the title Central Arizona Water Control Study (CAWCS). This EIS is prepared to be used by the Secretary in reaching decisions concerning total or partial implementation of the proposed action or approiated alternative.

The CAP was authorized on September 30, 1968. Its principal purpose is to furnish water for irrigation, municipal, and industrial use in central Arizona and western New Mexico through the importation of water from the Colorado River and conservation of local surface waters. Because of its large size and complexity, the CAP is divided into several features serving separate but interrelated functions. Six features, including the main aqueduct system (Granite Reef, Salt-Gila, and Tucson Phase A) are currently completed or under construction. Five remaining features, including the Regulatory Storage Division, are in the planning stage.

An overall EIS was filed for the entire CAP on September 26, 1972 which committed the Bureau of Reclamation (Reclamation) to prepare site-specific EIS's for individual CAP features. The six alternatives for the Regulatory Storage Division described in this EIS address regulatory storage of CAP water and flood control of the Salt and Gila Rivers through metropolitan Phoenix.

The EIS also describes concurrent and coincident aspects of the Safety of Dams (SOD) program. The 1978 Reclamation Safety of Dams Act (P.L. 95-578) directs the Secretary of the Interior to preserve the structural safety of Reclamation dams and related facilities by performing modifications that may be reasonably required. Since the construction and operation of the CAP Regulatory Storage Division and SOD features will involve common timing and locations, the purposes of both authorizing legislations have been combined in the CAWCS.

The EIS is supported by 15 technical reports covering all aspects of CAWCS planning, designs, public involvement, social and environmental impact assessment, economics, and hydrological analyses. Supporting documents are available for review at the Arizona Projects Office of the Bureau of Reclamation. Copies of the Final Environmental Impact Statement may also be obtained from Reclamation by those requiring more detailed information than is presented in this summary.

B. Geographic Setting

The CAWCS study area encompasses approximately 13,400 square miles, or 8,576,000 acres, in central Arizona, including portions of Maricopa, Gila, and Pinal Counties. The entire Phoenix metropolitan area is located within the CAWCS boundaries. Figure 1 shows the CAWCS study area. The population of the area is over 1.5 million people, almost 90 percent of whom live in Maricopa County. There are six Indian Communities in the study area.

C. Purpose and Need

The alternative actions described in this EIS have three principal purposes. These are:

1. To increase the operating efficiency of the CAP through the conservation of Salt, Verde, and Agua Fria River flows, and through regulation of Colorado River water deliveries from the Granite Reef Aqueduct.

2. To provide facilities and means to meet the flood control needs on the Salt and Gila Rivers through the Phoenix metropolitan area.

3. To provide for the structural safety of existing Bureau of Reclamation dams on the Salt and Verde Rivers.

Construction of a regulatory storage unit for CAP water will improve the operating flexibility and efficiency of the CAP and will allow the importation of greater quantities of Colorado River water in years when it is available. Without regulatory storage capacity the CAP system can be operated only in direct response to demand, limiting the opportunity to effectively manage the project's water and power resources.

A series of floods through the Phoenix metropolitan area between February 1978 and February 1980 caused substantial damage in the form of property damage, income losses, and emergency costs, and had severe impacts on transportation and on people living in the flood zone. These floods heightened public demands for flood control and flood protection.

Hydrologic analyses for the maximum probable flood (or Inflow Design Flood - IDF) indicate that all six Salt River Project (SRP) storage dams on the Salt and Verde Rivers have inadequate storage and/or spillway capacity to contain and/or pass the IDF without overtopping. Such an occurrence could jeopardize the safety of the dams. The potential overtopping or failure of any of these dams is considered serious because of the potentially catastrophic consequences which would result for Phoenix and other downstream communities.

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. Alternatives Eliminated from Further Study

The CAWCS was initiated in July 1978. The study was conducted in three stages, following a process of transition from a wide array of possible solutions in Stage I to a single proposed action at the end of Stage III.

During Stage I and Stage II, individual "elements" were analyzed which could provide CAP regulatory storage and/or flood control. Elements which were evaluated and eliminated from consideration during the CAWCS are shown in Table 1.

At the beginning of Stage III Reclamation widened the focus of the CAWCS to include SOD as a major objective. All "plans" (combinations of elements) developed for Stage III analysis considered both SOD and CAWCS purposes. These plans were evaluated on the basis of performance, cost, and environmental and social impacts. Eight "candidate" plans resulted from this analysis; two of these, Plans 4 and 5, were subsequently eliminated from consideration.

B. Alternatives Analyzed in Detail

Plans 1, 2, 3, 6, 7, and 8, were analyzed in detail and presented in the Draft EIS. In response to comments on the Draft EIS, Plan 9, a plan without Cliff Dam was analyzed. In November 1981, the Secretary of the Interior selected Plan 6 as the agency proposed action. His selection was based on the strong local support for Plan 6, the functional ability to meet statutory obligations required by authorizing legislation, and the fact that the severe impacts to the Fort McDowell Indian Community associated with some plans were avoided.

A description of the six candidate plans follows:

1. Plan 1: Cliff + Modified Roosevelt + Modified Stewart Mountain Dams

Under this plan, Cliff Dam would be constructed on the Verde River between Horseshoe Dam and Bartlett Dam (see Figure 1) and a new or modified Roosevelt Dam would be constructed. Both dams would provide flood control and CAP regulatory functions in addition to SOD. New or Modified Stewart Mountain Dam would be for SOD purposes only in all plans. This plan would not connect directly with the CAP aqueduct. Conservation space at Cliff and Roosevelt Reservoirs would increase CAP yield through water exchanges by 107,000 acre-feet (af) per year. Dedicated flood control space at Cliff and Roosevelt Dams would reduce the 200-year flood of 275,000 cubic feet per second (cfs) to 92,000 cfs at Sky Harbor Airport and 100-year event to 55,000 cfs at the airport. Conceptual recreation plans for Cliff and Roosevelt feature an increase in camping, picnicking, and boating facilities.

Table 1

ELEMENTS ELIMINATED FROM CONSIDERATION

VERDE RIVER:

Tangle Creek Dam, Modified Horseshoe Dam, New Bartlett Dam

SALT RIVER:

Carrizo Creek Dam, Klondike Buttes Dam, Coon Bluff Dam, New Granite Reef Dam, Rio Salado Low Dams, New Multipurpose Stewart Mountain Dam

AGUA FRIA RIVER:

Lake Pleasant Storage, Agua Fria Siphon Dam, Calderwood Butte Dam, North Phoenix flood control dams

GILA RIVER, SANTA ROSA WASH:

Coolidge Dam, Florence Dam, Buttes Dam, Tat Momolikat Reservoir, Painted Rock Reservoir

CHANNELS:

Granite Reef Dam to Country Club Drive, Country Club Drive to 35th Avenue, 35th Avenue to Gillespie Dam

LEVEES:

Granite Reef Dam to Country Club Drive, Country Club Drive to 35th Avenue, 35th Avenue to Salt/Gila Confluence, Salt/Gila Confluence to Gillespie Dam

GILA RIVER CHANNEL CLEARING FOR CAWCS FLOOD CONTROL

WATER EXCHANGE WITH SALT RIVER PROJECT (SRP)

SRP REREGULATION

GROUNDWATER RECHARGE

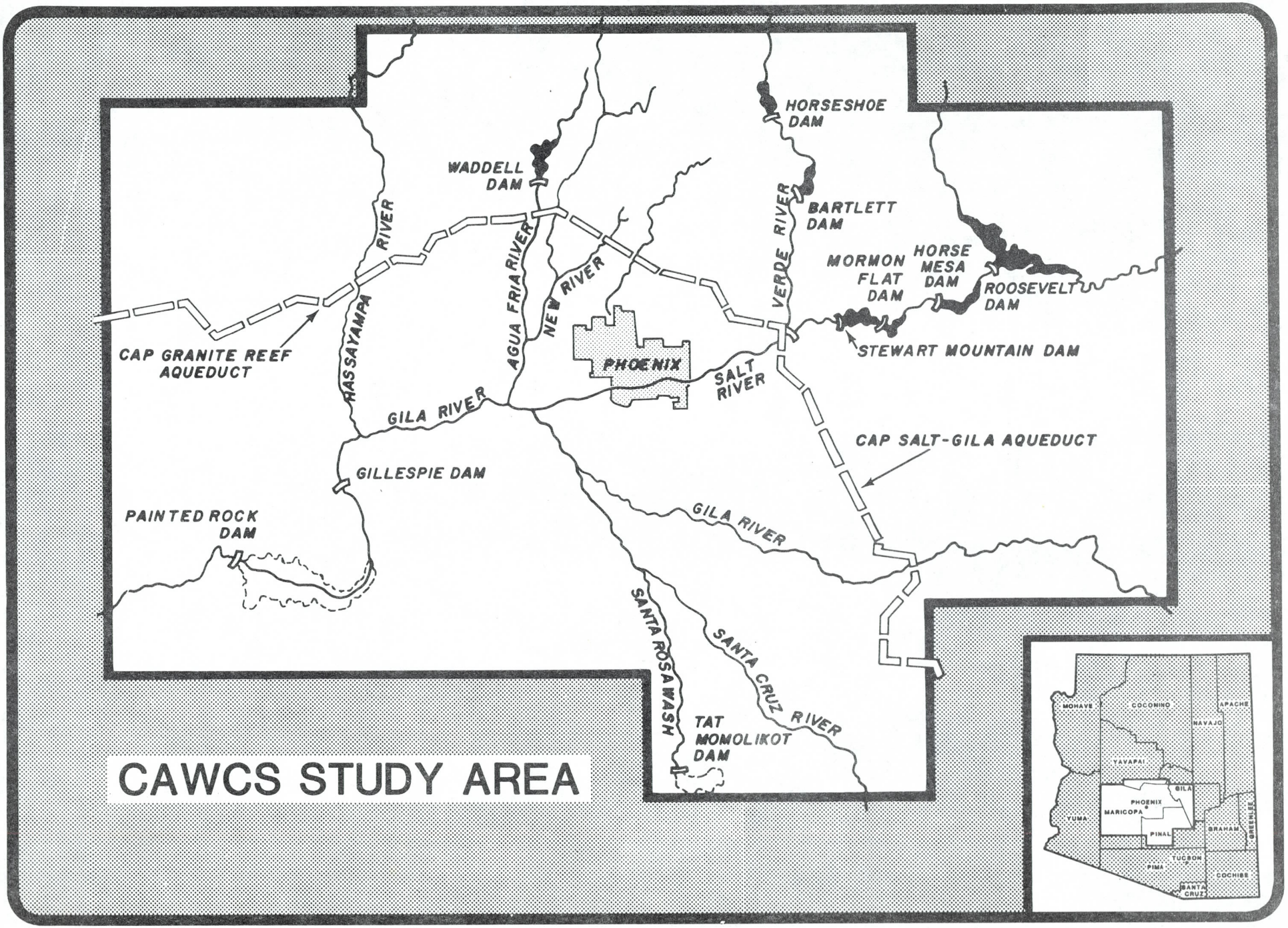
CAWCS STUDY AREA
HORSESHOE DAM
WADDELL DAM
BARTLETT DAM
MORMON FLAT DAM
HORSE MESA DAM
ROOSEVELT DAM
STEWART MOUNTAIN DAM
VERDE RIVER
NEW RIVER
AGUA FRIA RIVER
HASSAYAMPA RIVER
CAP GRANITE REEF AQUEDUCT
PHOENIX
SALT RIVER
GILA RIVER
CAP SALT-GILA AQUEDUCT
GILLESPIE DAM
PAINTED ROCK DAM
GILA RIVER
SANTA ROSA WASH
SANTA CRUZ RIVER
TAT MOMOLIKOT DAM
MOHAVE
COCONINO
APACHE
NAVAJO
YAVAPAI
GILA
PHOENIX
MARICOPA
YUMA
PINAL
GRAHAM
GREENLEE
TUCSON
PIMA
COCHISE
SANTA CRUZ

Figure 1

2. Plan 2: Cliff + Modified Roosevelt + Modified Stewart Mountain Dams + Nonstructural Measures

This plan limits construction at Cliff and Roosevelt Dams to that necessary for SOD purposes. Flood control, provided by the use of the surcharge space at Cliff and Roosevelt in combination with nonstructural flood damage reduction measures downstream would reduce the 200-year flood to 157,000 cfs and the 100-year flood to 150,000 cfs at the airport. Increased water supply for CAP (16,000 af per year) could be developed by additional water conservation at Roosevelt Reservoir. Because this is a limited structural plan, additional recreational facilities would be provided. New Roosevelt Dam is not being considered in Plan 2 since this is a SOD only plan, and the existing Roosevelt Dam can be reconstructed for SOD purposes.

3. Plan 3: Confluence + Cliff + Modified Roosevelt + Modified Stewart Mountain Dams

Under this plan, a dam at the confluence of the Salt and Verde Rivers (see Figure 1) would be constructed as well as Cliff, Roosevelt, and Stewart Mountain Dams. Cliff and Roosevelt Dams would provide flood control, new conservation space, and SOD. Confluence dam would be constructed for regulatory storage purposes. Confluence Dam would connect directly with the Salt-Gila Aqueduct via a pumping plant and canal. Under this plan, the 200-year flood would be reduced to between 92,000 and 70,000 cfs and the 100-year flood to 55,000 to 50,000 at the airport. The CAP yield could be increased by 163,000 af per year. Conceptual recreation plans include new recreation sites for Confluence, Cliff, and Roosevelt Dams.

4. Plan 6: (Agency Proposed Action) New Waddell + Cliff + Modified Roosevelt + Modified Stewart Mountain Dams

New Waddell Dam would replace the existing Waddell Dam at Lake Pleasant on the Agua Fria River (see Figure 1). It would be constructed for regulatory storage and would provide dedicated operational flood control. New Waddell would be connected to the CAP Granite Reef Aqueduct by a canal with a pumping plant. The CAP water supply would be increased by 137,600 af per year. Flood control, additional water conservation, and SOD would be provided at Cliff and Roosevelt. This plan would reduce the 200-year flood at the airport to 92,000 cfs and the 100-year flood to 55,000 cfs. Conceptual recreation plans include additional sites at New Waddell, Cliff, and Roosevelt.

5. Plan 7: New Waddell + Cliff + Modified Roosevelt + Modified Stewart Mountain Dams (environmental enhancement

This plan is the same as Plan 6, but would be operated to emphasize opportunities for environmental enhancement. A portion of the water supply generated at Cliff, Roosevelt and New Waddell Dams would be used for recreation and fish and wildlife conservation. Due to system losses for these purposes, the increase in CAP water supply is 114,000 af per year. Recreation plans are the same as for Plan 6.

6. Plan 9: New Waddell + Verde River Dams Modifications + Modified Roosevelt + Modified Stewart Mountain Dams

New Waddell Dam and Reservoir would be constructed and operated as in Plan 6. The CAP water supply would be increased by 115,500 af per year. Flood control and additional water conservation would be provided at Roosevelt Dam. Horseshoe and Bartlett Dams would be modified for SOD purposes. This plan would reduce the 200-year flood at the airport to 215,000 cfs and the 100-year flood to 170,000 cfs. Conceptual recreation plans include additional sites at New Waddell and Roosevelt Reservoirs.

7. Plan 8: No CAWCS Action

The No Action alternative provides the baseline against which all other plans are compared (future-without-the project). With this option, CAP would be constructed, but no CAWCS regulatory storage or flood control would be provided. SOD studies would, however, continue; SOD solutions may differ from the Cliff/Roosevelt combination in CAWCS/SOD plans. Plan 8 also includes the following assumptions: Twelve bridges in metropolitan Phoenix would be constructed or modified by state and local governments to withstand flows of 200,000 cfs. Floodplain management would occur, including enforcement of existing laws and regulations. Channelization around existing facilities at the airport would be conducted. Limited channel clearing in the Gila River would be undertaken. Flood warning systems would be improved. Several control facilities on area rivers would be constructed. A Tempe Rio Salado Project would be implemented; the overall Rio Salado concept was assumed not to be developed because it is dependent upon upstream flood control.

C. Comparative Analysis of Alternatives

Twenty-one evaluation criteria were developed during the CAWCS Stage III to provide a framework for determining which candidate plans were appropriate for consideration as the proposed action. Although all of the criteria were critical to the plan evaluation process, the CAWCS planning team identified the factors which most significantly discriminated among alternatives, and aggregated them into the following categories: performance (ability to meet CAWCS objectives), economics, environmental impacts, social impacts, and public acceptability. Performance of the plans has been discussed in the earlier description of alternatives. Public acceptability is discussed below in Section D. The environmental, social, and economic impacts of alternatives are presented in more detail in Chapter IV.

Table 2 provides a comparative display of the advantages and disadvantages of each plan relative to the significant evaluation criteria identified by the CAWCS study team.

As shown in Table 2, Plans 1, 3, 6, and 7 provide high levels of flood protection and solve dam safety problems. Plans 2 and 9 also solve dam safety problems but provides less flood protection. Plan 8 does not meet objectives for flood protection, but it does provide for continued studies to develop a plan to make Salt and Verde River dams safe.

Table 2

COMPARATIVE EVALUATION OF PLANS

	Advantages	Disadvantages
Plan 8 (No CAWCS action)	No project-related cost No project-related impacts to Fort McDowell Indian Community No project-related impacts to endangered species, riparian habitat, or cultural resources Moderate public support	No increased flood protection No additional water supply beyond CAP baseline Significantly less power revenues than regulatory storage plans No flexibility in CAP operations Dam safety studies continue
Plan 1	Relatively low cost No impacts to Fort McDowell Indian Community High level of flood protection Moderate increase in CAP yield Solves dam safety problems Moderate public support	Less reliable water supply than regulatory storage plans Significantly less power revenues and other economic benefits than regulatory storage plans No flexibility in CAP operation Adverse impacts to endangered species, riparian habitat, and cultural resources
Plan 2	Lowest cost of all action plans Solves dam safety problems No impacts to Fort McDowell Indian Community Insignificant impacts to endangered species Provides moderate increase in flood protection	Insignificant increase in CAP yield Less reliable water supply than regulatory storage plans Minimal power revenues and other economic benefits No flexibility in CAP operations Adverse impacts to riparian habitat and cultural resources Minimum public support
Plan 3	Highest increase in CAP yield High level of flood protection Significant increase in power revenues and other economic benefits Provides flexible CAP operations Provides reliable water supply Significant increase in lake recreation	Highest cost of all action plans Severe impacts to Fort McDowell Indian Community Severe impacts to endangered species, riparian habitat, and cultural resources Severe impacts to stream recreation Potential for reservoir eutrophication and degradation of water quality Highly controversial - divided public support
Plan 6 (Agency proposed action)	Significant increase in CAP yield High level of flood protection Highest increase in power revenues and other economic benefits Provides reliable water supply Provides flexible CAP operations Significant increase in lake recreation No impacts to Fort McDowell Indian Community Strong broad-based public support	High cost Adverse impacts to endangered species habitat and cultural resources*
Plan 7	Moderate increase in CAP yield High level of flood protection Significant increase in power revenues and other economic benefits Provides flexible CAP operations Provides reliable water supply Significant increase in lake recreation Provides opportunities for fish and wildlife enhancement Provides opportunities for development of Salt River recreation through Phoenix No impacts to Fort McDowell Indian Community Moderate public support	High cost Adverse impacts to endangered species, riparian habitat, and cultural resources

*Jeopardy Biological Opinion under Section 7 of the Endangered Species Act was issued by the Fish and Wildlife Service for the Proposed Action.

Table 2 (continued)

COMPARATIVE EVALUATION OF PLANS

	Advantages	Disadvantages
Plan 9	Provides reliable water supply Significant increase in power revenue and other economic benefits Moderate increase in CAP yield Significant increases in lake recreation No impacts to Fort McDowell Indian Community Reduced environmental impacts	Lower level of flood protection than with some of the other plans Adverse impacts to cultural resources High cost

Regulatory storage advantages are strongest with Plans 3, 6, and 7 because they include regulatory storage reservoirs to provide increased CAP yield, added flexibility in the operation of CAP, and energy management benefits. Plan 1 provides some increased yield because of water exchanges but does not have the flexibility or energy management benefits that are associated with a reservoir. Mainly because of energy management opportunities associated with New Waddell Reservoir, Plan 6 provides the highest annual economic benefits of any plan. Plan 8 does not meet project objectives for regulatory storage.

Costs of the action alternatives in rank order from highest to lowest are: Plan 3, 6, 7, 9, 1, and 2. Plan 8 has no construction costs at this time, but planning for dam safety would continue and ultimately the solution could involve dam construction.

Environmental impacts associated with construction, operation, and maintenance are most severe with Plan 3 because the plan includes Confluence Dam and Reservoir. The reservoir would inundate sensitive habitat and areas of human use, leading to severe impacts to endangered species, riparian habitat, perennial stream habitat, stream recreation, water quality, and cultural (prehistoric and historic) resources. Environmental impacts of Plan 6 include losses of riparian habitat and cultural resources and adverse impacts to the bald eagle; these same impacts would occur with Plans 1 and 7, which would also adversely affect endangered species. Plan 2 and 9 would have lesser impacts to riparian habitat and cultural resources than Plan 6. Plan 8 would have no project related impacts, but the dam safety solution found in continued studies could result in impacts that cannot be predicted at this time.

Social impacts are primarily the consequences of relocation because of land acquisition for dams and reservoirs. The most severe social impacts of relocation occur with Plan 3, which would require the relocation of the Fort McDowell Indian Community. No other plans would require the relocation of the community. With all of the action plans, some residents who currently live around the perimeter of Roosevelt Lake and a family who operate a ranch near Horseshoe Dam on the Verde River would be required to relocate. Although all action plans require Roosevelt Lake relocations, Plan 2 requires the fewest number of people to relocate.

Quantification of impacts is provided in Chapter IV, where the impacts, effects, and mitigation are summarized in Tables 4, 5, and 6.

D. The Proposed Action - Plan 6

Plan 6 has been selected as the agency proposed action for CAWCS because the plan meets project objectives, has strong public support, and does not have many of the severe social and environmental impacts associated with Plan 3. In particular, Plan 6 avoids impacts to the Fort McDowell Indian Community while still providing high performance for flood protection and CAP regulatory storage. While Plans 1, 2, 7, and 9 also avoid impacts to the Fort McDowell Community, they do not perform as well as does Plan 6. Plan 9 reduces the impacts on riparian vegetation and has less flood control benefits.

Strong, broad-based public support for Plan 6 was identified by the CAWCS public involvement program in Stage III, and included support of groups who participated in public values assessment workshops, speakers at three public meetings held in September 1981, comments received from response forms in a CAWCS publication, the CAWCS Governor's Advisory Committee, and the Central Arizona Water Conservation District.

In October 1981, the CAWCS planning team participated in a "tradeoff" meeting to review all available information on the alternatives and to formulate recommendations. Alternatives were evaluated based on performance, cost, economic benefits, public acceptability, engineering feasibility, environmental impacts, social impacts and implementability. As a result of these analyses, the Arizona Projects Office of the Bureau of Reclamation recommended that Plans 1, 3, and 6 were appropriate for consideration as the proposed action. After reviewing the three recommended plans, the Secretary of the Interior selected Plan 6 as the agency proposed action in November 1981, citing the plan's high performance, public support, and avoidance of impacts to the Fort McDowell Indian Community.

At the time of the Secretary's decision, both New and Modified Roosevelt and Stewart Mountain were included in the proposed action. After technical analysis and public review, modified in both cases have been selected as the option to be included in the proposed action.

III. AFFECTED ENVIRONMENT

A. General Description of CAWCS Area Significant Resources

1. Biological Resources

Six resource factors within the CAWCS area have been identified as having importance with respect to action-related impacts:

1. Riparian/Wetland Biotic Communities
2. Other Terrestrial Biotic Communities
3. Perennial Stream/Riverine Aquatic Communities
4. Reservoir Aquatic Communities (Lakes and Lacustrine Communities)
5. Threatened and Endangered Plants and Wildlife
6. Management and Special Use Areas

Acreage and percent ranges of the major biotic communities occurring in the CAWCS study area are shown in Table 3.

2. Water Quality

The water quality of local surface water sources in the CAWCS area is measured by concentrations for 45 constituents including a number of elements and compounds, fecal coliforms, dissolved solids, and phenolics, as well as by measures of alkalinity, hardness, specific conductance, and sodium absorption ratio. Safe levels of some constituents are prescribed by law for

Table 3

ACREAGE AND PERCENT RANGE OF
BIOTIC COMMUNITIES IN CAWCS AREA

Biotic Community	Acres	Percent of Study Area
Temperate Uplands		
including Montane conifer forest, Pinyon-juniper series, Oak-pine series, Interior chapparal, Sonoran savanna grassland	1,167,000	13.6
Riparian and Wetland Communities		
including warm-temperate, tropical-subtropical, and riparian forests	59,000	.7
Desert Uplands		
including Creosotebush-bursage series, Paloverde-mixed cacti series, Saltbush series	5,957,000	69.4
Aquatic Communities		
including lakes, rivers, and reservoirs	75,000	.9
Human Dominated Communities		
including agricultural and developed urban lands	1,318,000	15.4

various water uses; the levels of water quality constituents in surface water sources in the CAWCS area vary considerably from season to season and from one source to another. These local sources could be either improved or degraded by regulatory storage mixing.

3. Recreation

Significant water-related recreation resources and facilities are described as either stream-oriented or reservoir-oriented. The five-county region of Maricopa, Pima, Pinal, Gila, and Yavapai Counties was defined as the affected area to assess recreation impacts of CAWCS plans. Existing recreation resources and facilities in the five-county region include over 9,000 campsites, 11,600 picnic sites, 51 improved swimming sites, 985 miles of fishable stream, 34 miles of stream suitable for tubing (river floating), and 35,000 water surface acres suitable for boating.

4. Cultural Resources

Prehistoric resources in the CAWCS area date from the area's occupation from about 11000 B.C. to the advent of recorded history in the mid-1600s A.D. Some of the more significant sites in the study area reflect the highly-developed Hohokam tradition and culture, and present an opportunity to examine different models for the development of complex social, political, and agricultural systems. Larger archaeological sites are popular tourist attractions such as Tonto National Monument, Casa Grande National Monument, and Pueblo Grande Museum.

Historic resources in the study area date from Arizona's pre-territorial (to 1863) through territorial and statehood (after 1912) periods. Several of these sites, such as Theodore Roosevelt Dam, have been recognized as nationally significant resources.

5. Social Resources

CAWCS plans would affect the communities, individuals, families, and businesses who are currently subject to flooding along the Salt and Gila Rivers through metropolitan Phoenix, and the people who would be relocated because of construction and reservoir inundation associated with alternative action plans.

B. Description of Affected Site Areas

1. Modified Stewart Mountain Site Area

This site area is entirely included within the Confluence site area, and is describe in Section 4.

2. Cliff Site Area

The Cliff Dam and Reservoir site area is located on the Verde River between Horseshoe and Bartlett Dams. All of the land within the Cliff site area, with the exception of the KA Ranch, is owned and managed by the U.S. Forest Service, Tonto National Forest.

Significant biological resources include mature cottonwood-willow and mesquite woodlands, 20 miles of flowing stream with associated native and introduced fish species, and a bald eagle (Federal-listed endangered species) breeding area. Horseshoe Reservoir and the flowing stream are used for recreational activities.

Cultural resources within the Cliff site area include an estimated 1,465 prehistoric sites composed of artifact scatters, pueblo sites, and several special features such as trash mounds. Nine significant historic sites include the Verde River Sheep Bridge, which was placed on the National Register of Historic Places in 1978.

There are no communities in the Cliff site area, but the family who lives at the KA Ranch would be relocated under CAWCS action plans. Approximately 130 acres of prime farmland are located at the KA Ranch.

3. Verde River Dams Modifications Site Area

The Verde River Dams Modifications Site Area includes all of the Cliff site area and the Bartlett Dam and Reservoir area. All of the land within the Verde River Dams Modifications Site with the exception of KA Ranch is owned and managed by the U.S. Forest Service, Tonto National Forest.

Biological resources are the same as those of the Cliff site area with the addition of 1 mile of flowing stream at Bartlett Reservoir, one of Arizona's major sports fisheries, and an additional bald eagle breeding area.

In addition to the cultural resources of the Cliff site area, an estimated 290 sites are predicted to be within the area surrounding Bartlett Dam and Reservoir. There are three additional historic sites.

Social resources are the same as those at the Cliff site area.

4. Roosevelt Site Area

The site area surrounds the existing Roosevelt Dam and Roosevelt Lake, the largest lake in the study area. Most of the land in the Roosevelt site area is publicly-owned, and is managed by the Tonto National Forest for recreation, grazing, and wildlife habitat.

Important biological resources include 15 miles of flowing stream, self-sustaining fisheries, a bald eagle breeding area, a waterfowl refuge, and a managed wildlife area. Stream and lake recreational resources and facilities are heavily used.

Cultural resources are estimated to include 1,480 prehistoric sites similar to sites found in the CAWCS area in general. Of 57 significant historic sites, the most important is Theodore Roosevelt Dam, a National Historic Landmark.

Four communities at Roosevelt Lake would be affected by CAWCS alternatives. Some residents of Roosevelt Lake Estates, Rockhouse Farm, Roosevelt Gardens East, and North Bay Estates would be relocated under all alternative action plans. Many of the residents of these communities are retired and prefer to live in a rural setting.

5. Confluence Site Area

The Confluence site area is located around the confluence of the Salt and Verde Rivers approximately 25 miles northeast of Phoenix. Lands within the area are mainly controlled by public agencies and Indian communities. Private holdings include several residential communities such as Fountain Hills.

Biological resources include important riparian and wetland community types such as cottonwood-willow and mature mesquite forests, 31 miles of flowing stream with native and introduced fish species, 3 bald eagle breeding areas and associated preferred habitat, Yuma clapper rail (Federal-listed endangered species) and several species of Arizona special status wildlife, and a cottonwood habitat rehabilitation site. The flowing stream is used intensively for tubing, fishing, and other recreational activities.

About 265 prehistoric sites are estimated to be present. These are generally much larger than sites at the other affected site areas and include 13 ball courts, features indicative of large villages. The most significant historic site of 97 significant sites in the Confluence area is Fort McDowell.

The Fort McDowell Indian Community would be affected by one CAWCS alternative. Residents of this Yavapai Indian reservation would be relocated by dam construction. There are approximately 400 residents in the community, which is highly cohesive and maintains the traditional Yavapai culture, religion, and customs. The reservation also contains commercially-mined sand and gravel resources and approximately 680 acres of prime farmland.

6. New Waddell Site Area

The New Waddell site area is located around Waddell Dam and Lake Pleasant on the Agua Fria River approximately 45 miles northwest of Phoenix. The land in the area is mainly controlled by state, federal, and county agencies.

Tule Creek and Morgan City Wash are perennial streams in the site area. There are no special use and management areas in the site area. Recreation resources and facilities include Lake Pleasant and Lower Lake Pleasant, both used intensively by area residents, mainly for sailing, fishing and motorboating. The lakes are within Lake Pleasant Regional Park.

Cultural resources include an estimated 120 prehistoric sites. Eleven significant historic sites representative of agricultural, water control, and transportation activities are present.

No people in the New Waddell site area would be affected by CAWCS plans. The area contains approximately 70 acres of prime farmland.

7. Downstream Area

For purposes of CAWCS analysis the area affected by flooding is considered the Salt and Gila River floodplain from the Granite Reef Diversion Dam through metropolitan Phoenix to Gillespie Dam. Areas downstream of Waddell Dam on the Agua Fria River were not included in this analysis but are the subject of other flood control studies by the Corps of Engineers.

Biological resources in the downstream area include Yuma clapper rail habitat, and state and federally-managed wildlife areas. The streams or lakes in the downstream area support various recreational uses, including fishing and nature study. While records of prehistoric and historic sites exist for the area, these sites are generally not identifiable or are in poor condition due to previous flooding.

Communities in the downstream area affected by flood control provided by CAWCS alternatives are the cities of Mesa, Tempe, and Phoenix; the Salt River Pima-Maricopa and Gila River Indian Communities and the Buckeye and Holly Acres subdivision areas. Numerous infrastructure and transportation networks and facilities are also located in the flood plain area.

IV. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

Tables 4, 5, and 6 provide a description of the environmental consequences of the alternative plans, focusing on the significant resource categories identified during scoping. These tables summarize the analysis in a large number of CAWCS supporting documents, including Stage III Methodology for Environmental Quality Assessment, Environmental Impacts and Effects of Plans (7 vols.), Social Impacts and Effects of CAWCS Plans, and Economics-Financial Supporting Document.

A. Methodology

1. Impact Assessment

The procedure for assessing impacts of the plans involved aggregating impacts of the elements (Cliff, New/Modified Roosevelt, New/Modified Stewart Mountain, Confluence, and New Waddell Dams and Verde River Dams Modifications) that compose the plans. The impact assessment methodology consisted of a series of steps whereby environmental conditions without the project were compared to conditions with the project. The measured difference between the two conditions for a factor (i.e., stream-oriented recreation) is the impact. The baseline condition without the project is a projection of all the relevant environmental factors into the

year 2000. This future-without condition would occur if there were no project action and is therefore the condition associated with Plan 8, the No Action Alternative. The condition that would occur with each of the action alternatives (Plans 1, 2, 3, 6, 7, and 9) was compared against this future-without condition to arrive at the impact.

All aspects of project action were considered in assessing impacts, including construction, reservoir inundation, operation/maintenance, and secondary use.

2. Effects Evaluation

While the impact is the measured difference between future-without and future-with conditions for a factor, the effect is the interpretation of the significance of the impact. Effects were determined on the basis of the impact's direction (beneficial or adverse), duration (short-term or long-term), magnitude (degree of change), and the quality of the affected resource. Beneficial effects indicate that the quality of the resource is improved; adverse effects indicate the quality is degraded. Depending on the characteristics of the impact, one of the following effect levels has been assigned:

- Insignificant (I): small, ephemeral change, usually affecting a low-quality resource
- Significant Beneficial (SB): major improvement in a condition, usually long-term and affecting a high-quality resource
- Beneficial Flag (BF): extraordinary beneficial change in a unique, protected, or very high-quality resource
- Significant Adverse (SA): major degradation of a condition, usually long-term and affecting a high-quality resource
- Adverse Flag (AF): extraordinary adverse change in a unique, protected, or very high-quality resource.

3. Mitigation

Mitigation measures shown on Tables 4 and 5 represent mitigation concepts which were developed for the impacts in each of the resource areas. These concepts are workable mitigation measures that could reduce or avoid impacts if implemented. They are conceptual, rather than specific, because they were developed to apply equally to impacts of all plans. These conceptual measures were used for comparison purposes only.

After the selection of Plan 6 as the proposed action, Reclamation has developed and is committed to a mitigation program.

B. Impacts and Effects of Alternatives

Six resource categories are shown in the tables presented in this chapter, as are the important factors within each category which would be affected by project actions. Resources determined to be significant during the EIS scoping process are:

- Biological Resources
- Water Quality
- Recreation
- Cultural Resources
- Social Resources
- Economics

Resources which would be affected by project actions but were determined not to be significant to the choice among the alternatives are air quality, aesthetics, noise, geology/soils, and land resources. Impacts to these resources are not shown in the following tables, but are described in the supporting documents Environmental Impacts and Effects of Plans, Volumes 1-7.

1. Environmental Consequences

Table 4 summarizes the environmental consequences of Plans 8, 1, 2, 3, 6, 7, and 9. Environmental impacts and effects are displayed for significant resource factors, as are mitigation measures to reduce or avoid impacts where impacts are adverse. The unmitigated and mitigated effects are shown, separated by a slash (unmitigated/mitigated).

2. Social Consequences

Table 5 displays the social impacts and effects of relocations and of flood reduction. Where applicable, mitigation measures are described and the unmitigated and mitigated effects are shown. Social impacts and effects of plans are described in greater detail in the supporting document Social Impacts and Effects of CAWCS Plans.

3. Economic Consequences

Economic costs and benefits of plans are shown in Table 6. The benefits measure the provision of energy management (Plans 3, 6, 7, 9), flood control (all plans), recreation (Plans 1, 3, 6, 7, 9), water supply (all plans), SOD (all plans). Details of the economic analysis are presented in Economics-Financial Supporting Document. Options for New or Modified Roosevelt and Stewart Mountain Dams are displayed in Table 6. The determination to modify existing dams or construct new dams will be based upon the results of stability analyses and operations studies currently being

conducted by Reclamation; the environmental and social impacts and effects of new or modified structures are nearly identical and will not, therefore, be considered in the determination.

Table 4

SUMMARY OF ENVIRONMENTAL IMPACTS AND EFFECTS OF PLANS

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
BIOLOGICAL RESOURCES							
Threatened/Endangered Plants and Wildlife							
Loss of acres of preferred habitat in typical year (bald eagle in all plans and Yuma clapper rail in Plan 3)	+300 (2,260 acres in site areas)	-440	-430	-1,030	-440	-440	-170
Number of bald eagle breeding areas with disrupted productivity as a result of loss of stream miles (see Perennial Stream/Riverine Communities factor)	0 (5 breeding areas in site areas, of which 3 most productive are at Confluence; 6 breeding areas in CAWCS area; 13 breeding areas in southwestern U.S.)	1	0	2	3	1	0
Conceptual Mitigation		Establish 230 acres preferred habitat	None proposed	Establish 370 acres preferred habitat	Section 7 reasonable and prudent alternatives will be implemented	Establish 280 acres preferred habitat	None proposed
Typical Year Unmitigated/ Mitigated Effect		SA/I	I	AF/AF	SA/I	SA/I	I
Riparian/Wetland Biotic Communities							
Loss or gain of high quality habitat in typical year	-2,260 (9,970 acres in site areas)	-930	-900	-3,330	-1,140	-1,140	-740
Loss or gain of low-quality habitat in typical year	-90 (1,940 acres in site areas)	+420	+860	+1,040	+1,030	+1,020	+740
Total loss or gain of acres of habitat in typical year	-2,350 (11,910 acres in site areas)	-510	-40	-2,290	-110	-120	0
Conceptual Mitigation		Establish 480 acres of high quality habitat	Establish 790 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 120 acres of high quality habitat
Typical Year Unmitigated/ Mitigated Effect (on high quality habitat)		SA/SA	SA/SA	AF/AF	SA/I	SA/SA	I/I

Table 4 (continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
BIOLOGICAL RESOURCES Cont'd							
Perennial Stream/ Riverine Communities							
Loss of miles of perennial stream in typical year	0 (70 miles in site areas; 137 miles in CAWCS area)	-3	+1	-16	+1	-2	0
Change in flow characteristics of Salt and Verde Rivers	No change (on average, 106 days/ year $\leq$ 50 cfs in Salt, 61 days/year $\leq$ 50 cfs in Verde)	No change	No change	No change	No change	Guaranteed minimum flows of 200 cfs in Salt and Verde	No change
Conceptual Mitigation		None proposed	None proposed	Stream losses not mitigatable	None proposed	None proposed	None Proposed
Typical Year Unmitigated/ Mitigated Effect		I	I	AF/AF	I	SB	I
Reservoir Aquatic Communities							
Gain or loss of surface acres of habitat in typical year	0 (13,640 acres in site areas; 30,000 acres in CAWCS area)	+400	-360	+3,080	+1,900	+3,690	+1,770
Gain of guaranteed minimum pool(s)	0 (no guaranteed minimum pools at SRP lakes or Lake Pleasant)	0	0	+1 minimum pool at Confluence	+1 minimum pool at New Waddell	+2 minimum pools at Cliff and New Waddell	0
Drawdown rates greater than 2 inches/day during spawning season	No change (drawdown rates 1.3 in/day at Roosevelt, 9.2 in/day at Horseshoe, 1.6 in/day at Lake Pleasant)	4.6 in/day at Cliff (decrease from current condition)	9.2 in/day at Cliff (no change from current condition)	4.0 in/day at Cliff and 2.6 in/day at Confluence (increase over current condition)	4.0 in/day at Cliff and 4.7 in/day at New Waddell (increase over current condition)	4.5 in/day at Cliff and 4.7 in/day at New Waddell (increase over current condition)	4.7 in/day at New Waddell
Conceptual Mitigation		None proposed	None proposed		Reduction in drawdown rates to 2 in/day during spawning season		
Typical Year Unmitigated/ Mitigated Effect		I	I	SA/SB	SA/SB	SA/BF	SA/SB

Table 4 (continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
WATER QUALITY							
Constituents	CAP water in local systems at locations and times chosen by users. Local surface water sources maintain quality independent of CAP influence. CAP water known to have high levels of dissolved organics	Average of 70,000 af of SRP (Verde River) water exchanged w/CAP each year. Comparison of Water Sources[a] (mg/l) Ca 42.5 / 85.6 D Cd 0.00156 / <0.000286 T Cd 0.00619 / <0.00462 T Fe 0.192 / 0.159 Hard 212. / 339. Na 30.5 / 107. D Pb 0.00300 / 0.00144 T Pb 0.0714 / 0.0408 D Se 0.000750 / <0.00300 T Se 0.000600 / <0.00279 SO_4 52.9 / 309. TDS 314. / 722. After-exchange maximum concentrations reach new highs for numerous constituents. Degradation of some SRP water during period when only Verde River water is normally delivered. Possible short-term impacts to M&I and agricultural users. Short exchange period affects only 8% of SRP surface water.	No change from future-without condition.	Annual average of 845,000 af of SRP surface water mixed with 250,000 af of CAP water at Confluence site. 30-35% of SRP water treated for M&I use. Changes in Average Verde River Concentrations[a] (mg/l) Ca 42.5 to 61.4 (+44%) D Cd 0.00156 to 0.00100 (-36%) T Cd 0.00619 to 0.00550 (-11%) T Fe 0.192 to 0.178 (-7%) Hard 212. to 268. (+26%) Na 30.4 to 64.0 (+111%) D Pb 0.00300 to 0.00232 (-23%) T Pb 0.0714 to 0.0580 (-19%) D Se 0.000750 to 0.00174 (+132%) T Se 0.000600 to 0.00156 (+160%) SO_4 52.9 to 165. (+212%) TDS 314. to 493. (+57%) After-mix maximum SRP concentrations reach new highs for numerous constituents. All of SRP surface water degraded and possible increased M&I treatment costs with short-term maximum CAP concentrations. Possible changes in agricultural operation only during period when Verde River water is normally delivered. High dissolved organic levels in CAP water reach water treatment plants which otherwise would receive only SRP water.	Annual average of 25,000 af of MCMWCD#1 surface water mixed with 701,800 af of CAP water at Waddell site. None of the MCMWCD#1 water treated for M&I uses. Changes in Average MCMWCD#1 Concentrations[a] (mg/l) Ca 50.8 to 84.4 (+66%) D Cd <0.00300 to 0.000378 (-87%) T Cd <0.00150 to 0.00451 (+201%) T Fe 2.04 to 0.223 (-89%) Hard 215. to 335. (+56%) Na 37.8 to 105. (+178%) D Pb 0.00200 to 0.00146 (-27%) T Pb 0.00425 to 0.0396 (+832%) D Se <0.00100 to 0.00293 (+193%) T Se <0.00100 to 0.00273 (+173%) SO_4 85.0 to 301. (+254%) TDS 358. to 710. (+98%) After-mix maximum MCMWCD#1 concentrations reach new highs for numerous constituents with no significant effect on agricultural users.		
Conceptual Mitigation		None proposed	Not applicable	None proposed	None proposed	None proposed	
Typical Year Unmitigated Effect		I	No effect	SA	I	I	

Table 4 (continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
WATER QUALITY Cont'd							
Eutrophication							
Potential for eutrophic conditions to occur in reservoirs which store CAP Colorado River water in CAWCS study area[b].	No Colorado River water storage reservoir in study area.	Same as Future Without Condition		Confluence Reservoir has high potential for eutrophication with high probability for blue-green algal dominance. Probable aesthetic impacts on Verde arm in most years. Eutrophication provides potential for increased levels of dissolved organics in Confluence Reservoir water.	New Waddell Reservoir has low to moderate potential for eutrophication with no projected problems		
Conceptual Mitigation		------- Not applicable --------		Downstream impacts mitigatable with different disinfection process for SRP M&I water.	None proposed		
Typical Year Unmitigated/ Mitigated Effect		--------- No Effect ----------		SA/I	I	I	
Salt Loading							
Increased amount of dissolved salts imported in Colorado River water.	Baseline CAP imports average of 1,020,000 tons of dissolved salts each year.	10.6% increase in average annual imported salt volume.	1.6% increase in average annual imported salt volume.	16.2% increase in average annual imported salt volume.	13.3% increase in average annual imported salt volume.	11.3% increase in average annual imported salt volume	
Conceptual Mitigation		None proposed	None proposed	None proposed	None proposed	None proposed	
Typical Year Unmitigated/ Effect		I	I	I	I	I	

[a]Prefix D means dissolved fraction while T means total recoverable. All values shown rounded to three significant figures. Constituents shown on this table were selected to show some significant impacts; a more complete list of constituents and their impacts is included in Chapter IVB2.

[b]Eutrophication potentials were computed using the Canfield and Bachman equations described in the USBR Technical Memorandum titled "Guidelines for Studies of Potential Eutrophication" Denver, Co., 1981. Risk of eutrophication under normal operating conditions is based on phosphorus concentration which is assumed uniform over the studied area.

Table 4 (continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
CULTURAL RESOURCES							
Prehistoric Cultural Resources							
Number of sites destroyed by construction activities/total number of sites potentially affected in dam site areas[c]	0 sites in site areas)	132/2,942	72/2,942	156/3,208	158/3,062		53/3603
Acres of archaeological deposits affected	0 acres of deposits in site areas)	4,272	4,272	12,015	4,374		4688
Effects Factor (for total sites affected)[d]		-5,760	-4,747	-14,665	-5,887		-5456
Conceptual Mitigation		Avoiding resource; partial data recovery (e.g., mapping sites, collection of surface artifacts, use of remote sensing techniques, test excavations, partial site excavations); site protection (e.g., fencing around site, policing, site monitoring, enforcement of laws against vandalism). Complete mitigation of impacts not possible.					
Unmitigated/ Mitigated Effect		AF/AF	AF/AF	AF/AF	AF/AF		AF/AF
Historic Cultural Resources							
Number of sites destroyed by construction and related activities/ total number of sites potentially affected in dam site areas[c]	0 (192 sites in site areas)	29/64	29/64	73/90	39/73		36/67
Effects Factor (Range)[d]		-73 to -320	-173 to -370	-438 to -798	-225 to -422		-207 to -383
Conceptual Mitigation		Avoiding resource; partial data recovery; site protection; site documentation (e.g., recording surface architecture or structural features); additional historical research.					
		Roosevelt Dam and Verde River Sheep Bridge impacts only partially mitigable		Fort McDowell, Roosevelt Dam, and Verde River Sheep Bridge impacts only partially mitigable	Roosevelt Dam and Verde River sheep Bridge impacts only partially mitigable		Roosevelt Dam impacts only partially mitigable
Unmitigated/ Mitigated Effect		AF/AF	AF/AF	AF/AF	AF/AF		AF/AF

[c]Affected areas include all reservoir pool zones plus a secondary impact zone that extends approximately 1 mile beyond the maximum water surface elevation.

[d]This factor incorporates both the quality of the resource and the severity of the impacts. See Stage III Methodology for Environmental Quality Assessment (Dames & Moore, 1981) for details.

Table 4 (continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
RECREATION							
Stream-Oriented Recreation							
Net loss or gain of miles of perennial stream/loss of tubing miles in typical year	0/0 (70 stream miles in site areas; 986 miles in 5-county region)	-3/0	+1/0	-16/17	+1/0	-2/0	0/0
Net loss or gain in maximum annual recreation days for stream-oriented activities in typical year	0/0 (2,280,000 stream-oriented recreation days in site areas; 8,236,000 in 5-county region)	+5,850	+696	-1,504,802	+7,992	+6,386	0
Conceptual Mitigation		None proposed	None proposed	Loss of stream miles not mitigatable	None proposed	None proposed	None proposed
Typical Year Unmitigated/ Mitigated Effect		I	I	AF/AF	I	I	I
Reservoir-Oriented Recreation							
Net loss or gain in usable surface acres in typical year	0 (16,600 acres in site areas; 35,000 in 5-county region)	+683	-853	+5,243	+4,222	+5,095	+4,233
Net loss or gain in maximum annual recreation days for reservoir-oriented activities in typical year	0 (822,000 reservoir-oriented recreation days in site areas; 6,479,000 for 5-county region)	+670,520	-48,647	+3,537,383	+1,066,005	+1,085,873	+884,000
Conceptual Mitigation		---------- None proposed for this factor ----------					
Typical Year Unmitigated Effect		SB	I	SB	SB	BF	SB

Table 5

SUMMARY OF SOCIAL IMPACTS AND EFFECTS OF PLANS

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 8 CAWCS No Action (Future Without the Project)	For 374 Fort McDowell Indian Community residents: Normal incidence of physical and mental health problems. High satisfaction with way of life. High levels of personal automony. High potential for increased financial self-sufficiency. High levels of extended family ties. Normal incidence of family problems. High community cohesion and viability. High potential for increased tribal economic self-sufficiency. Moderate levels of unemployment. High potential for sustaining Yavapai culture.	For 596 Roosevelt Lake area residents: Normal incidence of physical and mental health problems. High levels of personal automony. High satisfaction with way of life. High potential for financial self-sufficiency. Low levels of informal support networks in all communities except Roosevelt Gardens. Low to moderate community cohesion in all communities except Roosevelt Gardens. Community development likely to remain at present low level.	For 46,560 people living in the flood prone areas by the year 2000 (conditions occur with a 200-year flood of 275,000 cfs) COMMUNITIES AFFECTED: Mesa, Tempe, Phoenix, Salt River Pima Maricopa Indian Community (SRPMIC), Gila River Indian Community (GRIC), Buckeye, Holly Acres: Potential for inundation for 46,560 individuals. High probability for large numbers of flood-related deaths. Projected $87,292,000 in residential property damage. Temporary lifestyle disruption for 46,560 individuals subjected to inundation by floodwaters. Permanent changes in lifestyle for majority of 525 sequential disaster victims in Holly Acres. Damages to roads and bridges projected to be $15,800,000. Transportation delay costs projected to be $39,694,000. Air and rail facility damages projected to be $7,021,000. Damages of $6,400,000 to power facilities. >$275,000 in damages to treatment plants. Temporary delays in telephone service. Business losses of $68,713,000; combined with both short- and long-term revenue losses, costs could be in excess of $150 million. Short- and long-term losses to tourism. Civil defense warning system fully activated. Emergency costs of $1,109,000. No additional land available for development.

Table 5 (continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 1	Same as Future-Without conditions.	IMPACTS For 347 Roosevelt Lake area residents: Slight increase in incidence of physical and mental health problems. Substantial decrease in personal automony. Substantial decrease in satisfaction with way of life. Moderately reduced financial capacity. Moderate decrease in informal support networks. Moderate decrease in community cohesion. Substantial decrease in community viability. MITIGATION: Relocate only those people who live within the 200-year flood pool, with no relocation of people in the IDF area. Provide Forest Service land in the Roosevelt Lake area for relocations, allowing enough space so neighbors may relocate near each other if they wish. Provide monetary compensation for all relocation expenses incurred by residents. Provide special services to meet needs that are unique to these communities. Provide an accurate and reliable system for disseminating information to residents so that they are constantly informed about relocation proceedings; provide a means by which residents can participate in the relocation planning process. UNMITIGATED/MITIGATED EFFECT: SA/I	IMPACTS For 46,560 people living in the flood prone areas by the year 2000 (conditions occur with reduction of a 200-year flood to 70-92,000 cfs at airport): Potential for inundation for less than 100 individuals in Holly Acres area. Projected $602,000 in residential property damage. Temporary lifestyle disruption for <100 individuals; permanent lifestyle disruption for majority of sequential disaster victims in Holly Acres. 15 bridge crossings remain operable. Damages to roads and bridges totalling <$5,000,000. No significant delays in transportation. Damages to electrical transmission towers and power lines would be well below $1 million. Possibility of delays in telephone service for some. No delays in delivery schedules of newspapers, mail, etc. Business losses totaling $6,194,000; majority of damages occurring to sand and gravel operations. No significant disruption to tourist trade. Emergency costs would be below $60,000. Approximately 3,563 additional acres valued at $107,311,000 available for higher urban uses. MITIGATION: Not required UNMITIGATED EFFECT: BF

Table 5 (continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 2	Same as Future-Without conditions.	IMPACTS For 247 Roosevelt Lake area residents: Slight increase in incidence of physical and mental health problems. Substantial decrease in personal automony. Moderate decrease in satisfaction with way of life. Moderately reduced financial capacity. Moderate decrease in informal support networks. Moderate decrease in community cohesion and slight decrease in social organization. Substantial decrease in potential for sustained community viability. MITIGATION: Relocate only those people who live within the 200-year flood pool, with no relocation of people in the IDF area. UNMITIGATED/MITIGATED EFFECT: SA/No effect	IMPACTS For 46,560 people living in the flood-prone areas by the year 2000 (conditions occur with a reduction of 200-year flood to 157,000 cfs at airport): Potential for inundation of approximately 525 individuals. Low probability of flood-related deaths. Projected $5,684,000 in residential property damage. Temporary lifestyle disruption for 525 individuals inundated; permanent lifestyle disruption for many sequential disaster victims in Holly Acres. 15 bridge crossings remain operable. Closure of all dip crossings. Damages to roads and bridge crossings totalling >$5,000,000. No significant delays in transportation. Damages totaling $1,500,000 to electrical transmission towers and power lines. Approximately $80,000 in damages to sewage and wastewater treatment plants. Temporary delays in telephone service in some areas. No delays in delivery schedules of newspapers, mail, etc. Business losses totalling $6,977,000; majority of damages to sand and gravel operations. No significant disruption in tourist trade. Civil defense warning system fully activated. Emergency costs in excess of $505,000. 2,248 acres valued at $66,026,000 available for higher urban uses. MITIGATION: Not required. UNMITIGATED EFFECT: SB

Table 5 (continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 3	IMPACTS: For 290 Fort McDowell Indian Community residents: High incidence of physical and mental health problems which is expected to result in increased illness and mortality. Extreme decline in levels of personal autonomy. Extreme decrease in satisfaction with way of life. Substantial decrease in potential for sustained financial self-sufficiency. Substantial decrease in extended family ties. Substantial increase in incidences of family problems. Extreme decrease in community cohesion and viability. Substantial decrease in potential for tribal economic self-sufficiency; substantial increase in unemployment. Extreme decrease in potential to sustain Yavapai culture. MITIGATION: Relocate the entire community together. Provide land of the highest available quality contiguous to the reservation. Monetary compensation should cover all expenditures. Provide for participation of the entire community in all decisions and plans. Provide a system for disseminating information to residents. UNMITIGATED/MITIGATED EFFECT: AF/AF	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.
Plan 6 (Agency Proposed Action)	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.
Plan 7	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.

Table 5 (continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 9	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	IMPACTS For 46,560 people living in the flood-prone areas by the year 2000 (conditions occur with a reduction of 200-year flood to 215,000 cfs at airport): Potential for inundation of >525 individuals. Low probability of flood-related deaths. Projected $18,954,000 in residential property damage. Temporary lifestyle disruption for >525 individuals inundated; permanent lifestyle disruption for many sequential disaster victims in Holly Acres. 3 bridge crossings remain operable. Closure of all dip crossings. Damage to roads and bridge crossings totalling $9,100,000. Significant delay in transportation. Damages totalling $4,800,000 to electrical transmission towers and power lines. Greater than $135,000 in damages to sewage and wastewater treatment plants. Temporary delays in telephone service in some areas. Delays in delivery schedules of newspapers, mail, etc. Business losses totalling $21,761,000; majority of damages to sand and gravel operations. Short-term disruption in tourist trade. Civil defense warning system fully activated. Emergency costs in excess of $809,000 MITIGATION: Not required. UNMITIGATED EFFECT: B

Table 6

SUMMARY OF ECONOMIC COSTS AND BENEFITS OF PLANS

ECONOMICS	Plan	Total Construction Cost ($ Range)[a]	Total Annual Cost ($ Range)[a]	Total Annual Benefits ($)	Net Economic Benefits ($ Range)[a]
Plan 8	(No CAWCS Action)	0	0	0	0
Plan 1		694,940,000 to 874,230,000	58,060,000 to 71,300,000	89,040,000	30,980,000 to 17,740,000
Plan 2[b]		541,570,000 to 627,460,000	41,870,000 to 48,210,000	53,310,000	11,440,000 to 5,100,000
Plan 3		1,116,250,000 to 1,295,540,000	93,970,000 to 107,200,000	125,970,000	32,000,000 to 18,770,000
Plan 6	(Agency Proposed Action)	978,430,000 to 1,157,720,000	82,710,000 to 95,940,000	174,290,000	91,580,000 to 78,350,000
Plan 7		same as Plan 6	same as Plan 6	168,160,000	85,450,000 to 72,220,000
Plan 9		931,790,000 to 1,111,080,000	76,030,000 to 89,260,000	143,089,000	53,829,000 to 60,169,000

[a]Costs range from Modified Roosevelt/Modified Stewart Mountain options to New Roosevelt/New Stewart Mountain options. Net economic benefits correspond to these options. Costs of plans would be allocated among several funding sources; for this analysis 2 sources were assumed: Reclamation Safety of Dams Act and Colorado River Basin Project Act.

[b]New Roosevelt is not included in Plan 2.

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I. PURPOSE AND NEED FOR THE ACTION

I. PURPOSE AND NEED FOR THE ACTION

A. Background

This environmental impact statement (EIS) describes and evaluates the proposed construction and operation of the Regulatory Storage Division of the Central Arizona Project (CAP) by the U.S. Bureau of Reclamation. Construction of the CAP Regulatory Storage Division was authorized by Section 301(a)(3) of the Colorado River Basin Project Act (P.L. 90-537) of 1968. This feature of the CAP was investigated under the title Central Arizona Water Control Study (CAWCS).

The CAP was authorized under P.L. 90-537 on September 30, 1968. The primary purpose of the CAP is to furnish water for irrigation, municipal, and industrial use in central Arizona and western New Mexico. Because of its large size and complexity, the CAP is divided into several features serving separate but interrelated functions.

To achieve compliance with the National Environmental Policy Act (NEPA) of 1969, an overall EIS was filed for the entire CAP on September 26, 1972 (U.S. Bureau of Reclamation, 1972). This statement committed the Bureau of Reclamation (Reclamation) to prepare individual site-specific EIS's for major features of the CAP. Since that time six final EIS's have been filed by Reclamation for individual features of the project: Havasu Intake Channel, Havasu Pumping Plant, Buckskin Mountains Tunnel (January 1973); Granite Reef Aqueduct (January 1974); Granite Reef Aqueduct Transmission System (August 1975); Salt-Gila Aqueduct (November 1979); Tucson Aqueduct Phase A (July 1982); and Water Allocations and Water Service Contracting (March 1982). These features of the CAP are either completed or are under construction. Remaining authorized features of the CAP, in addition to the Regulatory Storage Division, that are in the planning stage are Tucson Aqueduct Phase B, Hooker Dam or a suitable alternative, Indian Distribution System, and Buttes Dam and Reservoir.

The seven alternative plans for the CAP regulatory Storage Division described in detail in this EIS address regulatory storage of Central Arizona Project water and flood control of the Salt and Gila Rivers through the metropolitan Phoenix area. The EIS also described concurrent and coincident aspects of the Safety of Dams (SOD) program. The 1978 Reclamation Safety of Dams Act (P.L. 95-578) directs the Secretary of the Interior to preserve the structural safety of Reclamation dams and related facilities by performing modifications that may be reasonably required. Since the construction and operation of the CAP Regulatory Storage Division and SOD features will involve common timing and locations, the purposes of both authorizing legislations have been combined in the CAWCS.

A number of alternatives have been evaluated in the CAWCS planning process which provide for the authorized Regulatory Storage Division and include means to insure the structural safety of Reclamation dams operated by the Salt River Project (SRP). Based on the development and ranking of preliminary plans, six "candidate" plans in the draft EIS, including a CAWCS "no action" alternative, were identified. A seventh plan was included in this document in response to public comments received on the Draft EIS.

The EIS is supported by 23 technical reports covering all aspects of CAWCS planning, designs, public involvement, social and environmental impact assessment, economics, and hydrological analyses (see listing in Bibliography). Because of the magnitude and detail of information contained in these documents, the EIS complies with the Council on Environmental Quality (CEQ) regulations for incorporating material into an EIS by reference when the effect will be to reduce bulk without impeding agency and public review of the action. In order to present relevant information and to focus on major issues, the EIS presents information from the supporting documents in a greatly abbreviated manner and references appropriate documents where more detail may be found.

B. Geographic Setting

The CAWCS study area encompasses approximately 13,400 square miles, or 8,576,000 acres, in central Arizona, including portions of Maricopa, Gila, and Pinal Counties. Figure I-1 shows the study area. The entire metropolitan Phoenix area is located within the CAWCS boundaries. Portions of the study area outside the metropolitan area are characterized by mountain ranges with steep slopes and rugged topography separated by broad, gently sloping valleys. The climate is marked by low annual rainfall, hot summers, and mild winters. Vegetation and wildlife are typical of the southwestern Sonoran Desert.

Water in the study area comes from four major streams and their tributaries supplemented by ground water. These streams are the Salt, Verde, Gila, and Agua Fria Rivers. Several dams are located on these rivers including six Salt River Project-operated dams on the Salt and Verde Rivers which impound water for distribution to municipal, residential, and agricultural users. The SRP-operated dams are Federally owned. Waddell Dam on the Agua Fria River, stores water for agricultural use by Maricopa County Municipal Water Conservation District #1 (MCMWCD#1), the owner and operator of the facility.

The population of the area is over 1.5 million people, almost 90 percent of whom reside in Maricopa County. There are six Indian communities in the study area: Fort McDowell Mohave-Apache (Yavapai), Gila River, Salt River Pima-Maricopa, Ak-Chin, Gila Bend, and Papago. The aggregated population of these Indian communities is just over 13,000.

Vast portions of the CAWCS area remain in their natural state, unaltered or only slightly modified by man's activities. About 75 percent of the area is rangeland. Agricultural lands, urban built-up lands, forest lands, barren lands, water bodies, and wetlands comprise the remainder. About 70 percent of the lands in the area remain in public ownership or are Indian reservations.

The CAWCS area is a major center for economic activity in the Southwest. Leading factors in the area's economy are manufacturing, mining, tourism, retail trade and services, government, and agriculture. Over the last twenty years, the Phoenix area has experienced unprecendented growth due to heavy immigration.

C. Purpose

The alternative actions described in this EIS have three principal purposes. These are:

1. To increase the operating efficiency of the CAP through the conservation of Salt, Verde, and Agua Fria River flows, and through regulation of Colorado River water deliveries from the Granite Reef Aqueduct.
2. To provide facilities and means to meet the flood control needs on the Salt and Gila Rivers through the Phoenix metropolitan area.
3. To provide for the structural safety of existing Bureau of Reclamation dams on the Salt and Verde Rivers.

In addition to these major project purposes, several planning objectives were adopted to aid in developing and evaluating plans. These included, among other things, opportunities for fish and wildlife enhancement, potential for recreational development and enhancement, opportunities for hydroelectric power production, opportunities to improve the management and protection of open space and the potential for multi-purpose projects such as the Rio Salado concept, and protection of unique archaeological and historical resources in the CAWCS study area. These objectives are addressed either in the design of the alternative plans or in initiatives for impact mitigation.

D. Need

1. Regulatory Storage

Construction of regulatory storage unit for CAP water would improve the operating flexibility and efficiency of the CAP and would allow the importation of greater quantities of Colorado River water in years when it is available. Without regulatory storage capacity, the CAP system could be operated only in direct response to demand. The demand for water is greatest during the summer and during the daytime hours. If regulatory storage space is available, water could be pumped and stored, irrespective of demand, during off-peak periods for delivery during peak periods.

A major advantage of flexible operation of the CAP system is more efficient energy management. With regulatory storage, water could be pumped during off-peak periods (for example, at night or during the winter) when energy is less valuable. The benefit resulting from this energy management would be the ability to use surplus power not needed for CAP pumping to meet peak loads of other power producers, such as utility companies (see Economics-Financial Supporting Document, USBR, 1982d).

Regulatory storage would increase the efficiency (increase water yield) of the CAP system during years when the local rivers have surpluses or the Colorado River supplies are above normal, and during possible interruptions in the system such as power failures. In the event of the latter occurrences, water from regulatory storage could continue to be delivered to at least part of the system. During the supply surpluses,

regulatory storage would allow for storage and use of water which would otherwise be spilled and wasted.

2. Flood Control

Flooding of the Salt and Gila Rivers has been a problem in the Phoenix metropolitan area since its early settlement. Most recently, a series of floods caused substantial damages in the form of income losses, emergency costs, and property damage. Severe impacts on transportation and on people living in the flood zone also resulted. Monetary damages resulting from the February 1978 floods were estimated at $31 million, with damages from the December 1978 and February 1980 floods set at $46 million and $64 million, respectively (U.S. Army Corps of Engineers, 1979a,b; 1981a). These floods created strong public and private-sector demand for flood control on the Salt River.

The worst of these floods in February 1980 peaked at 170,000 cubic feet per second (cfs) through Phoenix. By comparison, the U.S. Army Corps of Engineers (Corps) has calculated the flow for a 200-year event under present conditions as 275,000 cfs. The 100-year event would have a flow of 215,000 cfs.

3. Dam Safety

Hydrologic analyses based on revised calculations for the maximum probable flood (in the CAWCS this is the Inflow Design Flood or IDF) on the Salt and Verde Rivers indicate that all six SRP storage dams have inadequate storage and/or spillway and outlet capacity to contain and/or pass the IDF without overtopping (see Hydrology Supporting Document, USBR, 1982h). Such an occurrence could jeopardize the safety of the dams. The overtopping or failure of any of these dams is considered serious because of the potentially catastrophic consequences which would result for Phoenix and other downstream communities.

The Reclamation Safety of Dams Act provides for the least cost solution to solve SOD problems on existing dams. Further information on dam safety requirements and possible solutions on the Salt and Verde Rivers is contained in Safety of Dams Supporting Document, (USBR, 1982c).

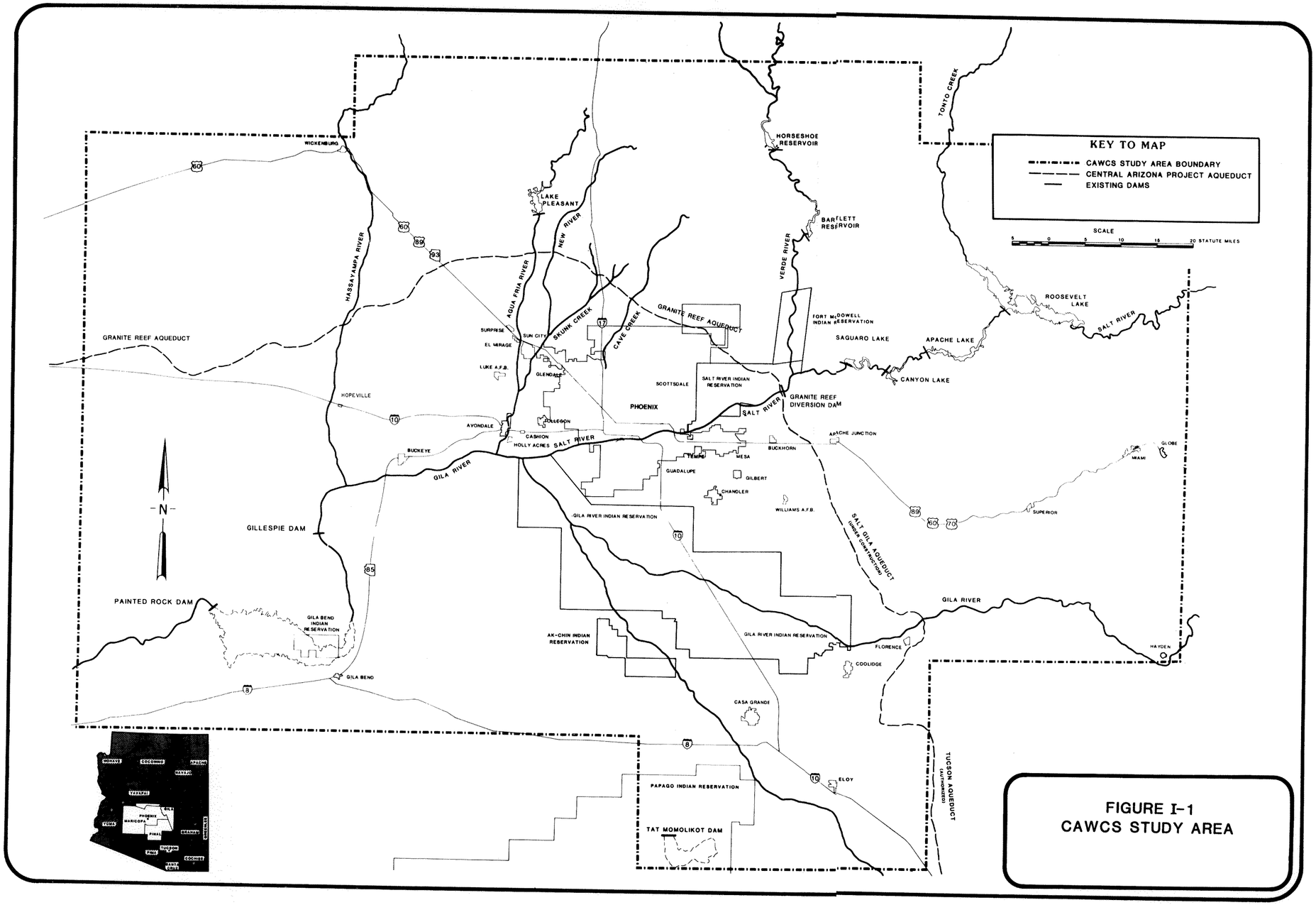


FIGURE I-1
CAWCS STUDY AREA

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

II. ALTERNATIVES INCLUDING THE PROPOSED ACTION

A. Alternatives Eliminated from Further Study

The CAWCS was initiated in July 1978 to develop and evaluate alternatives for regulatory storage of Central Arizona Project (CAP) water in central Arizona and flood control of the Salt and Gila Rivers through the Phoenix metropolitan area. Safety of the Bureau of Reclamation dams on the Salt and Verde Rivers was also included as a major objective of the CAWCS.

The study was conducted in three stages, following a process of transition from a wide array of possible solutions in Stage I to a single proposed action at the end of Stage III. This process is described in detail in Plan Formulation Supporting Document (USBR, 1982g).

1. Stage I Alternatives

Initially in Stage I, 34 separate elements were identified which singly or in combination could provide the two main CAWCS purposes of flood control and regulatory storage. The elements were examined at an initial level of study to determine their effectiveness, and 20 elements were recommended for more detailed study in Stage II, largely on the basis of site suitability, location, and cost. The results of the Stage I analysis are displayed in Table II-1.

2. Stage II Alternatives

Some of the elements carried into Stage II were "competing"; this means that two or more elements provided essentially the same function in different locations. Therefore, the first step in Stage II was to screen the competing elements to identify the best to be used in forming systems which could provide both regulatory storage and flood control. The results of the screening were as follows:

- Three sites were screened primarily for flood control on the Verde River: New Horseshoe Dam Cliff Dam which would be located 6 miles downstream from the existing Horseshoe Dam and New Bartlett Dam. The analysis showed that the New Horseshoe site was clearly inferior to New Bartlett in terms of environmental impact. However, the cost for New Bartlett was over twice that of other elements. Cliff Dam was comparable to New Horseshoe in cost and better in terms of environmental impact. Therefore, Cliff Dam was selected for use in forming systems.

- The two sites that were investigated for flood control and/or regulatory storage at the Salt/Verde confluence were Confluence Dam and New Granite Reef Dam, 4 miles downstream. New Granite Reef Dam was eliminated because geology and cost significantly favored the Confluence site, while environmental and social impacts were essentially the same at both sites.
- Three channelization elements were studied: channels on the Salt River, levees on the Salt and Gila Rivers, and greenbelt areas constructed with the Salt River levee system. The screening indicated that the elements were similar except for cost. On the basis of cost, levees were selected for forming systems.

Table II-1

STAGE I RESULTS OF ELEMENT EVALUATION

Element	Purpose		Further Study	
	Flood Control	CAP Storage	Warranted	Unwarranted
VERDE RIVER				
Tangle Creek	o	o		o
Modified Horseshoe	o	o	o	
Cliff	o	o	o	
New Bartlett	o	o	o	
SALT RIVER				
Carrizo Creek	o			o
Klondike Buttes	o			o
Modified Roosevelt	o	o	o	
Coon Bluff		o		o
Confluence	o	o	o	
Granite Reef	o	o	o	
Rio Salado Low Dams		o		o
AGUA FRIA RIVER				
Lake Pleasant		o	o	
New Waddell		o	o	
Agua Fria Siphon		o		o
Calderwood Butte		o		o
North Phoenix Dams (for CAP)		o		o
GILA RIVER, SANTA ROSA WASH				
Coolidge		o		o
Florence		o	o	
Buttes		o	o	
Tat Momolikot		o	o	
Painted Rock Reservoir		o		o

Table II-1 (Continued)

Element	Purpose		Further Study	
	Flood Control	CAP Storage	Warranted	Unwarranted
CHANNELS				
Granite Reef to Country Club	o			o
Country Club to 35th Ave.	o		o	
35th Ave. to Gillespie Dam	o			o
LEVEES				
Granite Reef to Country Club	o			o
Country Club to 35th Ave.	o		o	
35th Ave. to Salt-Gila Confluence	o			o
Salt-Gila Confluence to Gillespie Dam	o		o	
CHANNEL CLEARING	o		o	
WATER EXCHANGE WITH SRP		o	o	
SRP REREGULATION	o		o	
NONSTRUCTURAL MEASURES	o		o	
GROUNDWATER RECHARGE	o	o	o	
NO ACTION			o	

- Several sites not located on the Salt or Verde River were considered primarily for regulatory storage: New Waddell Dam on the Agua Fria River, use of existing storage in Lake Pleasant behind the existing Waddell Dam on the Agua Fria River, Buttes Dam on the Gila River, Florence Dam on the Gila River and Tat Momolikot Dam - an existing flood control dam on Santa Rosa Wash. The analysis showed that on the basis of site suitability, cost and environmental/social impact, sites on the Agua Fria River were preferred; therefore, the elements on the Gila River and Santa Rosa Wash were eliminated. Comparison of New Waddell and Lake Pleasant storage indicated that while Lake Pleasant storage was less costly and had less environmental impact, New Waddell was preferred on the basis of better regulatory storage performance and the potential to provide other benefits such as recreation and incidental flood control.

Table II-2 shows the Stage II element screening results.

During Stage II, the feasibility of modifying existing Roosevelt Dam was questionable. As a result, New Roosevelt Dam was added for flood control, SOD, and CAP storage on the Salt River. A New Stewart Mountain Dam was also added, for the same purposes.

The remaining elements were combined into 13 systems which provided 1) SALT OR VERDE RIVER CONTROL: 2) SALT AND VERDE RIVER CONTROL; 3) DOWNSTREAM PROTECTION; 4) a combination of upstream control and downstream protection; 5) LIMITED STRUCTURAL (taking advantage of existing structures); or 6) nonstructural flood damage reduction measures. The "No Action" alternative was included as well. The Stage II systems are displayed in Table II-3. The analysis of systems on the basis of performance, dam safety, economics, social and environmental impacts, and institutional constraints resulted in the elimination of several alternatives:

- Large levees were eliminated due to excessive cost and the lack of positive environmental/social benefits to offset the high cost. However, the option to use small, local levees where justified was retained.

- Underground storage was eliminated because of difficult operation associated with institutional and legal problems and because of energy dependency. However, ground water recharge was retained as possible mitigation for SRP Reregulation water losses and also as a possible method of conserving flood waters.

- Water exchange with the existing SRP dams for regulatory storage was eliminated on the basis of low performance, increased dam safety risks, and potential adverse environmental/social impact. However, the option was retained to exchange water with SRP if new water conservation space was provided in upstream reservoirs.

Table II-2

STAGE II RESULTS OF SCREENING FOR COMPETING ELEMENTS

Element	Purpose		Further Study	
	Flood Control	CAP Storage	Warranted	Unwarranted
VERDE RIVER				
New Horseshoe Dam	o	o		o
Cliff Dam	o	o	o	
New Bartlett Dam	o	o		o
SALT RIVER				
New/Enlarged Roosevelt Dam	o	o	o	
New Stewart Mountain Dam[a]	o	o	o	
CONFLUENCE				
Confluence Dam	o	o	o	
Granite Reef Dam	o	o		o
SRP REREGULATION	o		o	
CHANNELIZATION				
Channels	o			o
Levees	o		o	
Phoenix Greenbelt	o			o
NONSTRUCTURAL MEASURES	o		o	
OFF-SALT/VERDE REGULATORY STORAGE				
New Waddell Dam		o	o	
Lake Pleasant Storage		o		o
Buttes Dam		o		o
Florence Dam		o		o
Tat Momolikot Dam		o		o
UNDERGROUND STORAGE/ GROUNDWATER RECHARGE		o	o	
WATER EXCHANGE WITH SRP		o	o	
NO ACTION			o	

[a]Multipurpose

Table II-3

STAGE II SYSTEMS

CONCEPT 1	SALT OR VERDE CONTROL
1A	Cliff Dam
1B	Enlarged/New Roosevelt Dam
1C	New Stewart Mountain Dam[a]
CONCEPT 2	SALT AND VERDE CONTROL
2A	Confluence Dam
2B	Cliff Dam + Enlarged/New Roosevelt Dam
2C	Confluence Dam + Enlarged/New Roosevelt Dam
2D	Cliff Dam + New Stewart Mountain Dam[a] + New Waddell Dam
CONCEPT 3	DOWNSTREAM
3	Phoenix Levee + Gila Levee + New Waddell Dam
CONCEPT 4	UPSTREAM/DOWNSTREAM
4A	Enlarged/New Roosevelt Dam + Phoenix Levee + Gila Levee
4B	New Stewart Mountain Dam[a] + Phoenix Levee + Gila Levee
CONCEPT 5	LIMITED STRUCTURAL
5A	SRP Reregulation (without modifications) + Underground Storage/ Groundwater Recharge
5B	SRP Reregulation (with modifications) + Underground Storage/ Groundwater Recharge
CONCEPT 6	NONSTRUCTURAL MEASURES
6	Nonstructural Flood Damage Reduction Measures + SRP Exchange

[a]Multipurpose

3. Stage III Alternatives

At the start of Stage III, ten elements remained for combination into plans for the most detailed level of study. These elements were:

Cliff Dam
New/Modified Roosevelt Dam
Confluence Dam
New Stewart Mountain Dam (multipurpose)
New Waddell Dam
SRP Reregulation
Groundwater Recharge (as mitigation for water losses with SRP Reregulation)
Water Exchange (with new upstream storage only)
Limited Local Levees
Nonstructural Measures

Concurrent with the CAWCS, the Bureau of Reclamation had been conducting a study of Safety of Dams (SOD) on the Salt and Verde Rivers. SOD considerations became increasingly important in CAWCS plan development. Therefore, at the outset of stage III, Reclamation widened the focus on the CAWCS to include SOD as a major objective. All plans developed for Stage III analysis considered both SOD and CAWCS purposes.

With the inclusion of SOD, over 100 possible plans were developed. Since the two studies were under separate authorization, and either portion of a plan could be delayed, plans were developed in which 1) a joint SOD/CAWCS solution could be implemented; 2) a CAWCS solution could be implemented first with SOD delayed; or 3) there was no CAWCS action and SOD studies continued. A complete list of plans developed is contained in Plan Formulation Supporting Document (USBR, 1982g). The plans were screened on the basis of performance, cost, and environmental/social impact to reduce the number of alternatives for detailed analysis. As a result of the screening and further analysis:

- Cliff and New/Modified Roosevelt Dams were included in all candidate plans for SOD purposes, because 1) these large upstream structures could suppress flows to a level which limited the need for major modifications at downstream structures, and 2) CAWCS and SOD solutions could be combined in each of the structures.

- New (enlarged) Stewart Mountain Dam was eliminated from further consideration as a regulatory storage and flood control element due to high cost. Reconstructed Stewart Mountain Dam was included in all candidate plans for SOD purposes only.

- SRP Reregulation was eliminated because, with Cliff and New Roosevelt Dams as the CAWCS dam safety solution, incidental flood control at a level comparable to SRP Reregulation could be obtained without the institutional problems and water loss associated with dedicating flood control space in existing SRP Dams.

Eight "candidate" plans resulted from this analysis:

Plan 1 Cliff + New/Modified Roosevelt + Reconstructed Stewart Mountain Dams

Plan 2 Cliff (SOD only) + New/Modified Roosevelt (SOD only) + Reconstructed Stewart Mountain Dams + Nonstructural Measures

Plan 3 Confluence (CAP storage only) + Cliff + New/Modified Roosevelt + Reconstructed Stewart Mountain Dams (concurrent construction)

Plan 4 Confluence (CAP storage and flood control) with a large service spillway + Cliff (SOD only) + New/Modified Roosevelt (SOD only) + Reconstructed Stewart Mountain Dams

Plan 5 Same as Plan 4 but Confluence has an emergency spillway and a small service spillway

Plan 6 New Waddell + Cliff + New/Modified Roosevelt + Reconstructed Stewart Mountain Dams

Plan 7 Same as Plan 6 but with emphasis on opportunities for environmental enhancement from water development

Plan 8 CAWCS No Action and continued SOD studies

In September 1981, Plans 4 and 5 were eliminated from consideration because the benefits derived from the plans were not sufficient to offset their high cost and adverse social and environmental impacts. A more detailed discussion of plan development and selection is contained in Plan Formulation Supporting Document (USBR, 1982g), and is also presented in Reclamation's Stage III Report (USBR, 1982i).

B. Alternatives Analyzed in Detail

During the first part of Stage III plans 1, 2, 3, 6, 7, and 8 were analyzed in detail. In October 1981, the CAWCS Governor's Advisory Committee, representing the interests of affected communities, environmental groups, business groups, Indian tribes, the media, and citizens, recommended Plan 6 as their preferred plan to the Governor of Arizona and the Bureau of Reclamation.

Reclamation concluded that Plans 1, 3, and 6 were appropriate for consideration as the proposed action, because 1) they had moderate to high levels of performance for flood control, regulatory storage and energy management and 2) they could be implemented for a reasonable cost.

In November 1981, following review of the eight candidate plans and after conferring with the Governor of Arizona and the Arizona congressional delegation, the Secretary of Interior selected Plan 6 as the agency proposed action. His selection was based on the strong local support for Plan 6, the functional ability to meet statutory obligations required by authorizing legislation, and the fact that the severe impacts to the Fort McDowell Indian Community associated with some plans were avoided.

Subsequently, Reclamation found that the level of reconstruction being considered for Stewart Mountain Dam might not be sufficient to solve existing dam safety problems. Because the exact nature and extent of required construction has not been determined, it was decided to include descriptions of both New and Modified Stewart Mountain Dam in the EIS. Consequently, both the Modified and New Stewart Mountain Dam appear in all candidate plans.

A determination has not yet been made whether to reconstruct the existing Roosevelt Dam or to construct a new dam to provide flood control for the Salt River; therefore, both New and Modified Roosevelt Dam appear in the EIS in all action plans except Plan 2. Plan 2 is a SOD-only plan which provides no dedicated flood control or regulatory storage space. Designs for Roosevelt Dam indicate that the existing dam can be raised to elevation 2,185 feet to accomplish dam safety objectives (surcharge space for the Inflow Design Flood (IDF)). New Roosevelt Dam or a larger Modified Roosevelt Dam would be required in plans which contain dedicated flood control space at Roosevelt Lake.

Impacts are assessed for construction of new dams at both the Roosevelt and Stewart Mountain sites (except Plan 2), with the difference in impact from modification also noted.

In July 1982, Reclamation completed a sizing study of New Waddell Dam to determine the size at which regulatory storage and energy management benefits are maximized (see New Waddell Sizing Study, USBR, 1982b). The optimum size reservoir is larger than the reservoir which was under consideration at the time Plan 6 was chosen by the Secretary of the Interior. The larger New Waddell Dam is described in the EIS.

The Draft EIS was filed April 29, 1983. Three public hearings were held. Numerous oral and written comments were received. One of the major concerns expressed was that all of the candidate plans displayed in the Draft EIS, except Plan 8, included Cliff Dam. In response to these concerns, it was decided to include in the Final EIS a plan (Plan 9) that did not include Cliff Dam. This plan had been studied earlier in Stage III and eliminated from further consideration. Plan 9 was then analyzed again to assure the information developed for it was at a level of detail comparable to the other candidate plans. After examining Plan 9, the agency proposed action remains Plan 6.

All plans, except the No Action alternative, and Plan 9 share common components. These are Cliff, New/Modified Roosevelt, and New/Modified Stewart Mountain Dams. Cliff and New/Modified Roosevelt Dams would be the same structure in Plans 1, 3, 6, and 7; they differ significantly in Plan 2 (SOD only). New/Modified Stewart Mountain Dam would be the same in all plans. Details of dam and reservoir designs can be found in Designs and Estimates Supporting Document (USBR, 1982e). For purposes of brevity in the EIS, Cliff, Roosevelt, and Stewart Mountain Dams are described once and referenced in plans in which they are the same.

1. Major Project-Related Activities

With the implementation of any CAWCS action plan there would be activities associated with construction and operation that would cause environmental and social impacts. The impacts are described in Chapter IV. The activities are described in the following subsections.

a. Construction Activities

The size of construction areas at each affected site area was estimated for the purpose of impact assessment. A summary of these construction impact areas is presented on Table II-4. Construction areas are described for each site as are sizes of the areas in different plans. These areas are shown in green on the plates in the map pockets at the end of the Draft EIS.

Lands would be acquired by the federal government (as required) at each site for the dam, spillway, canals or aqueducts, power plant, pumping plant, borrow areas, waste areas, construction staging areas, recreation sites, access roads, land within the reservoir area to the top of the flood surcharge pool. Land acquisition and any required relocations of people and facilities would occur in accordance with Public Law 91-646, the Uniform Relocation Assistance and Land Acquisition Policies Act of 1970. This act also covers any relocations of homes or businesses that would be necessary. Relocation compensation would be either monetary or by replacement-in-kind. The government would acquire in fee an area which would be to the top of the surcharge (IDF) pool of the reservoir. Lands within the IDF area but above normal pool levels could be leased for agricultural or grazing purposes. Lands which are above the maximum storage pool (MSP) and which are not leased for these purposes or set aside for recreation purposes would be unaffected by the project construction and would remain in a natural state except for possible infrequent inundation by floodwater.

There would be permanent site modification from the construction of the dam, spillway, power facilities, recreation facilities, and access roads. These areas would be subject to removal of vegetation, excavation, possible blasting, and heavy vehicular traffic. Vegetation within the conservation pool would be cleared, piled, and burned onsite. Vegetation within the flood pool would not require modification, except where access to the conservation pool was necessary.

The borrow areas, waste areas, construction staging areas, and haul road areas would be temporarily modified. Haul roads would be 30 feet wide, requiring a 60-foot-wide right-of-way; access roads would be 24 feet wide requiring a 30 foot right-of-way. All construction areas and haul roads not converted to access roads and not ultimately within the reservoir would be returned to natural grade and revegetated upon completion of construction. Construction and installation of transmission towers for the new transmission lines would cause minimal site disturbance. Chain link fencing would be installed on both sides of reversible canals upon completion of construction. Natural drainage may be modified to bypass the open canal. Construction areas outside of the fenced area would be graded and revegetated.

Table II-4
CONSTRUCTION IMPACT AREAS[a]

	Units	Cliff Plans 1,3,6&7	Cliff Plan 2	Roosevelt Plans 1,3,6,7,9	Roosevelt Plan 2	Stewart Mountain Plans 1,2,3,6,7,9 Modified	Stewart Mountain Plans 1,2,3,6,7,9 New	Confluence Plan 3	New Waddell Plans 6,7,9	CAP Pumping Plant Plans 1,6,7,9	Verde River Dams Modifications Plan 9
Total Area Within Take Line (IDF area)	Acres	14,246	10,970	29,854	27,391	--	--	12,975	12,680	--	6,880
Total Area of Dam Site (Includes detached spillways and outlets)	Acres	110	110	15	15	10	20	110	150	--	70
Total Area for New Pump Station	Acres	--	--	--	--	--	--	--	--	5.0	--
Total Length of New Canal/ Aqueduct (200 foot right-of-way)	Miles	--	--	--	--	--	--	3.2	4.8	0.2	--
Total Length of New Transmission Lines (200-foot easement)	Miles	--	--	0.6	0.6	--	--	4.4	1.5	b	--
Total Area of Construction Related Sites (includes offices, storage areas, maintenance areas, and parking for heavy equipment and automobiles	Acres	89	89	56	56	9	9	40	37	c	10
Total Area of Borrow Pits	Acres	2,080	2,080	680	680	--	--	1,250	1,872	--	20
Total Length of New Haul Roads (60-foot ROW)	Miles	--	--	8.8	8.8	--	--	3.3	2.6	--	--
Total Length of New ROW for Access Roads (30-foot ROW, length does not include ROW for existing roads)	Miles	16.3	3.4	12.3	--	--	--	8.0	6.6	--	--
Total Length of Relocated Road	Miles	--	--	2.5[d]	d	--	--	9.2	--	--	--

[a]Sizes of construction areas were estimated for purposes of this impact assessment. All lengths and areas refer to impacts as shown on the respective Site Maps in the map pockets.

[b]Transmission line would be installed along the aqueduct ROW.

[c]Construction related sites would be included in pump station area.

[d]Some minor relocation of State Routes 88 and 188 would also be required and is not included here.

Removal of rock during construction would require drilling, blasting, and ripping. The blasting generally would be limited to a series of small charges. There would be placement of new material for the new dam. Concrete would be produced onsite. These operations would require a substantial amount and variety of heavy equipment. The equipment and the borrow areas would probably not be covered to minimize dust, but dust suppression controls such as periodically wetting haul roads would be used whenever possible.

b. Operation Activities

Operational activities primarily concern reservoir filling and use. Reservoir levels can vary from minimum conservation and regulatory storage pools to the maximum Inflow Design Flood (IDF) pool due to highly variable year-to-year runoff of central Arizona rivers. To anchor the operational impact assessment, a "representative" pool was needed. In response to this need for assessing likely impacts, a "typical-year" scenario was developed from elevation-duration curves based on Reclamation's operation studies for each reservoir included in the CAWCS plans. The typical-year pool fluctuates during a year because of seasonal inflow and demand; this annual fluctuation provides the basis for analyzing impacts of regular variation in water elevations. Reservoir elevation levels, associated volume and acreages, and percent of time the reservoirs are expected to fill to the various levels are given in Appendix C. Pool levels are shown on the plates that depict the reservoirs for the elements (see the map pocket at the back of the draft EIS. The pools shown are the typical-year high and low pools, the maximum storage pool (MSP), the 200-year flood pool, and the IDF pool. The MSP is the pool that includes conservation storage and/or CAP regulatory storage. The other pools are self-explanatory or have been defined.

2. Plan 8: No CAWCS Action

The No Action plan includes future conditions in the study area without CAWCS projects for CAP regulatory storage, flood control, and dam safety. (A detailed projection of future conditions in the CAWCS area is contained in Regional Future Without the Project, Dames & Moore, 1981b.) Under Plan 8, CAP would be constructed, but no CAWCS regulatory storage or flood control would be provided. SOD studies would, however, continue toward selection of a preferred SOD solution. Such a solution may differ from the Cliff/Roosevelt combination in plans described in this EIS. With no CAWCS action and continued SOD studies, the following is assumed:

- The CAP aqueducts would operate essentially as a demand system. Reclamation operation studies indicate that an average annual water supply of 1,006,000 acre-feet (af) of Colorado River water would be delivered to central and southern Arizona without regulatory storage.

- No flood control measures or structures under study by the CAWCS would be implemented by the Federal government.

- Under the Reclamation Safety of Dams Act, dams operated by SRP would be modified. Modifications could include large spillways to pass flows or, as in Plan 2, construction of Cliff and Modified Roosevelt Dams to suppress flows on the Verde and Salt Rivers. Stewart Mountain Dam would also be replaced or modified to include a larger spillway. More detailed information on the SOD studies is contained in Safety of Dams Supporting Document (USBR, 1982c).

- Twelve bridges on the Salt and Gila Rivers would withstand flows of up to 200,000 cubic feet per second (cfs) after proposed construction or modification. None would be large enough to remain open should larger floods such as the 200-year flood (275,000 cfs) occur. The new bridges would eliminate much of the traffic disruption which now results during floods.

- Buttes Dam and reservoir is an authorized feature of the CAP and would be constructed. Studies are underway to determine if this dam or a suitable alternative should be implemented. The purposes of this feature could include development of Gila River water for CAP water supply, and flood control and/or sediment control for the Gila River valley below Ashurst-Hayden Diversion Dam. Other CAP features which would be constructed are the Granite Reef Aqueduct, Salt-Gila Aqueduct, Tucson Aqueduct, and Hooker Dam or a suitable alternative.

- Floodplain management is assumed, including enforcement of existing laws and regulations. No existing structures in the flood plain would be abandoned, but new structures in 100-year flood plain fringes would be floodproofed to protect against a 100-year flood.

- The City of Phoenix would construct an interim 100-year flood channel in the Salt River near Sky Harbor Airport. The channel would protect the runways against damages similar to those which have occurred in the past. The channel is, however, an interim protection plan and would have a limited life because the present airport expansion plans include adding another runway south of the existing south runway.

- Limited channel clearing along the Salt and Gila River from 91st Avenue to Gillespie Dam would be completed by the Flood Control District of Maricopa County. The clearing would ultimately be 1,000 feet wide and would be regularly maintained. This channel clearing program is an interim (25-year) measure to provide increased flood protection until upstream flood control is provided.

- Flood warning systems maintained by, and coordinated among, the State of Arizona, Salt River Project, and the Flood Control District of Maricopa County would be continued and improved.

- Non-CAWCS flood control facilities including New River, Cave Buttes, and Adobe Dams, several Soil Conservation Service dams, and Indian Bend Wash would be completed.

- The U.S. Forest Service Cottonwood Recovery Program would be implemented on the Verde River to improve wildlife habitat.

- The Tempe Rio Salado Project would be implemented. For the purposes of this study, the overall Rio Salado concept was assumed not to be developed in the future-without-the project, because upstream flood control would be required for implementation of this recreational and commercial development project along the Salt River flood plain through Phoenix. Studies for the Rio Salado Development District are progressing at a reconnaissance level.

3. Plan 1: Cliff + Roosevelt + Stewart Mountain Dams

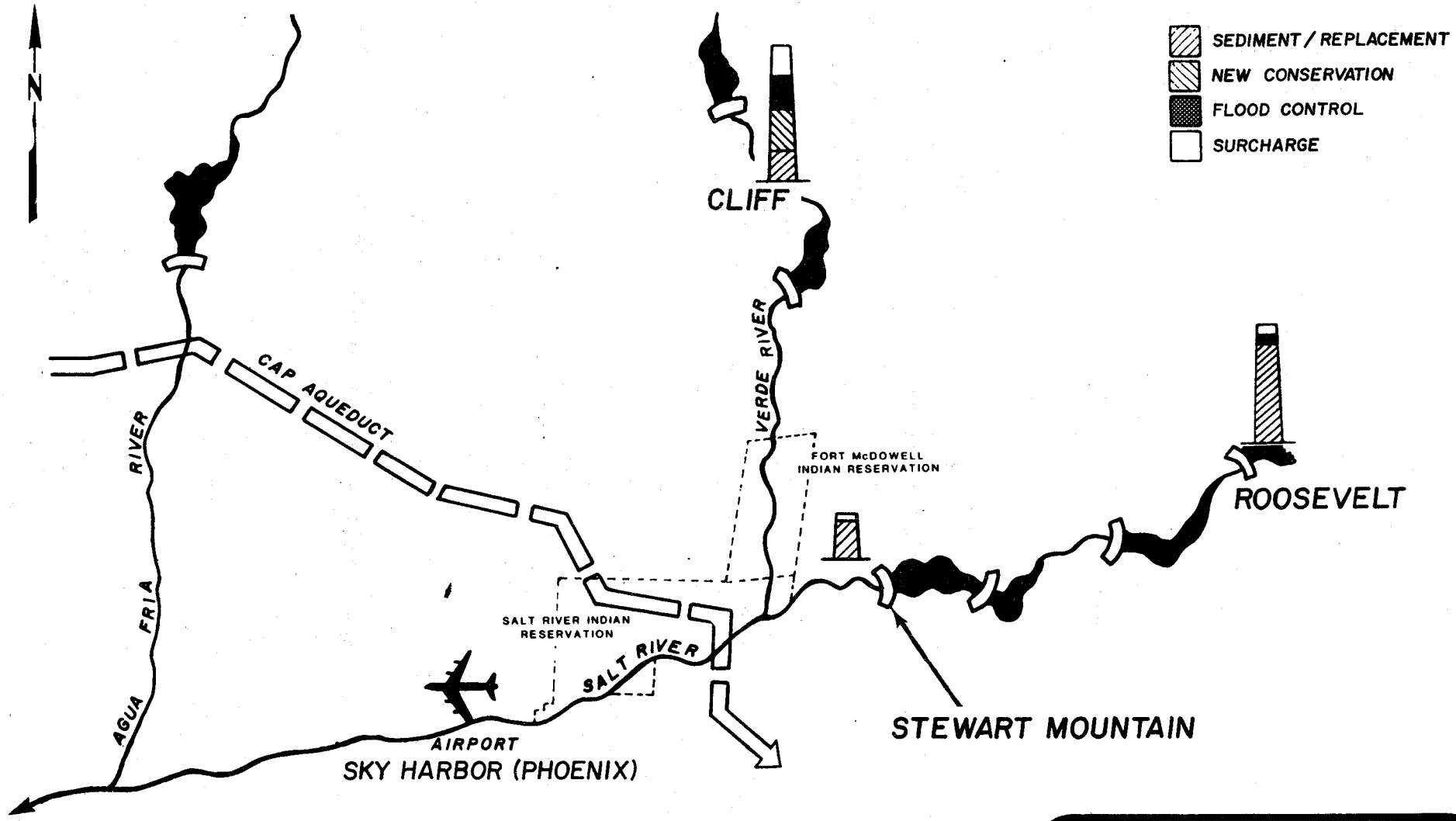
This plan consists of construction of Cliff Dam on the Verde River and New or Modified Roosevelt Dam on the Salt River to provide flood control, additional water conservation, hydropower, recreation and dam safety, and New or Modified Stewart Mountain Dam on the Salt River for dam safety purposes. The general location of the structures is shown in Figure II-1.

This plan would provide 170,000 af of new water conservation space at Cliff Dam and would use one half of the sediment pool at Roosevelt Lake to increase the average annual amount of available CAP water (CAP yield) by 107,000 af/yr. Projected average annual CAP water yield for this plan is 1,113,000 af/yr.

Sufficient flood control space would be provided to control the 200-year event (275,000 cfs) to a flow of 92,000 cfs measured at Sky Harbor International Airport, and the 100-year event (215,000 cfs) to 55,000 cfs at the airport. In Plan 1, and in all other plans, these target flows represent flows which are expected to occur at the designated location under 200-year or 100-year flood conditions. Should events larger than the 200-year flood occur, flows in the river would be higher than the target flow. Flows lower than the target flow could occur in the river in events smaller than a 100-year flood because water would be released from the dams as soon as the dedicated flood control space begins to fill. Additionally, flows could occur if a storm occurred on the watershed downstream of the flood control structures.

The hydrologic safety problems at the existing Salt and Verde River dams within the SRP system would be corrected. Because this plan would not connect directly with the CAP aqueduct, there is limited potential for energy management.

Water supply, hydropower capacity, and recreation facilities at the existing Roosevelt and Stewart Mountain Dams would be maintained at the sites whether new dams are built or the existing dams are modified. If new dams are built at these sites, the existing dams would be breached. All action plans, including Plan 1, require relocation of some residents living around Roosevelt Lake. On the Verde River, Horseshoe Dam would be breached, and the storage replaced in Cliff Reservoir. The recreation facilities and dam tender facilities at Horseshoe Dam would be inundated. These facilities would be replaced at the new dam. The ranch below Horseshoe Dam (KA Ranch) would also be inundated, requiring relocation of the residents.



CAP YIELD	107,000 af/yr
FLOOD CONTROL	
200-YEAR at AIRPORT	92,000 cfs
100-YEAR at AIRPORT	55,000 cfs

FIGURE II-1

PLAN 1
CLIFF + ROOSEVELT +
STEWART MOUNTAIN DAM

Design information on dams and related features included in Plan 1 is displayed in Table II-5. Total construction cost of Plan 1 would be between $694,940,000 and $874,230,000 depending upon whether new or modified Roosevelt and Stewart Mountain Dams are constructed.

a. Cliff Dam and Reservoir

Cliff Dam and Reservoir would be located on the Verde River about 6 miles downstream from the existing Horseshoe Dam. The site area delineated for impact assessment purposes includes approximately 52,800 acres. Most of the land required for the project is currently under Federal ownership.

Cliff Dam would be an embankment (earthfill/rockfill, etc.) structure and would include flood and water supply outlet works. All releases would be to the Verde River channel.

Conceptual Recreation Plans have been developed by the U.S. Army Corps of Engineers and Reclamation for all reservoirs included in alternative plans. Details of these recreation plans are described in Recreation Planning Supporting Document (USBR, 1982f). Recreation sites at Cliff Reservoir in Plans 1, 3, 6, and 7 include four sites totaling 332,5 acres.

Plate 1 ("Cliff Site - Plan 1") in the map pocket in the back of the Draft EIS shows the locations of the dam, spillway, reservoir area, recreation sites, borrow and waste areas, construction staging areas, and roads. The plate also shows the various pool levels of the reservoir including the maximum storage pool (MSP), the 200-year flood pool, the IDF level, and the typical-year high and typical-year low pools.

(1) Construction Considerations

A temporary Reclamation construction field office would be installed at the construction related site near the dam. The construction contractor would also be expected to establish temporary construction offices in the same location. These offices together with storage and parking would require about 90 acres.

Local transportation would not be affected by the construction of Cliff Dam. The existing road to Horseshoe Dam would serve for access to the site area. A new 4.5 mile-long access road would connect the existing road to the dam site. Haul roads for the earth materials for the dam would be limited to the borrow areas.

Table II-5

DESIGN DETAILS - PLAN 1

	CLIFF DAM
DAM STRUCTURE:	
Height	338 feet
Crest Length	2,900 feet
Embankment Dam Volume	15,000,000 cubic yards
SPILLWAY:	(perched and ungated)
Crest Length	125 feet
Head	47 feet
Capacity	150,000 cfs
APPURTENANT WORKS:	
Hydroelectric Powerplant	none
Pumping Plant	1,600 cfs combined for Cliff and Roosevelt (located at Granite Reef)
Service Outlet	4,000 cfs
Flood Outlet:	
Capacity in Flood Pool	25,000 cfs
Capacity at MWS[a]	36,000 cfs
Reversible Canal:	none
Capacity	
Length	

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,810
Sediment	41,300	41,300	Varies	Varies
Inactive	--	--	--	--
Replacement	131,400	172,700	3,316	1,962
New Conservation	170,000	342,700	5,328	2,001
Flood Control	445,000	787,700	8,713	2,066
Surcharge	861,000	1,648,700	14,246	2,143
Dam Crest	--	--	--	2,148

TABLE II-5 (Continued)

	ROOSEVELT DAM	
	New	Modified
DAM STRUCTURE:		
Height	299 feet	299 feet
Crest Length	1,250 feet	1,220 feet
Concrete Dam Volume	340,000 cubic yards	300,000 cubic yards
SPILLWAY:	(gated)	(gated)
Crest Length	200 feet	200 feet
Head	90 feet	90 feet
Capacity	150,000 cfs	150,000 cfs
APPURTENANT WORKS:		
Hydroelectric Powerplant	replace existing capacity	existing plant remains
Pumping Plant	...1,600 cfs combined for Cliff and Roosevelt (located at Granite Reef)...	
Service Outlet	11,000 cfs	11,000 cfs
Flood Outlet:	.....spillway to be used as flood outlet.....	
Capacity in Flood Pool		
Capacity at MWS[a]		
Reversible Canal:	none	none
Capacity		
Length		

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,902
Sediment	268,000	268,000	Varies	Varies
Inactive	--	--	--	--
Replacement	1,344,000	1,612,000	20,933	2,147
New Conservation	--	--	--	--
Flood Control	565,000	2,177,000	25,256	2,172
Surcharge	774,000	2,951,000	30,004	2,201
Dam Crest	--	--	--	2,201

TABLE II-5 (Continued)

	STEWART MOUNTAIN DAM			
	New		Modified (same as existing)	
DAM STRUCTURE:				
Height	118 feet		116 feet	
Crest Length	1,300 feet		1,260 feet	
Concrete Dam Volume	130,000 cubic yards		130,000 cubic yards	
SPILLWAY:	Existing	Auxiliary	Existing	Auxiliary
Crest Length	270 feet	150 feet	270 feet	150 feet
Head	27 feet	37 feet	27 feet	37 feet
Capacity	123,000 cfs	87,000 cfs	123,000 cfs	87,000 cfs
APPURTENANT WORKS:				
Hydroelectric Powerplant	replace existing capacity		existing plant remains	
Pumping Plant	none		none	
Service Outlet	4,000 cfs		4,000 cfs	
Flood Outlet:	none		none	
Capacity in Flood Pool				
Capacity at MWS[a]				
Reversible Canal:	none		none	
Capacity				
Length				

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,417
Sediment	--	--	--	--
Inactive	--	--	--	--
Replacement	69,800	69,800	1,254	1,529
New Conservation	--	--	--	--
Flood Control	--	--	--	--
Surcharge	--	--	--	1,533
Dam Crest	--	--	--	1,535

[a]Maximum Water Storage

Earthen materials for the embankment construction would be obtained from the borrow areas in the vicinity of the dam. Any concrete required during construction would be produced at a batch plant located at the site. Any other materials would be delivered to the site over the access road. Any waste material would be hauled to approved existing disposal sites or buried in the reservoir area according to construction specifications. All disposals will be approved by the Arizona Department of Health Services.

Contractors would be responsible for obtaining water for construction activities. The sources would be from existing surface water supplies or wells near the site. The water would be transported to the construction site by pipelines or trucks.

Periodic flows in the Verde River would be controlled by the upstream Horseshoe Dam until the dam is breached. Service releases from Horseshoe Reservoir would flow through the construction site in a temporary pipeline until the low-level outlets are completed and the dam constructed high enough to divert water through the outlets. A temporary earthfill coffer dam would be installed just upstream of the dam site to control floodwaters originating from the drainage area below Horseshoe Dam.

The only existing services and facilities which would be affected would be Horseshoe Dam, dam tender facilities, recreational facilities, an air strip near the dam, and Tangle Creek gaging station. Except for the air strip, these would be left intact until the replacement facilities were completed at Cliff Dam. The air strip is located in a potential borrow site and may be closed early during the construction period.

(2) Cliff Dam Water Supply Operation

Cliff Dam would be operated in a manner similar to current SRP operation of Horseshoe Dam. During the summer, water would be stored in Cliff Reservoir only when Bartlett Reservoir is full. The winter operation is to split the Verde River storage between the two reservoirs. Therefore, the conservation pool would normally be at its highest level during late winter-early spring, and lowest in the late summer. In a typical-year, the water surface elevation would fluctuate 71 feet.

The CAP Granite Reef Aqueduct would not be directly connected to Cliff Reservoir. CAP storage space in Cliff Reservoir would be created "on paper" by exchange with the SRP system. When CAP demand is less than the flow in the aqueduct, excess CAP water could be delivered to SRP users in lieu of releases from SRP storage, with an equal amount of SRP water credited to CAP and retained in storage in the new Cliff Reservoir. When CAP demand exceeds the flow in the aqueduct, the stored water could be delivered to CAP users through SRP facilities or to the CAP aqueduct for delivery to downstream CAP users.

To deliver water from Cliff Reservoir to the CAP system, the water would be allowed to flow downstream to a point above Granite Reef Diversion Dam where it would be pumped up to the CAP aqueduct through a 1,000-foot-long connection capable of conveying a flow of approximately 1,600 cfs. A new transmission line would connect the pumping plant with the existing CAP power system. These facilities are shown on Plate 2 ("New CAP Pumping Facilities") in the map pocket at the back of the draft EIS.

The operation of this exchange would alter the historic flow regime in the Verde River below Bartlett Dam. Currently, flows typically average 425 cfs and usually range between 50 cfs and 1,450 cfs; however, there are as many as 60 days per year, in the early winter, when no flow occurs in the river. Under Cliff Dam operation, flow in the Verde would be reduced during the months of November through mid-March, while maintaining a minimum of 50 cfs. During the months of April to September there would be increased flow in the Verde River with a maximum increase of 300 to 350 cfs over future-without-the-project flowrates during the months of July and August; however, at no time would the Verde River flow be stopped to optimize water exchange operations.

(3) Cliff Dam Flood Control Operation

Cliff Dam would be combined with Roosevelt Dam on the Salt River to form a dual reservoir flood control system. Flood control releases made from the individual reservoirs in the system would be based on the flood control space available in each reservoir, the total flood control space available, and the total release allowed to meet a given target flow. The total flood control release from the system would be based on the total inflow to the reservoir and the intervening flows.

If the water surface elevation of either reservoir is lower than the maximum conservation storage pool elevation, then there would be no flood control release from that reservoir.

If the water surface elevation at either or both of the reservoirs is greater than or equal to the maximum conservation storage pool elevation of that reservoir and below the maximum flood control storage pool elevation, flood control releases would be such that the total flow from the reservoir would not exceed 25,000 cfs.

Flood control releases from the reservoir system would be apportioned between Cliff and Roosevelt Reservoirs because it is desirable to keep the percentage of available flood control space in each reservoir approximately equal. The releases from the individual reservoirs would be prorated according to the total dedicated flood control space in the reservoir, as well as the percentage of that flood control space available. However, the maximum release from either reservoir would be held to 25,000 cfs.

If the water surface rises above the top of the designated flood control space, then the flood control operation criteria would no longer be used and the reservoir would be operated to protect the dam from overtopping.

b. New/Modified Roosevelt Dam and Reservoir

The two options being considered to provide new flood storage space and make the dam at Roosevelt safe under maximum flooding and earthquake events are modification of the existing dam and construction of a new dam. Both actions would involve the same construction activities, would have the same borrow areas and haul roads, would result in the same dam height and reservoir size, and would be accompanied by the same recreation plan. Locations of the dam, spillway, reservoir area, power transmission facilities, recreation sites, borrow and waste areas, construction staging areas, roads, and pool levels are shown on Plate 3 ("Roosevelt Site - Plans 1, 3, 6, 7") in the map pocket at the end of the Draft EIS. Typical-year low and high pools are not shown because both are below the MSP level of the existing Roosevelt Lake as shown on the plate.

The differences between New and Modified Roosevelt are in the treatment of the existing Roosevelt Dam, a National Historic Landmark, and in the drawdown of Roosevelt Lake during the construction period. Construction of the new dam would not require drawdown of the existing reservoir, but the alternative dam modifications might require drawdown if construction occurs during years of high runoff on the watershed.

Existing recreation facilities at Roosevelt Lake would be replaced with ten new and expanded recreation sites covering 638 acres in Plans 1, 3, 6, 7, and 9 (see USBR, 1982f).

(1) Modified Roosevelt Dam

Modification of existing Roosevelt Dam would include increasing the dam's height approximately 59 feet to provide additional sediment storage, flood storage space, and surcharge space for the IDF beyond the existing storage allocations. The storage allocations and elevations would be the same for the modified or the new dam. Modifications would take approximately 3-1/2 years to complete.

The section added to the dam would be concrete, either with or without rock facing to match the existing dam. Removal of the existing dam down to elevation 2,100 is anticipated. Construction would include modifications to the dam, spillways, and access bridges. The existing tool house towers at each end of the dam would be left intact. The existing spillways would be removed and reconstructed with a total maximum capacity of 150,000 cfs. Spillway capacity would be as low as 92,000 cfs depending on the results of ongoing design studies. Some rock excavation would be required in the upstream and downstream spillway channels. Concrete work would be required for the spillway chutes and walls. The access bridges at either end of the dam would be removed and reconstructed. An alternative means of routing traffic would be required; a permanent or temporary bridge upstream of the dam is an option.

There would be drawdown of the reservoir during various stages of the construction. A preliminary construction schedule calls for the reservoir to be drawndown to elevation 2,100 feet from about August to February during each year of construction. Between October and January during the second year of construction the drawdown would be to elevation 2,065 feet for modifications to the low elevation concrete works.

The construction drawdown periods are scheduled to coincide with periods when normal pool levels are below the 2,100-foot elevation. If that is the case, no water would have to be released to accommodate the construction. This is also true of the 3-month drawdown to elevation 2,065 feet; the period between October 1 and January 1 has historically been when the reservoir is below elevation 2,065 feet. If water does need to be released, it would be at a rate similar to normal summer discharges. If unusually high runoff occurs, releases could be at a higher than normal rate.

(2) New Roosevelt Dam

New Roosevelt Dam would be located on the Salt River 1,000 feet downstream from the existing Roosevelt Dam. Most required land, necessary easements, and rights-of-way are owned by the Federal government; any additional lands required for this project would be acquired by the government.

New Roosevelt Dam would be a double curvature concrete arch structure and would include flood and water supply outlet works. All releases would be to the Salt River channel. Preliminary designs indicate that gated spillways would be located at either end of the dam, with a total capacity of 150,000 cfs.

While New Roosevelt Dam is under construction, the existing Roosevelt Dam would control normal flows in the river. The outlet works of the new dam would be constructed first and then flows released from the existing Roosevelt Dam would be diverted through these outlet works while the new dam is under construction. Upon completion of the new dam, the existing dam would be breached. It is assumed that the Salt River Project would experience no loss of water due to the construction of New Roosevelt Dam.

A hydroelectric powerplant would be constructed at the base of the new dam, replacing the power plant at the existing dam. A new transmission line would be required to connect to existing lines.

The existing dam carries the traffic of State Highway 188 across the top of the dam. Constructing New Roosevelt Dam would require that the access across the river be replaced. The highway traffic could be routed across a new bridge constructed over the foundation of the old dam or just upstream of the old dam.

(3) Construction Considerations

A temporary Reclamation construction field office would be installed at the construction-related site near the dam. The contractor would also be expected to establish temporary construction offices in the same location. These offices together with storage and parking would require about 60 acres.

The existing road to Roosevelt Dam (State Route 188) would serve for access to the dam site. Approximately 8.8 miles of new haul road would be required to connect the borrow sites to the existing roads.

Concrete aggregate for the construction of the new dam or modification of the existing dam would be obtained from the designated borrow areas. The concrete would be batched at the dam site or at the construction-related site and delivered to the dam site by truck or pipeline. All other construction materials would be delivered over the access roads.

Any waste material would be hauled to approved existing disposal sites or buried in the reservoir area according to construction specifications. All disposals will be approved by the Arizona Department of Health Services.

Contractors would be responsible for obtaining water for construction activities. The sources would be from existing surface water supplies or wells near the site. The water would be transported to the construction site by pipelines or trucks.

There will be a heavy volume of construction vehicles in the vicinity of the dam site and this may reduce the effective flow of local traffic. If the existing dam is raised, a new bridge would be opened to traffic before dam construction starts. If a new dam is constructed, the existing dam would continue to handle local traffic throughout the construction period.

Normal releases through the existing dam would not be affected by the dam modifications. Releases from the existing dam would have to be diverted through the new dam construction site. This would require temporary construction of an earthen coffer dam and a pipeline until the new dam's low-level outlets were operational and the dam was completed to an elevation high enough to divert water through the outlets.

All existing services and facilities would be maintained throughout the construction period. For those facilities which would be replaced after the construction period, the new facilities would become operational before the existing facilities are taken out of operation.

(4) Roosevelt Dam Water Supply Operation

The new dam would be operated in the same manner as existing Roosevelt Dam has been operated. Natural runoff would be collected through late summer and released downstream when storage volume becomes available in the downstream reservoirs. The typical-year fluctuation would be 23 feet.

During the life of the project, an average of one-half of the sediment pool (134,000 af) could be used for water storage purposes, providing new conservation space.

There would be no direct connection between Roosevelt Reservoir and the CAP aqueduct. As with Cliff Dam, CAP water would be developed through exchange with the SRP system. The same facilities near Granite Reef Dam as previously discussed under Cliff Dam and Reservoir would be used for this exchange.

Exchanges would not significantly affect overall water supply operation except for minor changes in the flow rates in the Salt River below Roosevelt Dam during some months.

(5) Roosevelt Dam Flood Control Operation

Flood control operation would vary as with Cliff Dam. Cliff and Roosevelt Dams with Standard Project Flood (SPF) design storage would reduce the 200-year flood event to a flow of 92,000 cfs at the Sky Harbor Airport. At no time would the total releases at Roosevelt endanger any downstream dams. The surcharge pool would contain water very infrequently (only in events exceeding 200-year frequency).

c. New/Modified Stewart Mountain Dam

Dam safety problems at Stewart Mountain Dam necessitate that an auxiliary spillway be constructed. Construction of a new dam would be required if the existing dam is found not to be stable enough to withstand the maximum credible earthquake (MCE) without a structural failure. The New/Modified Stewart Mountain site area is included within the Confluence site area, and is detailed on Plate 4 ("Stewart Mountain Site and Potential Sources of Construction Materials") in the map pocket at the back of the draft EIS.

The sole purpose of the New or Modified Stewart Mountain Dam would be to solve dam safety problems. No new flood storage space would be provided nor would CAP regulatory storage space be included. The dam would be operated in the same manner as the existing dam is operated.

(1) Modified Stewart Mountain Dam

Modification of the existing Stewart Mountain Dam would consist of construction of an auxiliary spillway located on the right abutment of the dam. The spillway, with a crest elevation of 1,496 feet, would be a gated concrete structure with a capacity of 87,000 cfs. The total capacity of the existing and auxiliary spillways combined would be 210,000 cfs.

During construction of the auxiliary spillway, earth and rock would be excavated at the site and disposed of in Saguaro Lake, reducing its capacity by about 300 af. Spillway construction material would be acquired from one or more Reclamation approved commercial sources shown on Plate 4. These materials would be hauled to the site using Bush Highway

and/or Highway 87 (Beeline Highway). Neither highway would be closed for construction purposes. Approximately 2 years would be required to build the auxiliary spillway.

During the construction period, activities in the area would include removal of vegetation at the spillway site, excavation, blasting, and heavy vehicular traffic. Approximately 10 acres of land would be required for construction of the new spillway. During and after construction, the reservoir level in Saguaro Lake would not change from its current level. Recreation opportunities at Saguaro Lake and along the Salt River downstream from Stewart Mountain Dam would not be affected.

(2) New Stewart Mountain Dam

New Stewart Mountain Dam would be constructed against the downstream base of the existing dam, and would be a concrete dam about 118 feet high with a crest length of 1,300 feet; an auxiliary spillway would be located on the right abutment of the new dam. Total spillway capacity of the new dam would be 210,000 cfs. Outlet works in the new dam could release flows of up to 4,000 cfs to the Salt River channel. The hydroelectric powerplant at the existing dam would be replaced. The existing allocated space in Saguaro Lake would not be significantly affected by replacement of the old dam. Only the sediment and replacement pools would be maintained, with no flood control or spillway surcharge space added to the reservoir.

Construction activities for the new dam and spillway would be similar to those described above for the spillway alone. In addition to the spillway excavation, about 140,000 additional cubic yards of earth and rock would be excavated and disposed of during construction (total of 510,000 cubic yards). This material would be wasted in the reservoir, causing an additional loss of 90 acre-feet in storage capacity (total of 390 acre-feet). Approximately 4 years would be required for construction of the new dam and spillway.

With construction of New Stewart Mountain Dam, the maximum water surface (MWS) elevation of Saguaro Lake would be 1,533 feet, approximately 2 feet below the current MWS elevation. This change would not affect the operation of the pumped-storage facility at Mormon Flat Dam. The top of the conservation pool would remain at elevation 1,529 feet. During construction, Saguaro Lake would not be drained and releases to the Salt River below the dam would not be altered. No new recreation facilities or sites would be constructed at Saguaro Lake.

(3) Construction Considerations

A temporary Reclamation construction field office would be installed at the construction-related site near the dam. The contractor would also be expected to establish temporary construction offices in the same location. These offices together with storage and parking would require about 7 acres.

All access to the Stewart Mountain site would be provided by existing roads. All aggregate for construction would be brought to the site from existing sources in the Salt River below Granite Reef Diversion Dam. Concrete would be batched onsite. All other construction materials would be delivered over the access roads. There will be a heavy volume of construction vehicles in the vicinity of the dam site and this may reduce the effective flow of local traffic along parts of the Bush and/or Beeline Highway.

Any waste material would be hauled to approved existing disposal sites or buried in the reservoir area according to construction specifications. All disposals will be approved by the Arizona Department of Health Services.

Contractors would be responsible for obtaining water for construction activities. The sources would be from existing surface water supplies or wells near the site. The water would be transported to the construction site by pipelines or trucks.

All normal flows in the river would be controlled by the existing Stewart Mountain Dam. Any service releases from the existing dam would be passed through the new dam site in a temporary pipe until the new dam's service outlets are completed. All existing services and facilities would be maintained throughout the construction period.

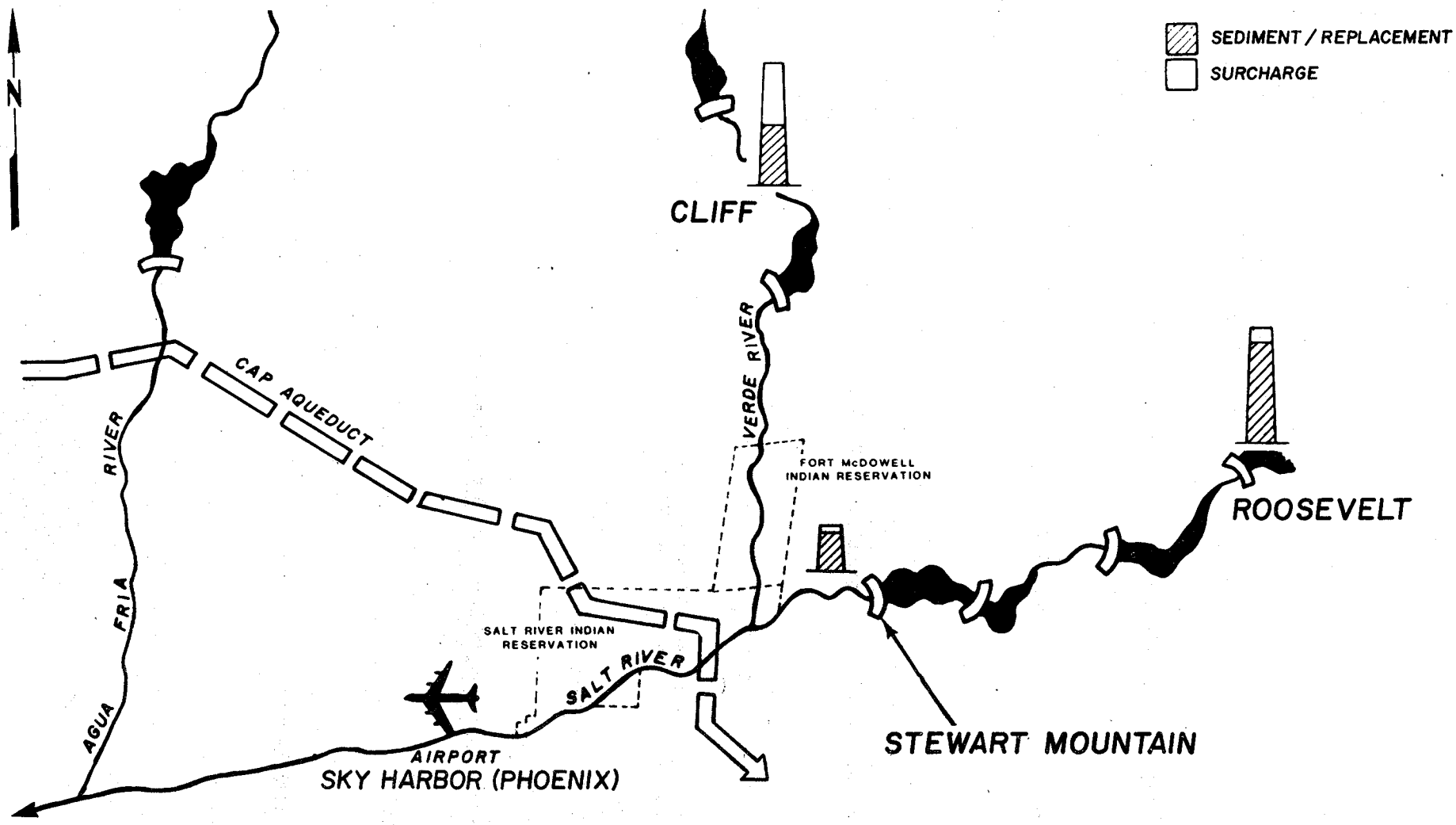
4. Plan 2: Cliff + Roosevelt + Stewart Mountain Dams + Nonstructural Measures

This plan limits construction to that necessary for dam safety purposes. The plan consists of construction of Cliff Dam on the Verde River, Roosevelt Dam on the Salt River, and Stewart Mountain Dam on the Salt River for dam safety purposes, and nonstructural flood damage reduction measures downstream. The general location of structures in Plan 2 is shown on Figure II-2.

This plan would provide no new conservation space for CAP, but through dual use of the sediment space at Roosevelt Dam over the life of the project, the CAP yield could be increased by 16,000 af/yr. Projected average annual CAP water yield is 1,022,000 af/yr.

Under this plan, incidental flood control provided by the use of the surcharge space at Cliff and Roosevelt Dams (no dedicated flood control space) would reduce the 200-year flood to 157,000 cfs, measured at Sky Harbor Airport, and the 100-year flood to 150,000 cfs at the airport. Because of this lower level of flood control, nonstructural flood damage reduction measures may be required downstream (see Nonstructural Supporting Document, USBR, 1982a). These measures, however, would be local actions implemented with local funds.

The hydrologic safety problems at the existing Salt and Verde River dams within the SRP system would be alleviated by the Plan 2 actions. Because this plan was developed with the objective of limiting construction



CAP YIELD	16,000 af/yr
FLOOD CONTROL	
200-YEAR at AIRPORT	157,000 cfs
100-YEAR at AIRPORT	150,000 cfs

FIGURE II-2

PLAN 2
CLIFF + ROOSEVELT +
STEWART MOUNTAIN +
NONSTRUCTURAL

and minimizing environmental and social impacts, hydropower and additional recreational facilities would not be provided, except for replacement of existing facilities. Horseshoe Dam would be breached and the storage relocated in Cliff Reservoir. Existing water supply, hydropower, and recreation facilities at Roosevelt and Stewart Mountain Dams would be maintained at the sites. New Roosevelt Dam is not included as an option in Plan 2 because existing Roosevelt Dam can be raised to elevation 2,185 feet to provide surcharge space for the Inflow Design Flood and solve dam safety problems.

Design information on the dams and related features is displayed in Table II-6. Total construction cost of Plan 2 would be between $541,570,000 and $713,840,000 depending upon whether new or modified dams are constructed.

a. Cliff Dam and Reservoir

Cliff Dam and Reservoir would be smaller than in Plan 1. The locations for the dam, spillway, reservoir area, borrow and waste areas, construction staging areas, roads, and pool levels are shown on Plate 5 ("Cliff Site - Plan 2") in the map pocket at the end of the Draft EIS.

No Conceptual Recreation Plan has been developed for this safety of dams element in Plan 2. Affected recreation facilities in the site area would be replaced in-kind.

(1) Cliff Dam Water Supply Operation

Since no new conservation space for CAP water would be provided at Cliff, the dam would be operated in the same manner as Horseshoe Dam has been operated. Typical-year fluctuation would be 70 feet.

(2) Cliff Dam Flood Operation and Safety of Dams

Under flood conditions, once the conservation storage pool is full, incoming floodwaters would be released through the low-level outlets. Outflow would equal inflow up to the capacity of the outlets (37,500 cfs). Should inflow exceed outflow long enough to begin to fill the surcharge pool, releases would begin over the spillway. Releases would continue over the spillway and through the outlets until the surcharge pool was emptied. The maximum combined releases from the Cliff Dam outlets and spillway could be safely passed at Bartlett Dam.

b. Modified Roosevelt Dam and Reservoir

In Plan 2, Modified Roosevelt Dam would be smaller than in Plan 1. The dam, spillway, reservoir area, power transmission facilities, borrow and waste areas, construction staging areas, roads, and pool levels (except typical-year) are shown on Plate 6 ("Roosevelt Site - Plan 2") at the end of the Draft EIS.

TABLE II-6

DESIGN DETAILS - PLAN 2[a]

	CLIFF DAM
DAM STRUCTURE:	
Height	299 feet
Crest Length	2,550 feet
Embankment Dam Volume	11,000,000 cubic yards
SPILLWAY:	(ungated)
Crest Length	125 feet
Head	44 feet
Capacity	131,000 cfs
APPURTENANT WORKS:	
Hydroelectric Powerplant	none
Pumping Plant	none
Service Outlet	4,000 cfs
Low-Level Outlets:	
Capacity at Top of Conservation	37,500 cfs
Capacity at MWS[b]	55,000 cfs
Reversible Canal:	none
Capacity	
Length	

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,810
Sediment	5,000	5,000	Varies	Varies
Inactive	--	--	--	--
Replacement	139,000	144,000	2,912	1,952
New Conservation	--	--	--	--
Flood Control	--	--	--	--
Surcharge	1,022,000	1,166,000	10,970	2,104
Dam Crest	--	--	--	2,109

TABLE II-6 (Continued)

	ROOSEVELT DAM Modified (no New Roosevelt in Plan 2)
DAM STRUCTURE:	
Height	283 feet
Crest Length	1,210 feet
Concrete Dam Volume	250,000 cubic yards
SPILLWAY:	
Crest Length	200 feet
Head	70 feet
Capacity	150,000 cfs
APPURTENANT WORKS:	
Hydroelectric Powerplant	existing plant remains
Pumping Plant	300 cfs
Service Outlet	11,000 cfs
Low-Level Outlets:	
Capacity at Top of Conservation	--
Capacity at MWS	--
Reversible Canal:	
Capacity	--
Length	--

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,902
Sediment	268,000	268,000	Varies	Varies
Inactive	--	--	--	--
Replacement	1,344,000	1,612,000	20,933	2,147
New Conservation	--	--	--	--
Flood Control	--	--	--	--
Surcharge	926,000	2,538,000	27,391	2,185
Dam Crest	--	--	--	2,185

[a]Stewart Mountain Dam same as Plan 1

[b]Maximum Water Storage

With Plan 2, no Conceptual Recreation Plan has been developed for this safety of dams element. Affected recreation facilities would be replaced in-kind.

(1) Roosevelt Dam Water Supply Operation

Although no new conservation space would be provided in Roosevelt Lake, dual use of the sediment space during the life of the project would permit development of approximately 16,000 af/yr of Salt River water. There would be no direct connection between the CAP Granite Reef Aqueduct and Roosevelt Lake. The Roosevelt water yield would be delivered to CAP users in the SRP service area through the existing SRP canals. Roosevelt Dam and Reservoir would be operated in the same way that the existing dam and reservoir have been operated.

(2) Roosevelt Dam Flood Operation and Safety of Dams

Under flood conditions, once the conservation storage pool is full, floodwaters would be detained in the surcharge pool and released through the spillway at a maximum release of 92,000 cfs, a flow which could safely be passed by the downstream structures.

c. New/Modified Stewart Mountain Dam

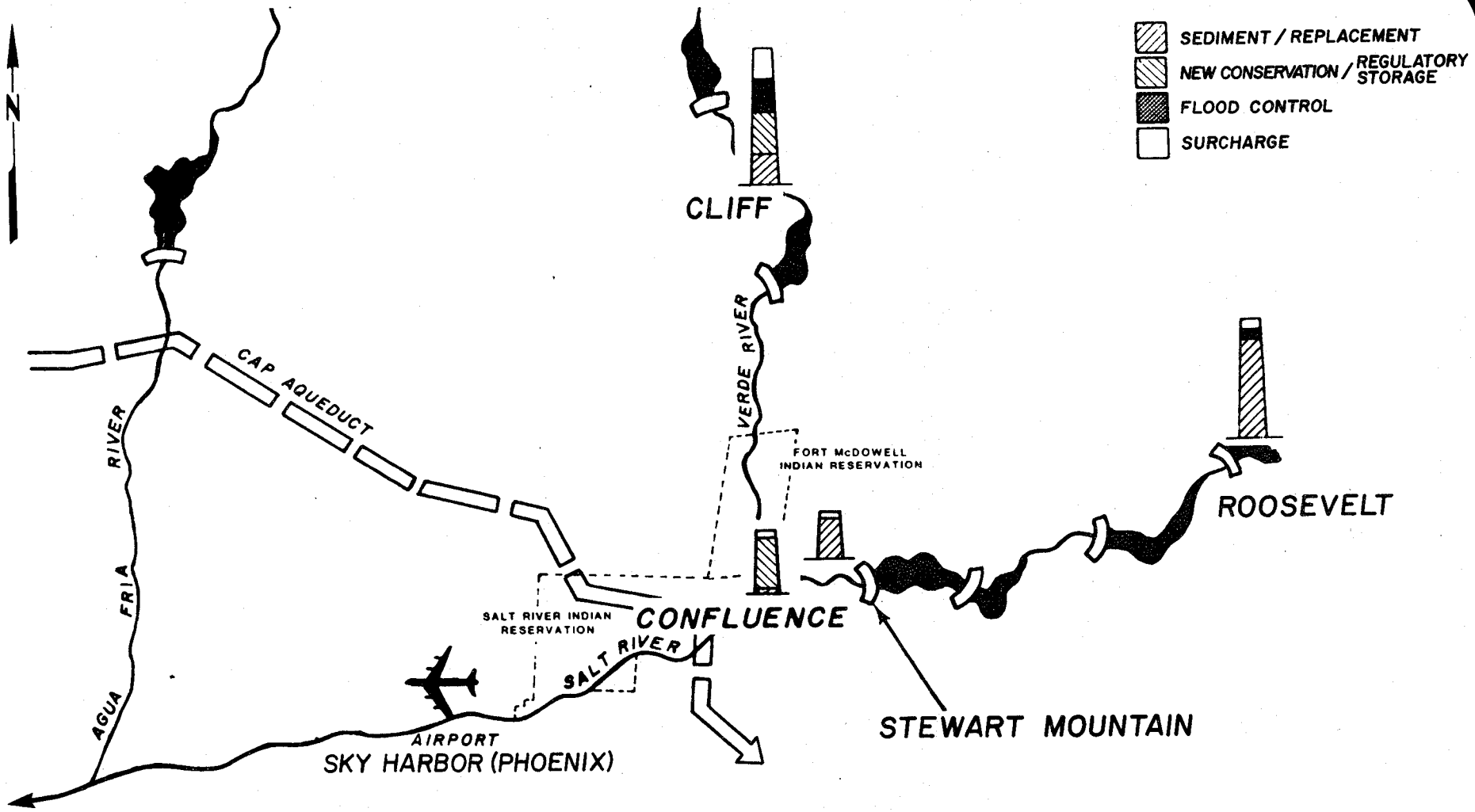
This element would be the same as described in Plan 1 and shown on Plate 4.

5. Plan 3: Confluence + Cliff + Roosevelt + Stewart Mountain Dams

In Plan 3, Cliff Dam on the Verde River and Roosevelt Dam on the Salt River would be constructed for flood control, additional water conservation, hydropower, and SOD. Confluence Dam would be constructed at the confluence of the Salt and Verde Rivers to provide CAP regulatory storage. Stewart Mountain Dam would be constructed on the Salt River for SOD only. The general location of the structures in Plan 3 is shown on Figure II-3.

This plan would provide 300,000 af of regulatory storage space in Confluence Reservoir, 170,000 af of new CAP conservation space in Cliff Reservoir, and could use one half of the sediment pool at Roosevelt Lake to increase CAP yield by 163,600 af/yr. Projected average annual CAP water yield for this plan is 1,169,600 af/yr.

Sufficient flood control space would be provided at Cliff and Roosevelt to control the 200-year flood to between 70,000 and 92,000 cfs at Sky Harbor Airport, and the 100-year flood to 50,000 cfs at the airport; routing floodwaters through Confluence Reservoir may provide some additional reduction in flows compared to other plans. This plan would alleviate the hydrologic safety problems at the existing Salt and Verde River dams within the SRP system.



CAP YIELD	163,000 af/yr
FLOOD CONTROL	
200-YEAR at AIRPORT	80,000 cfs
100-YEAR at AIRPORT	50,000 cfs

FIGURE II-3

PLAN 3
CONFLUENCE + CLIFF +
ROOSEVELT +
STEWART MOUNTAIN DAM

Plan 3 would provide the potential for additional hydropower and recreation. Cliff, Roosevelt, and Stewart Mountain Dams would be constructed as described for Plan 1. The reservoir behind Confluence Dam would inundate portions of the Fort McDowell Yavapai and Salt River Pima-Maricopa Indian Reservations, requiring relocation of people and structures. Confluence Dam would also necessitate relocation of several roads, some utilities, and construction of a new bridge over the Verde River.

Design information on the dams and related features included in Plan 3 is displayed in Table II-7. Total construction cost of Plan 3 would be between $1,116,250,000 and $1,295,540,000 depending upon whether new or modified dams are constructed.

a. Confluence Dam and Reservoir

Confluence Dam and Reservoir would be located at the confluence of the Salt and Verde Rivers, about 3.5 miles upstream of the existing Granite Reef Diversion Dam. The locations for the dam, spillway, canal, power transmission facilities, borrow and waste areas, construction staging areas, recreation sites, roads, and pool levels are shown on Plate 7 ("Confluence Site - Plan 3") in the map pocket at the end of the Draft EIS. Land requirement for the project, as well as necessary easements and rights-of-way, would be acquired by the Federal government. Approximately 8,295 acres would be purchased from the Fort McDowell Indian Reservation and 1,164 acres from the Salt River Indian Reservation. The land needed for the reversible canal and transmission line is already government owned.

Confluence Dam would be an earthfill structure with water supply outlet works. SRP releases would be to the Salt River channel and most CAP releases would be to a new reversible canal connected to the Salt-Gila Aqueduct. A minimum pool would be maintained in Confluence Reservoir for fish and wildlife enhancement and recreation.

A new hydroelectric powerplant would be constructed at the base of the dam. A new transmission line would connect the powerplant and the pump-generation facility to the CAP power transmission system. The new reservoir would back water up on the face of the existing Stewart Mountain Dam and this could cause damage to the power plant, outlet works, spillway, and the dam. Modifications would be made to these facilities to prevent damages unless Stewart Mountain Dam was replaced for dam safety purposes. In this plan, New Stewart Mountain Dam would be designed to be compatible with the Confluence Dam.

On the Fort McDowell Indian Reservation, facilities that would be inundated and require relocation would include churches, community and commercial buildings, utilities, roads, irrigation facilities and housing. Five miles of the Bush Highway would be inundated requiring the construction of 3.4 miles of new road. The inundation of 2.5 miles of State Highway 87 would require the construction of 5.8 miles of road and a new bridge over the Verde River. The Heber-Teno stock crossing trail at Blue Point Bridge on the

TABLE II-7

DESIGN DETAILS - PLAN 3[a]

	CONFLUENCE DAM
DAM STRUCTURE:	
Height	143 feet
Crest Length	4,200 feet
Embankment Volume	12,000,000 cubic yards
SPILLWAY:	(ungated)
Crest Length	520 feet
Head	26 feet
Capacity	240,000 cfs
APPURTENANT WORKS:	
Hydroelectric Powerplant	12,220 KW
Pumping/Generating Facility	3,000 cfs
Service Outlet	4,700 cfs
Flood Outlet:	none
Capacity in Flood Pool	
Capacity at MWS[b]	
Reversible Canal:	
Capacity	3,000 cfs
Length	4 miles

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,320
Sediment	50,000	50,000	Varies	Varies
Inactive	7,000	57,000	2,731	1,378
Replacement	--	--	--	--
Regulatory Storage	300,000	357,000	8,853	1,431
Flood Control	--	--	--	--
Surcharge	279,000	636,000	12,975	1,457
Dam Crest	--	--	--	1,463

[a]Cliff, Roosevelt, and Stewart Mountain Dams same a Plan 1.

[b]Maximum Water Storage

Bush Highway, two USGS gaging stations, U.S. Forest Service Blue Point Administrative Facilities, SRP operator residences near Stewart Mountain Dam, some utilities, and a privately-owned guest ranch below Stewart Mountain Dam would have to be relocated. The City of Phoenix well field and infiltration gallery would be inundated; future water would be supplied from Confluence Reservoir, but could require treatment, which the existing supply does not.

Recreation plans for the Confluence site have been prepared for those lands which are on the Salt River-Pima-Maricopa Indian Reservation and within the boundaries of the Tonto National Forest. No new recreation facilties are included as part of this plan for the Fort McDowell Indian Reservation lands. Eight recreation sites would cover 454 acres and include picnicking, boating, camping, hiking, equestrain, and swimming facilities.

(1) Construction Considerations

A temporary Reclamation construction field office would be installed at the construction-related site near the dam. The contractor would also be expected to establish temporary construction offices in the same location. These offices together with storage and parking would require about 40 acres.

The existing roads would provide access to the dam site. About 3.3 miles of new haul roads would be required to connect the borrow areas to the existing road.

Earthen materials from the embankment construction would be obtained from the borrow areas in the vicinity of the dam. Any concrete required during construction would be produced at a batch plant located at the site. Any other materials would be delivered to the site via the access road. Any waste material would be hauled to approved existing disposal sites or dumped in the reservoir area according to construction specifications. All disposals will be approved by the Arizona Department of Health Services.

Contractors would be responsible for obtaining water for construction activities. The sources would be from existing surface water supplies (Saguaro Lake) or wells near the site area. The water would be transported to the construction site by pipeline or trucks.

There will be a heavy volume of construction vehicles in the vicinity of the dam site and this may reduce the effective flow of local traffic.

All normal flows in the river would be controlled by the existing upstream dams. Any service releases from the existing dams would be passed through the new dam site in a temporary pipe until the new dam's service outlets are completed and the new dam is raised to ann elevation high enough to direct water through the outlets.

All existing services and facilities would be maintained throughout the construction period. New facilities would become operational before the existing facilities were taken out of operation.

(2) Confluence Dam Water Supply Operation

The regulatory storage pool would begin filling whenever the demand for CAP water is less than the flow in the Granite Reef Aqueduct. The regulatory storage pool would contain the most water in the late spring, and would be nearly empty from late summer to late fall when it starts filling again. Typical-year fluctuation would be 46 feet.

CAP water would be delivered to and returned from the reservoir through a new 4-mile-long reversible canal, at an approximate elevation of 1,494 feet. Since this elevation is higher than the top of the regulatory storage pool, the water would flow from the Granite Reef Aqueduct through a pumping/generating facility before it enters the regulatory storage pool of the reservoir. The pumping/generating facility would produce electrical power as water is placed into the regulatory storage pool. When CAP water from the regulatory storage pool is returned to the aqueduct, the pumping/generating facility would be used to pump the water from the reservoir into the reversible canal, where it would flow back to the aqueduct.

SRP requirements would be met by releasing the required water into the river channel, from which the water would then be diverted into the Arizona and Southern Canals at the Granite Reef Diversion Dam.

(3) Confluence Dam Flood Operation

When flooding occurs, normal operations would change because Confluence Reservoir would not have space allocated for flood control. Pumping of CAP water would be halted, and, when the regulatory storage pool was filled with the inflowing floodwaters, the water supply outlets would be opened as long as the inflow continued. If the surface of the reservoir rose high enough, water would flow over an ungated spillway to the Salt River channel.

b. Cliff Dam and Reservoir

Cliff Dam and Reservoir would be as described in Plan 1, except that the typical-year low and high pools would be different, as shown on Plate 8 ("Cliff Site - Plans 3 and 6") at the end of the Draft EIS.

(1) Cliff Dam Water Supply Operation

Cliff Dam would be operated for water supply similar to the operation described under Plan 1. However, in Plan 3, no water exchanges would occur, and water captured in the new conservation space at the Cliff Reservoir would be delivered to Confluence Reservoir from which it could be pumped to the Salt-Gila Aqueduct. Typical-year water fluctuations would also differ from those in Plan 1 and would be 48 feet.

(2) Cliff Dam Flood Control Operation

Flood control operations at Cliff would be as described in Plan 1.

c. New/Modified Roosevelt Dam and Reservoir

Roosevelt Dam would be as described in Plan 1 and as shown on Plate 3.

(1) Roosevelt Dam Water Supply Operation

Water supply operations at Roosevelt Dam would be similar to those described under Plan 1. However, no water exchanges would occur, and water yield from new conservation space, provided by dual use of the sediment space for water storage, would be delivered to Confluence Reservoir from which it could be pumped to the CAP aqueduct.

(2) Roosevelt Dam Flood Control Operation

Roosevelt Dam would be operated for flood control as described in Plan 1.

d. New/Modified Stewart Mountain Dam

Stewart Mountain Dam would be as described in Plan 1 and shown on Plate 4.

6. Plan 6 (Agency-Proposed Action): New Waddell + Cliff + Roosevelt + Stewart Mountain Dams

In this plan, Cliff Dam on the Verde River and Roosevelt Dam on the Salt River would be constructed for flood control, additional water conservation, and SOD. New Waddell Dam on the Agua Fria River would be constructed for regulatory storage purposes and would provide incidental flood control. Stewart Mountain Dam on the Salt River would be replaced or modified for SOD only. The general location of the structures is shown on Figure II-4.

This plan would provide 660,000 af of regulatory storage space at New Waddell Reservoir, 170,000 af of new conservation space at Cliff Reservoir, and would use one half of the sediment pool at Roosevelt Lake to increase CAP yield by 137,600 af/yr. Projected average annual CAP water yield for this plan is 1,172,000 af/yr.

Sufficient flood control space would be provided to control the 200-year Salt/Verde River flood event to a flow of 92,000 cfs at Sky Harbor Airport, and the 100-year event to 55,000 cfs at the airport. This plan would also alleviate the hydrologic safety problems at the existing Salt and Verde River dams within the SRP system, and would provide the potential for additional hydropower and recreation.

Cliff, Roosevelt, and Stewart Mountain Dams would be as described in Plan 1. Water storage capacity and recreation facilities at existing Waddell Dam would be replaced at the new reservoir.

Design information on the dams and related features included in this plan is displayed in Table II-8. Total construction cost of Plan 6 would be between $978,430,000 and $1,157,720,000 depending upon whether new or modified dams are constructed.

a. New Waddell Dam and Reservoir

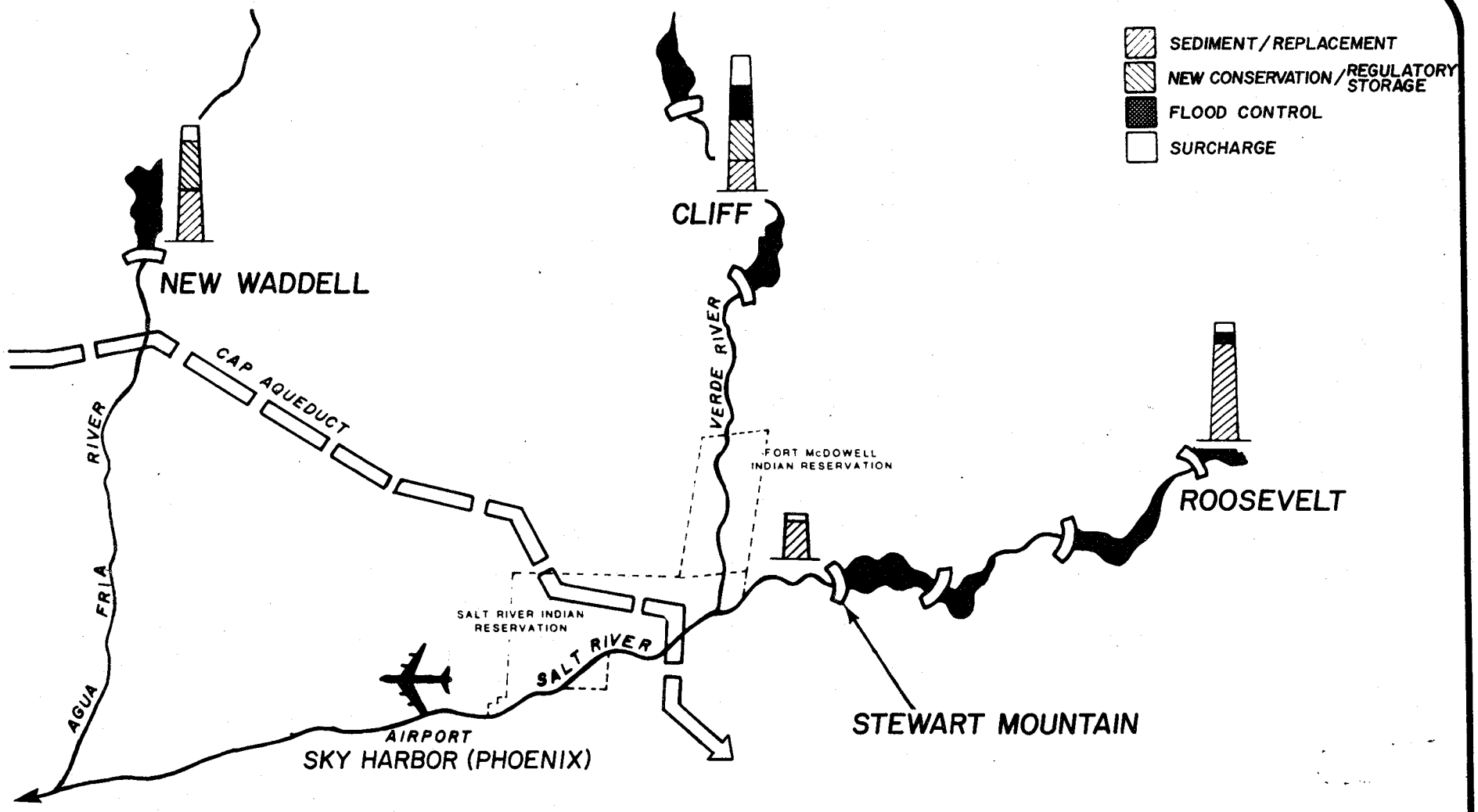
The New Waddell Dam would be located approximately one-quarter mile downstream from the existing Waddell Dam within the Lake Pleasant Regional Park. The site area includes 41,080 acres. The dam, spillway, reservoir area, canal, pumping/generating facility, and transmission facilities, as well as roads, borrow areas, areas for other construction-related activities, recreation sites, and pool levels are shown on Plate 9 ("New Waddell Site - Plan 6 and 7") in the map pocket at the end of the Draft EIS. Typical-year pools are not shown; the typical-year low pool is below the current water level of Lake Pleasant, and the typical-year high pool is nearly the same as the maximum storage pool MSP level shown on the plate. Lands, necessary easements, and rights-of-way for the project would be acquired by the Federal government.

New Waddell Dam would be an earthfill structure, with a gated or ungated spillway. Discharges from the spillway would occur only in events in excess of a 200-year flood, and would be to the Morgan City Wash which flows into the Agua Fria River about 3/4 mile downstream of the new dam location. Incidental flood control of the Agua Fria River would be provided through the operation of the conservation pool.

Two water supply outlet works would be part of the dam. Maricopa County Municipal Water Conservation District #1 (MCMWCD#1) presently uses water storage in Lake Pleasant. One service outlet would be required for MCMWCD#1 releases to Lower Lake Pleasant, which would be reduced in area from 75 acres to 40 acres as a result of the project. The water would then be diverted into the existing Beardsley Canal. The other service outlet would be to a reversible canal which would connect the Granite Reef Aqueduct to the base of the dam.

A minimum pool would be maintained for fisheries and recreation. Four recreation sites are proposed for New Waddell Dam. These include a total of 270 acres and are all located on the west side of the reservoir.

Lower Lake Pleasant would be drained during the construction period. The existing Waddell Dam would control normal flows in the river during construction. The contractor would first devise a means of diverting any releases from the existing dam and also of making MCMWDC#1 deliveries to the Beardsley Canal while the new dam is under construction. When construction of the new dam is completed, the existing dam would then be partially breached by removing approximately the top third of the dam and then removing a small section down to the top of the existing sediment pool to



CAP YIELD	137,600 af/yr
FLOOD CONTROL	
200-YEAR at AIRPORT	92,000 cfs
100-YEAR at AIRPORT	55,000 cfs

FIGURE II-4

PLAN 6
NEW WADDELL + CLIFF + ROOSEVELT + STEWART MOUNTAIN DAM

TABLE II-8

DESIGN DETAILS - PLAN 6
(Agency Proposed Action)[a]

	NEW WADDELL DAM
DAM STRUCTURE:	
Height	306 feet
Crest Length	5,000 feet
Embankment Dam Volume	24,000,000 cubic yards
SPILLWAY:	
Crest Length	500 feet
Head	26 feet
Capacity	250,000 cfs
APPURTENANT WORKS:	
Pumping/Generating Facility	3,000 cfs (29.6 MW power production)
Hydroelectric Powerplant	none
Service Outlet	600 cfs
Flood Outlet:	
Capacity in Flood Pool	none
Capacity at MWS[b]	
Reversible Canal:	
Capacity	3,000 cfs
Length	5 miles

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,430
Sediment	68,800	68,800	Varies	Varies
Inactive (minimum)	5,000	73,800	2,298	1,506
Replacement	157,600	231,400	4,692	1,611
Regulatory Storage	660,000	891,400	10,238	1,702
Flood Control	--	--	--	--
Surcharge	297,200	1,188,600	12,680	1,728
Dam Crest	--	--	--	1,736

[a]Cliff, Roosevelt, and Stewart Mountain Dams same as Plan 1

[b]Maximum Water Storage

ensure that there could be some flow of water to the outlets when the lake is drawn down. The rest of the dam would be left in place and would serve to catch the sediment. No loss of MCMWCD#1 water is anticipated.

(1) Construction Considerations

A temporary Reclamation construction field office would be installed at the construction-related site near the dam. The contractor would also be expected to establish temporary construction offices in the same location. These offices together with storage and parking would require about 40 acres.

Existing roads would provide access to the dam site. About 2.6 miles of new haul roads would be required to connect the borrow areas to the existing roads.

Earthen materials for the embankment construction would be obtained from the borrow areas in the vicinity of the dam. Any concrete required during construction would be produced at a batch plant located at the site. Any other construction materials would be delivered to the site over the access road. Any waste material would be hauled to approved existing disposal sites or buried in the reservoir area according to construction specifications. All disposals will be approved by the Arizona Department of Health Services.

Contractors would be responsible for obtaining water for construction activities. The sources would be from existing surface water supplies (Lake Pleasant) or wells near the site. The water would be transported to the construction site by pipelines or trucks.

There would be a heavy volume of construction vehicles in the vicinity of the dam site and this may reduce the effective flow of local traffic.

All normal flows in the river would be controlled by the existing dam. Any service releases from the existing dam would be passed through the new dam site in a temporary pipe until the new dam's service outlets are completed and the new dam is raised to an elevation high enough to direct water through the outlets.

All existing services and facilities would be maintained throughout the construction period; the new facilities would become operational before the existing facilities are taken out of operation.

(2) New Waddell Dam Water Supply Operation

The regulatory storage pool would allow the maximum pumping of Colorado River water through the Granite Reef Aqueduct to New Waddell Dam over the six-month winter season (October to March). The regulatory storage pool would be filling during this period at the aqueduct capacity of 3,000 cfs less the amount being delivered from the system for water demands. During the remainder of the year, CAP would release water

from the regulatory storage pool to supplement the aqueduct flow being imported at a low, uniform rate. Typical-year fluctuation would be 123 feet, compared to a future-without-project fluctuation of approximately 20 feet.

A 25,600-foot-long reversible canal with a capacity of 3,000 cfs would be constructed with a pumping/generating facility to deliver CAP water into and out of the new reservoir. Diversions from the Granite Reef Aqueduct would be made into the reversible canal from which the water would be pumped into the reservoir at the pump station. Power would be produced when CAP diversions from the reservoir flows through the pumping/generating facility and reversible canal and back into the Granite Reef Aqueduct. The canal would be located on the east side of the Agua Fria River. The pumping/generating facility would be located near the left abutment of the dam. Approximately 1.5 miles of transmission line would be required to connect these facilities to existing transmission lines.

Delivery of water to MCMWCD#1 would be into the Beardsley Canal, via Lower Lake Pleasant, as is currently done.

The potential exists to produce additional hydroelectric power at New Waddell Dam through a pump-back storage facility which would cycle water between the reservoir and Lower Lake Pleasant on a daily basis. While such a facility is not included in Reclamation's design for New Waddell, pump generation could be added to the dam by other governmental agencies or utility companies. Applications and plans to include pump-back storage at the dam would require separate environmental review and compliance by any agency proposing to install such a facility.

(3) New Waddell Dam Flood Operation

New Waddell Reservoir would not include year-round dedication of flood control space. However, Bureau studies of flood control potential at New Waddell Dam showed that substantial flood control on the Agua Fria River could be achieved through operation of the reservoir. Studies have shown that if the reservoir surface remains at or below an elevation of 1,694 feet rather than the maximum elevation of 1,702 feet, releases during the 200-year flood would remain below a target flow of 25,000 cfs. New Waddell Dam would be operated to maintain the water surface elevation below 1,694 feet except when there is low probability of storms occurring, generally during the period from March through June of each year. With this operational regime the annual probability of damaging releases from a 200-year flood is reduced to .0001.

b. Cliff Dam and Reservoir

Cliff Dam would be as described in Plan 1 except there would be no water exchanges. The typical-year fluctuation would be 48 feet.

c. New/Modified Roosevelt Dam and Reservoir

Roosevelt Dam would be the same as in Plan 1, except there would be no water exchanges.

d. New/Modified Stewart Mountain Dam

Stewart Mountain Dam would be as described in Plan 1.

7. Plan 7: New Waddell + Cliff + Roosevelt + Stewart Mountain Dams (environmental enhancement)

This plan is the same as Plan 6, except: 1) water would be made available to maintain minimum flows (enough water to sustain fish populations) in the Salt River between Stewart Mountain and Granite Reef Diversion Dams and in the Verde River below Bartlett Dam, and 2) water would also be made available to provide the potential for recreation and fish and wildlife enhancement on the Salt River through the Phoenix area by providing approximately 30,000 af of water for the proposed Rio Salado development. The method of delivery of this Rio Salado water from the CAP system is yet to be determined. CAP water supply would be increased by 114,000 af/yr for an average annual CAP yield of 1,120,000 af/yr.

This plan provides for a minimum pool at Cliff Reservoir as well as at New Waddell for fish and wildlife enhancement and recreation purposes. Typical-year fluctuation would be 39 feet. This is shown on Plate 10 ("Cliff Site - Plan 7") in the map pocket at the end of the Draft EIS.

Design information on the dams and related features in Plan 7 is displayed on Table II-9. Total construction cost of Plan 7 would be between $978,430,000 and $1,157,720,000 depending upon whether new or modified dams are constructed.

8. Plan 9: New Waddell + Roosevelt + Stewart Mountain Dams + Verde River Dams Modifications

This plan would consist of constructing New Waddell Dam on the Agua Fria River for regulatory storage purposes. Roosevelt Dam on the Salt River would be modified for flood control, additional water conservation, and safety of dams purposes. Stewart Mountain Dam on the Salt River would be replaced or modified for SOD only. Bartlett Dam on the Verde River would be raised 27 feet and an auxiliary spillway would be added for SOD purposes. A spillway would also be added at Horseshoe Dam on the Verde River for SOD purposes. The general location of the structures is shown on Figure II-5.

This plan would provide 660,000 af of regulatory storage space at New Waddell Reservoir and would use one-half of the sediment space at Roosevelt Lake to increase the CAP yield by 115,500 af/yr. The projected average annual CAP yield with this plan is 1,149,900 af/yr.

Roosevelt Dam would have sufficient flood control space available to control the 200-year Salt/Verde River flood event to a flow of 215,000 cfs at Sky Harbor Airport, and the 100-year event to 170,000 cfs at the airport. This plan would also alleviate the hydrologic safety problems at the existing Salt and Verde River Dams within the SRP system, and would provide the potential for additional hydropower and recreation.

TABLE II-9

DESIGN DETAILS - PLAN 7[a]

	CLIFF DAM
DAM STRUCTURE:	
Height	338 feet
Crest Length	2,900 feet
Embankment Dam Volume	15,000,000 cubic yards
SPILLWAY:	(ungated)
Crest Length	125 feet
Head	47 feet
Capacity	150,000 cfs
APPURTENANT WORKS:	
Pumping Plant (combined for Cliff and Roosevelt)	1,000 cfs
Service Outlet	4,000 cfs
Flood Outlet:	
Capacity in Flood Pool	25,000 cfs
Capacity at MWS[b]	36,000 cfs

STORAGE ALLOCATION:

	Incremental Storage (af)	Total Storage (af)	Surface Area (acres)	Elevation (feet)
Conservation:				
Streambed	0	0	0	1,810
Sediment	41,300	41,300	Varies	Varies
Inactive	10,000	51,300	1,443	1,909
Replacement	131,400	182,700	3,472	1,965
New Conservation	170,000	352,700	5,421	2,003
Flood Control	445,000	797,700	8,773	2,067
Surcharge	851,000	1,648,700	14,246	2,143
Dam Crest	--	--	--	2,148

[a]New Waddell Dam same as Plan 6; Roosevelt and Stewart Mountain Dams same as Plan 1.

[b]Maximum Water Storage

Design information of the dams and related features included in this plan is displayed in Table II-10. Total construction cost of Plan 9 would be between $931,790,000 and $1,111,080,000 depending on whether new or modified dams are constructed.

a. New Waddell Dam and Reservoir

New Waddell Dam would be as described in Plan 6.

b. New/Modified Roosevelt Dam and Reservoir

Roosevelt Dam would be as described in Plan 1.

(1) Roosevelt Dam Water Supply Operation

Water supply operations at Roosevelt Dam would be similar to those described under Plan 1; however, no water exchanges would occur. Water yield from the new conservation space, provided by dual use of the sediment space for water storage, would be delivered to CAP users in the SRP service area through the existing SRP canals and to the CAP aqueduct through a 300 cfs pumping plant at the Granite Reef Diversion Dam.

(2) Roosevelt Dam Flood Control Operation

The flood control operation for Roosevelt Dam differs from that described in Plan 1. In Plan 9, Roosevelt Dam is the only dam on the Salt and Verde River System to have dedicated flood control space and would be operated as such.

If the water surface elevation of the reservoir is lower than the maximum conservation storage pool elevation, then there would be no flood control release from the reservoir.

If the water surface elevation of Roosevelt Reservoir is greater than or equal to the maximum conservation storage pool elevation and if the total is less than 25,000 cfs, then the release from the reservoir is equal to the total inflow. If the total inflow is greater than 25,000 cfs, then the flood control release from the reservoir is limited to 25,000 cfs.

If the water surface rises above the top of the designated flood control space, then the flood control operation criteria would no longer be used and the reservoir would be operated to protect the dam from overtopping.

c. New/Modified Stewart Mountain Dam

Stewart Mountain Dam would be described in Plan 1.

d. Horseshoe Dam Modification

The sole purpose of this element would be to solve dam safety problems. No new flood control space would be provided nor would CAP regulatory storage space be included.

Table II-10
Design Details - Plan 9[a]

	Horseshoe Dam (same as existing)
Dam Structure:	
Height	142 feet
Crest Length	1,140 feet
Embankment Dam Volume	1,082,000 cubic yards

Spillway	Existing (gated)	Auxiliary (gated)
Crest Length	350 feet	712 feet
Head	36 feet	36 feet
Capacity	250,000 cfs	498,000 cfs

Appurtenant Works	
Hydroelectric Powerplant	None
Pumping Plant[b]	None
Service Outlets	2,200 cfs
Flood Outlets	None
Reversible Canal	None

Storage Allocation:	Incremental Storage (af)	Total Storage (af)	Surface Area (Acres)	Elevation (feet)
Streambed	0	0	0	
Conservation	139,000	139,000	2,762	2026
Surcharge	-	-	-	2035
Dam Crest	-	-	-	2040

a New Waddell Dam same as Plan 6. Roosevelt and Stewart Mountain Dams same as Plan 1.

b The Pumping Plant, located at the Granite Reef Diversion Dam, for Roosevelt Dam would have a 300 cfs capacity.

Table II-10

(continued)

	Bartlett Dam
Dam Structure:	
Height	215 feet
Crest Length	1,000 feet
Concrete Dam Volume	260,000 cubic yards

Spillway	Existing (gated)	Auxiliary (gated)
Crest Length	150 feet	412 feet
Head	79 feet	79 feet
Capacity	270,000 cfs	479,000 cfs

Appurtenant Works	
Hydroelectric Powerplant	None
Pumping Plant	None
Service Outlets	4,000 cfs
Flood Outlets	None
Reversible Canal	None

Storage Allocation:	Incremental Storage (af)	Total Storage (af)	Surface Area (Acres)	Elevation (feet)
Streambed	0	0	0	1612
Conservation	178,000	178,000	2,775	1798
Surcharge	-	-	-	1827
Dam Crest	-	-	-	1827

Modification of the existing Horseshoe Dam would involve adding a gated spillway. The exsting spillway and outlet totgether with the additional gated spillway would release a maximum discharge of 764,000 cfs.

During the construction period, activities in the area would include removal of vegetation at the spillway site, excavation, and heavy vehicular traffic. Construction material would be acquired from borrow areas downstream of the existing dam. Approximately 2 years would be required to build the auxiliary spillway. The Horseshoe Dam site and general location of potential sources for construction materials are shown on Figure II-6.

During and after construction, the reservoir operation at Horseshoe Lake would not change.

e. Bartlett Dam Modification

The purpose of this element would also be to solve dam safety problems. No new flood control space or CAP regulatory storage space would be included.

Modification of the existing Bartlett Dam would involve raising the dam 27 feet and adding a concrete-lined auxiliary spillway. The dam crest would be raised to elevation 1827. The existing spillway would be modified to withstand the higher water surface and to regulate releases to the maximum discharge. The existing spillway and outlet, operating under the higher water level, together with the new auxiliary spillway at the existing saddle dike on the left abutment would release a maximum discharge of 755,000 cfs.

Construction activities would be similar to those described for the modification to Horseshoe Dam. It would take about 3½ years to complete modification. The Bartlett Dam site and location of potential sources for construction materials are shown on Figure II-7.

After the modifications are completed, the top of the conservation space would not change, but the top of the surcharge space would. Upon completion, the reservoir would be operated in a manner similar to current operations.

C. Comparative Analysis of Alternatives

Twenty-one evaluation criteria were developed during the CAWCS Stage III to provide a framework for determining which candidate plans were appropriate for consideration as the proposed action. Although all of the criteria were critical to the plan evaluation process, the CAWCS planning team identified the factors which most significantly discriminated among alternatives, and aggregated them into the following categories: performance (ability to meet CAWCS objectives), economics, environmental impacts, social impacts, and public acceptability. Performance of the plans has been discussed in the earlier description of alternatives. Public acceptability is discussed below in Section D. The environmental, social, and economic impacts of alternatives are presented in detail in Chapter IV.

Table II-11 provides a comparative display of the advantages and disadvantages of each plan relative to the significant evaluation criteria identified by the CAWCS study team.

As shown in Table II-11, Plans 1, 3, 6, and 7 provide high levels of flood protection and solve dam safety problems. Plans 2 and 9 also solve dam safety problems but provide less flood protection. Plan 8 does not meet objectives for flood protection, but it does provide for continued studies to develop a plan to make Salt and Verde River Dams safe.

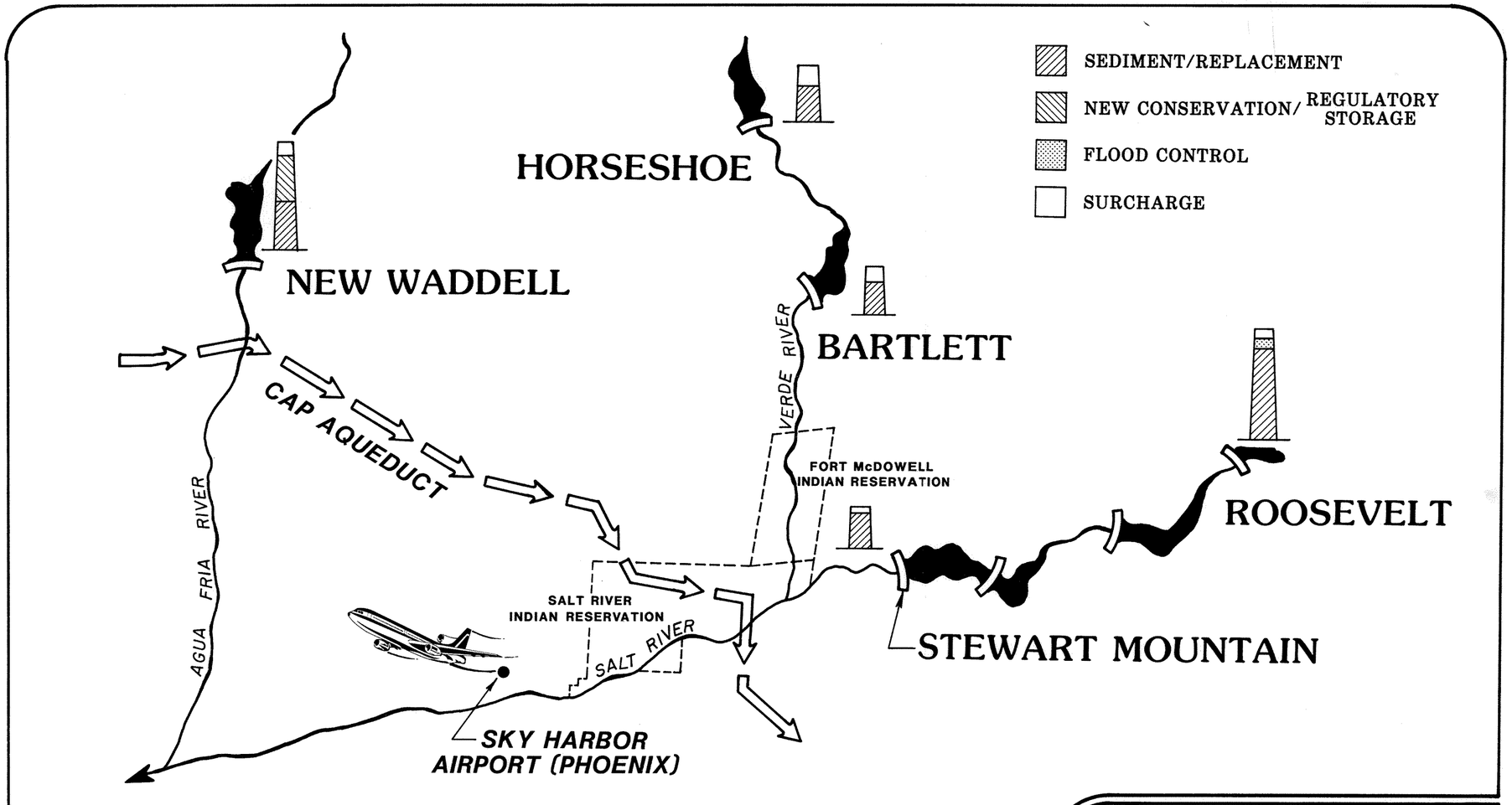
Regulatory storage advantages are strongest with Plans 3, 6, 7, and 9 because they include regulatory storage reservoirs to provide increased CAP yield, added flexibility in the operation of CAP, and energy management benefits. Plan 1 provides some increased yield because of water exchanges but does not have the flexibility or energy management benefits that are associated with a reservoir. Mainly because of energy management opportunities associated with New Waddell Reservoir, Plan 6 provides the highest annual economic benefits of any plan. Plan 8 does not meet project objectives for regulatory storage.

Costs of the action alternatives in rank order from highest to lowest, are: Plan 3, 6 and 7, 9, 1, 2. Plan 8 has no construction costs at this time, but planning for dam safety would continue and ultimately the solution could involve dam construction.

Environmental impacts associated with construction, operation, and maintenance are most severe with Plan 3 because the plan includes Confluence Dam and Reservoir. The reservoir would inundate sensitive habitat and areas of human use, leading to severe impacts to endangered species, riparian habitat, perennial stream habitat, stream recreation, water quality, and cultural (prehistoric and historic) resources. Environmental impacts of Plan 6 include losses of riparian habitat and cultural resources; these same impacts would occur with Plans 1 and 7, which would also adversely affect endangered species. Plan 2 would have lesser impacts to riparian habitat and cultural resources than Plan 6. Plan 9 would have a lesser impact to riparian habitat and endangered species than Plans 1, 2, 3, 6, and 7. Plan 8 would have no project related impacts, but the dam safety solution found in continued studies could result in impacts that cannot be predicted at this time.

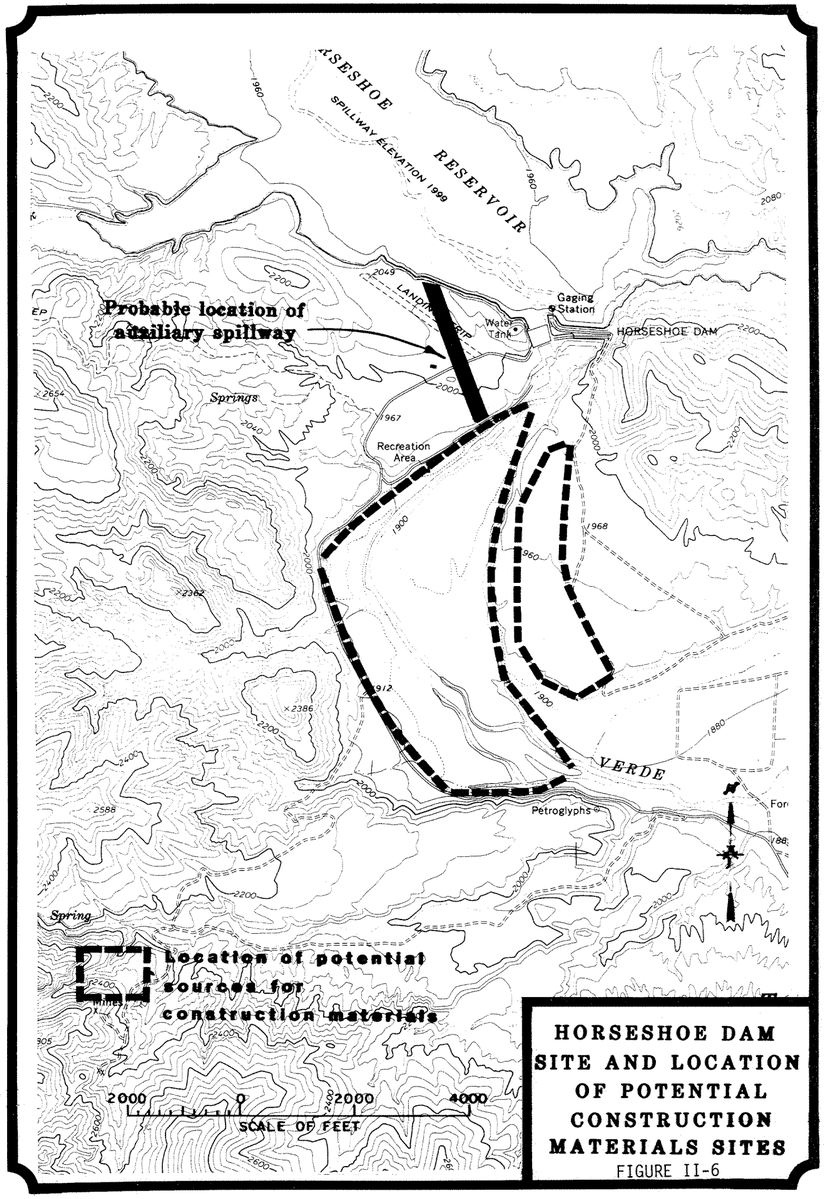
Social impacts are primarily the consequences of relocation because of land acquisition for dams and reservoirs. The most severe social impacts of relocation occur with Plan 3, which would require the relocation of the Fort McDowell Indian Community. No other plans would require the relocation of the community. With Plans 1, 2, 3, 6, and 7, some residents who currently live around the perimeter of Roosevelt Lake and a family who operates a ranch near Horseshoe Dam on the Verde River would be required to relocate. Although all action plans require Roosevelt Lake relocations, Plan 2 requires the fewest number of people to relocate. Plan 9 would not require relocation of the family who operates the ranch near Horseshoe Dam.

Quantification of impacts is provided in Chapter IV, and the impacts are summarized in Table IV-39 and IV-40.



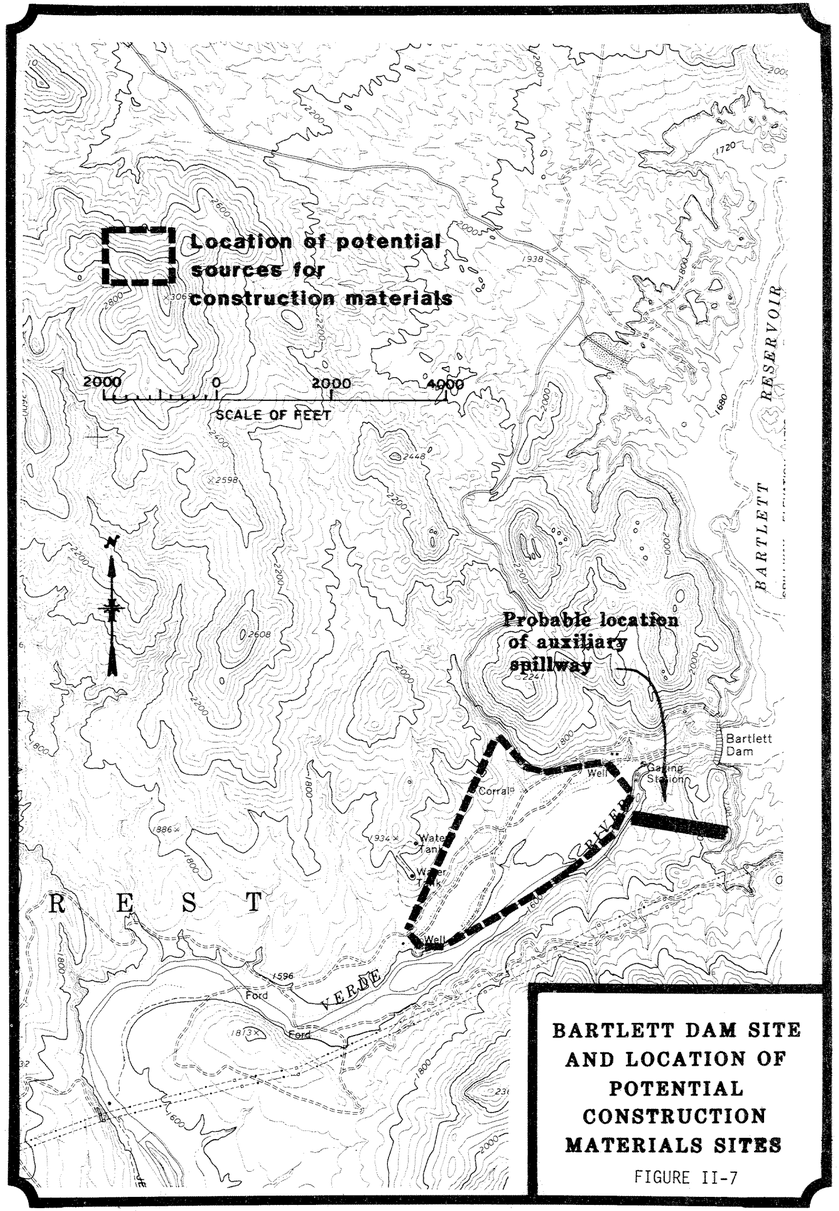
CAP YIELD	115,500 af/yr
FLOOD CONTROL	
200-YEAR at AIRPORT	215,000 cfs
100-YEAR at AIRPORT	170,000 cfs

PLAN 9
NEW WADDELL + ROOSEVELT + STEWART MOUNTAIN DAM + VERDE RIVER DAMS MODIFICATIONS



HORSESHOE DAM SITE AND LOCATION OF POTENTIAL CONSTRUCTION MATERIALS SITES

FIGURE II-6



BARTLETT DAM SITE AND LOCATION OF POTENTIAL CONSTRUCTION MATERIALS SITES

FIGURE II-7

Table II-11

COMPARATIVE EVALUATION OF PLANS

	Advantages	Disadvantages
Plan 8 (No CAWCS action)	No project-related cost No project-related impacts to Fort McDowell Indian Community No project-related impacts to endangered species, riparian habitat, or cultural resources Moderate public support	No increased flood protection No additional water supply beyond CAP baseline Significantly less power revenues than regulatory storage plans No flexibility in CAP operations Dam safety studies continue
Plan 1	Relatively low cost No impacts to Fort McDowell Indian Community High level of flood protection Moderate increase in CAP yield Solves dam safety problems Moderate public support	Less reliable water supply than regulatory storage plans Significantly less power revenues and other economic benefits than regulatory storage plans No flexibility in CAP operation Adverse impacts to endangered species, riparian habitat, and cultural resources
Plan 2	Lowest cost of all action plans Solves dam safety problems No impacts to Fort McDowell Indian Community Insignificant impacts to endangered species Provides moderate increase in flood protection	Insignificant increase in CAP yield Less reliable water supply than regulatory storage plans Minimal power revenues and other economic benefits No flexibility in CAP operations Adverse impacts to riparian habitat and cultural resources Minimum public support
Plan 3	Highest increase in CAP yield High level of flood protection Significant increase in power revenues and other economic benefits Provides flexible CAP operations Provides reliable water supply Significant increase in lake recreation	Highest cost of all action plans Severe impacts to Fort McDowell Indian Community Severe impacts to endangered species, riparian habitat, and cultural resources Severe impacts to stream recreation Potential for reservoir eutrophication and degradation of water quality Highly controversial - divided public support
Plan 6 (Agency proposed action)	Significant increase in CAP yield High level of flood protection Highest increase in power revenues and other economic benefits Provides reliable water supply Provides flexible CAP operations Significant increase in lake recreation No impacts to Fort McDowell Indian Community Strong broad-based public support	High cost Adverse impacts to endangered species habitat and cultural resources*
Plan 7	Moderate increase in CAP yield High level of flood protection Significant increase in power revenues and other economic benefits Provides flexible CAP operations Provides reliable water supply Significant increase in lake recreation Provides opportunities for fish and wildlife enhancement Provides opportunities for development of Salt River recreation through Phoenix No impacts to Fort McDowell Indian Community Moderate public support	High cost Adverse impacts to endangered species, riparian habitat, and cultural resources

*Jeopardy Biological Opinion under Section 7 of the Endangered Species Act was issued by the Fish and Wildlife Service for the Proposed Action.

Table II-11 (continued)

COMPARATIVE EVALUATION OF PLANS

	Advantages	Disadvantages
Plan 9	Provides reliable water supply Significant increase in power revenue and other economic benefits Moderate increase in CAP yield Significant increases in lake recreation No impacts to Fort McDowell Indian Community Reduced environmental impacts	Lower level of flood protection than with some of the other plans Adverse impacts to cultural resources High cost

D. The Proposed Action - Plan 6

Plan 6 has been selected as the agency proposed action for CAWCS because the plan meets project objectives, has strong public support, and does not have many of the severe social and environmental impacts associated with Plan 3. In particular, Plan 6 avoids impacts to the Fort McDowell Indian Community while still providing high performance for flood protection and CAP regulatory storage. While Plans 1, 2, 7, and 9 also avoid impacts to the Fort McDowell Community, they do not perform as well as does Plan 6.

Strong, broad-based public support for Plan 6 was identified by the CAWCS public involvement program in Stage III. In a series of workshops to assess public values in relation to the plans, 60 groups and agencies found Plan 6 to be an acceptable alternative. The majority of speakers at three public meetings held in September 1981 favored Plans 6, 7, and 8. Comments received from response forms in a CAWCS publication indicated that nearly half of the respondents favored Plan 6 among the alternatives.

On October 2, 1981 the CAWCS Governor's Advisory Committee, composed of government, business, agriculture, and environmental representatives, reviewed the alternatives and voted 20 to 1 to recommend Plan 6 to the Governor of Arizona as their preferred plan. The Governor subsequently recommended Plan 6 to the Secretary of the Interior. The Central Arizona Water Conservation District, the state agency responsible for CAP repayment, also endorsed Plan 6.

In October 1981, the CAWCS planning team participated in a "tradeoff" meeting to review all available information on the alternatives and to formulate recommendations. Alternatives were evaluated based on performance, cost, economic benefits, public acceptability, engineering feasibility, environmental impacts, social impacts, and implementability. As a result of these analyses, the Arizona Projects Office of the Bureau of Reclamation recommended that Plans 1, 3, and 6 were appropriate for consideration as the proposed action. Plan 2 was not recommended because it does not provide any regulatory storage capability and offers less flood protection than other action plans. Plan 7 is an environmentally-oriented variation of Plan 6, and many of the benefits of Plan 7 could be obtained with mitigation measures included as part of Plan 6. Therefore, although Plan 7 was not recommended for further consideration, features of this plan could still be obtained. Plan 8 was not recommended because the plan does not meet project objectives.

After reviewing the three recommended plans, the Secretary of the Interior selected Plan 6 as the agency proposed action on November 1981, citing the plan's high performance, public support, and avoidance of impacts to the Fort McDowell Indian Community.

At the time the Secretary decided on the Proposed Action, it contained two options for Roosevelt Dam. Since that time all aspects of the two options have been evaluated. After technical analysis and review and public input, it has been decided to pursue modified Roosevelt Dam as part of Plan 6, the Proposed Action. Because both options were displayed at the time of the decision, this EIS continues to display both options.

III. AFFECTED ENVIRONMENT

III. AFFECTED ENVIRONMENT

A. Determination of Significant Resources

Scoping occurred throughout the Central Arizona Water Control Study (CAWCS), so that the range of alternatives and issues was progressively narrowed. The scope of the study was finally limited to the candidate plans, and the issues were sharpened so that only the most significant ones were treated in depth. Significant issues were those recognized as being institutionally, publicly, or technically important to people.

In August 1981, a special edition of the CAWCS newsletter was published describing the candidate plans and the proposed significant issues to be discussed in detail in the EIS. The public was asked to comment on the range of alternatives and issues using a response form provided. The resulting areas of concern and factors within each issue are as follows:

Biological Resources - including impacts to endangered species, riparian wetland communities, desert communities, reservoir communities, perennial stream/riverine communities, and special use and management areas.

Water Quality - including changes in concentrations of constituents in local surface water mixed with CAP water, and eutrophication potential in the New Waddell and Confluence Reservoirs.

Cultural Resources - including impacts to prehistoric sites and artifacts and historic sites and properties which are on or are eligible for inclusion on the National Register of Historic Places.

Recreation - including changes in stream-oriented and lake-oriented recreation resources, facilities, and activities.

Social Impacts - including impacts of relocation on people living in project areas, and impacts of flooding on transportation, health, and safety.

Economics - including costs, benefits, and economic justification of the candidate plans.

The affected resources related to these issues are described in detail in this chapter. Other resources judged not to be significant as a result of the scoping process are also described, but not in as much detail. These other resources are: air quality, noise, aesthetics, land resources, and geology/soils.

Chapter III. B describes the affected resources in the general CAWCS area (see Figure I-1). Section C describes the affected site areas (Cliff, Roosevelt, Stewart Mountain, Confluence, New Waddell, downstream). The affected site areas shown in Figure III-1 are areas around the proposed dam and reservoirs in the candidate plans. These areas were used as the geographic basis for assessing impacts of plans. The downstream segment of the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam is also shown as a site area for impact analysis.

Descriptions of affected resources are excerpted from the EIS supporting document, Second Level Environmental Inventory (Dames & Moore, 1982a) which contains detailed descriptions of all affected resources in the CAWCS area and in affected site areas. All information in this chapter is based on the Second Level Environmental Inventory unless otherwise indicated.

B. General Description of Area Resources

1. Significant Resources

a. Biological Resources

Within the study area there is an extreme elevation gradient of approximately 7,600 feet, a diverse microclimatic regime, an extensive drainage pattern, and a variety of landforms and soils. These factors contribute to diverse ecosystems, of which many biotic communities can be identified based on vegetation and associated vertebrate wildlife. The description of the biological resources focuses on the major biotic communities of the study area including their dominant flowering plants and wildlife.

Six resource factors have been identified as having the greatest importance with respect to action-related impacts:

1. Riparian/Wetland Biotic Communities
2. Other Terrestrial Biotic Communities
3. Perennial Stream/Riverine Aquatic Communities
4. Reservoir Aquatic Communities (Lakes and Lacustrine Communities)
5. Threatened and Endangered Plants and Wildlife
6. Management and Special Use Areas

Of these, riparian/wetland communities, perennial stream/riverine communities, and threatened and endangered plants and wildlife have been identified through the scoping process as most important.

Acreage and percent range of the major biotic communities (factors 1-4 above) occurring within the CAWCS study area vary considerably, as shown in the Table III-1.

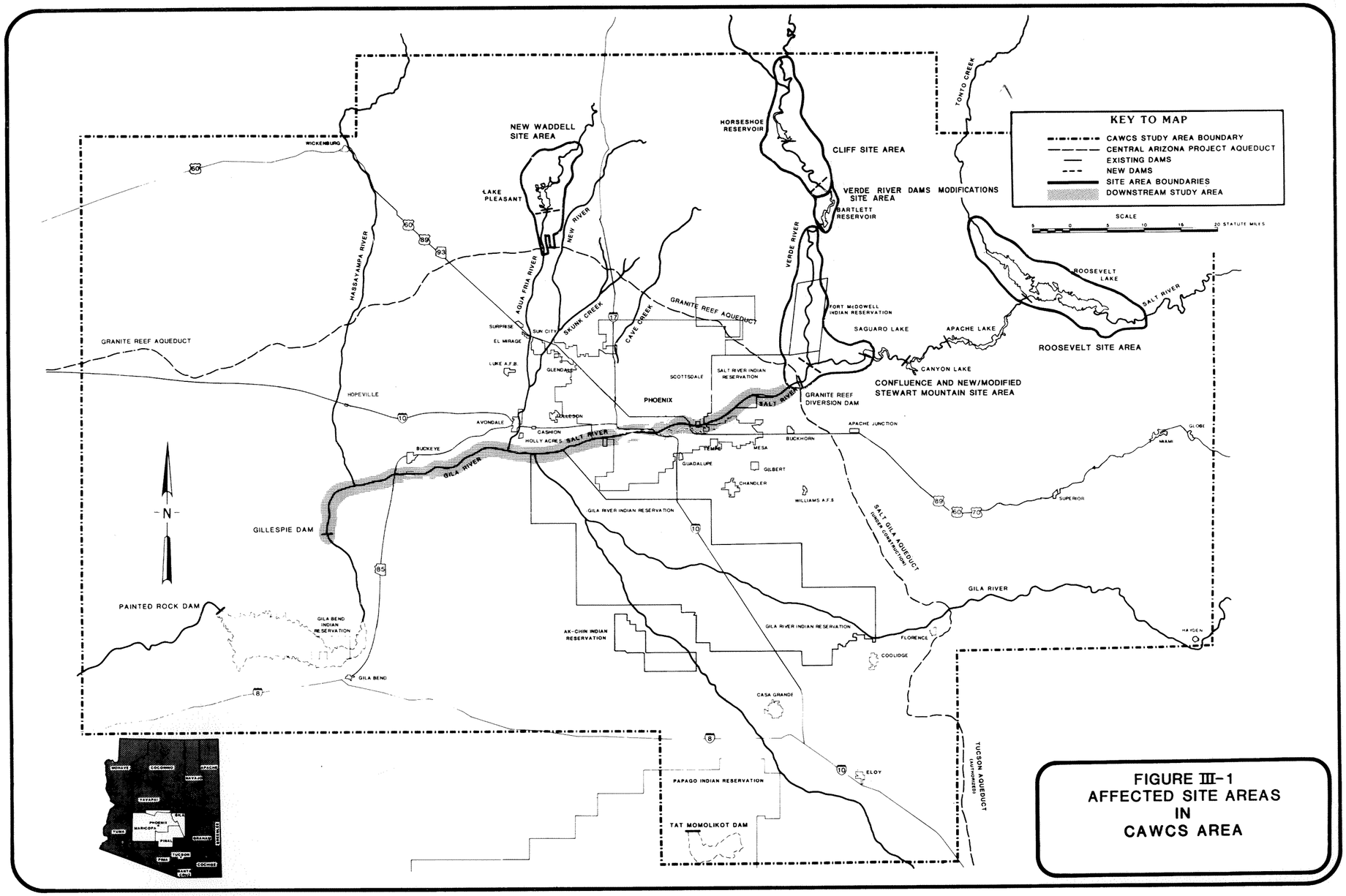


FIGURE III-1
AFFECTED SITE AREAS
IN
CAWCS AREA

Table III-1

ACREAGE AND PERCENT RANGE OF BIOMES AND BIOTIC SERIES IN THE STUDY AREA

Biotic Community	Acres	Percent
Temperate Uplands:		
Montane conifer forest	82,200	1.0
Pinyon-juniper series	189,000	2.2
Oak-pine series	24,700	0.3
Interior chaparral	756,100	8.8
Sonoran savanna grassland	115,000	1.3
Riparian and Wetland Communities:[a]		
Warm temperate and tropical-subtropical and riparian forests	59,000	0.7
Desert Uplands:		
Creosotebush-bursage series	2,037,000	23.7
Paloverde-mixed cacti series	3,509,000	40.9
Saltbush series	411,000	4.8
Aquatic Communities:		
Lakes, rivers, reservoirs	75,000	0.9
Human-Dominated Communities:		
Agricultural lands	1,055,000	12.3
Developed urban lands[b]	263,000	3.1
Total	8,576,000	100.0

[a]The series within riparian and wetland communities were not segregated due to scalar resolution. However, the inclusive series are elaborated in the text.

[b]Developed urban lands refer to lands modified for human occupation and may not necessarily conform to jurisdictional boundaries.

Source: Second Level Environmental Inventory, Dames & Moore, 1982.

The community types which occur in the CAWCS affected site areas include lake and river aquatic communities, riparian and wetland communities, and desert upland communities. The temperate upland communities occur at higher elevations within the study area, but do not occur within the site areas. Human-dominated community types are essentially urban and farmlands and are nearly absent from the site areas.

The biotic communities identified within the site areas are representative of the Southwestern Sonoran Desert and are either upland desert-communities that directly rely on precipitation or are riparian and quasi-riparian communities that depend on soil moisture which is more readily available along drainages. The floral composition varies accordingly between these two community groups and lends to the conspicuous contrast of open cacti-desert shrubland and the more verdant riparian woodland and wetland life forms occurring as green vegetation corridors along washes and perennial streams.

(1) Riparian and Wetland Communities

Riparian/wetland biotic communities, although they occupy less than 1 percent of the CAWCS area, have been given high priority both in the EIS scoping process and by wildlife management agencies, mainly because they are used by numerous wildlife species including the bald eagle, black hawk, osprey, snowy egret, great egret, javelina, and raccoon.

The riparian-wetland biotic communities within the CAWCS study area are primarily confined to the main Gila drainage. Of the 59,000 acres of riparian/wetland community types in the CAWCS area, the following six community types have been identified.

Mixed-broadleaf forest consists of stands of large sycamore, ash, and walnut trees intermixed with cottonwood and willow. Only about 100 acres of mixed-broadleaf forest occur in all the affected site areas. Specifically all of this community occurs upstream of Horseshoe Dam along cobble and gravel alluvial benches adjacent to the Verde River and perennial-flowing tributaries.

Cottonwood-willow series consisting of pure stands and intermixed stands of cottonwood and willow also occur along perennial streams. The larger stands of cottonwood-willow forest within the CAWCS study area occur at the Salt-Verde confluence, near Horseshoe Reservoir on the Verde River, near the Blue Point Ranger Station and Coon Bluff on the Salt River, and upstream of Ashurst-Hayden Dam on the Gila River.

Mesquite bosques - ("river forests") are somewhat different than the mixed-broadleaf and cottonwood-willow communities. Mesquite forests generally are less than 50 feet tall and are more "acacia-like", forming rather large stands of pure mesquite to mesquite intermixed with other riparian and quasi-riparian communities including cottonwood-willow and salt cedar. The largest mesquite bosque occurs near the Salt-Verde confluence, where some 6,000 acres are found, varying from dense woodland adjacent to the rivers to more open savanna adjacent to the desert.

Cattail marsh - represents a community type almost exclusively confined to backwater pools of the Salt-Verde-Gila Rivers and downstream of Waddell Dam. Usually this vegetation consists of pure to mixed stands of cattail and rushes in shallow waters.

Mixed scrub - consists of degenerated or newly established vegetation associated with disturbed sites adjacent to lakes and rivers. The vegetation composition consists of a conglomerate of seep willow, salt-cedar, arrowweed, and seedling and sapling species of the aforementioned communities.

Salt-cedar communities - are dominated by the Asiatic exotic species, salt-cedar. The salt-cedar communities are the predominant woodland-shrubland habitat downstream of the Salt-Verde confluence and along the Gila River in the CAWCS area.

(2) Other Terrestrial Communities

Desert communities are the predominant communities of the study area, and represent about 69 percent of the area (Table III-1). Three upland desert communities occur within the study area: creosotebush-bursage, saltbush, and paloverde-mixed cacti series. The first two are open scrubland desert vegetation and occur at lower elevations than the affected site areas.

The paloverde-mixed cacti series occurs within affected site areas. This series, also referred to as the Arizona upland subdivision of the Sonoran Desert, occurs on bajadas, foothills, and steep slopes of desert mountains at 800 to 3,500 foot elevations. It supports a diverse plant species complex including such trees as foothills paloverde, blue paloverde, ironwood; cacti such as saguaro, cholla, pricklypear; and shrubs such as triangle bursage, ratany, and Mormon tea.

The fauna of the paloverde-mixed cacti series is abundant and diverse and includes Gila woodpecker, cactus wren, elf owl, phainopepla, black-tailed jackrabbit, javelina, coyote, and kangaroo rat.

(3) Perennial Stream/Riverine Communities

There are 137 miles of perennial stream community in the CAWCS area. This represents about 30 percent of the original perennial rivers in the study area, due to the construction of water storage dams along the Verde, Salt, Agua Fria, and Gila Rivers. Approximately 70 miles of perennial streams occur within specific site areas.

Riverine fishes include such native species as longfin dace, desert sucker, and round-tailed chub, as well as introduced species such as bass, catfish, carp, and rainbow trout.

(4) Reservoir Aquatic Communities

Other aquatic communities are primarily represented by the approximately 35,000 surface acres in reservoirs on the Agua Fria, Verde, and Salt Rivers. Introduced game species dominate the fish fauna within these impoundments. Largemouth and smallmouth bass, black crappie, threadfin shad, channel catfish, and sunfish are all common in reservoirs. Lake Pleasant is a popular white bass fishery. At Horseshoe Reservoir the success of sportfish production is somewhat compromised by fluctuating water levels.

(5) Threatened and Endangered Plants and Wildlife

Descriptions of threatened and endangered species occurring in the CAWCS study area are excerpted from the EIS supporting document, A Biological Assessment of Endangered Species (Dames & Moore, 1982c), and from Threatened Native Wildlife in Arizona (Arizona Game and Fish Department, 1982).

The U.S. Fish and Wildlife Service, through Section 7 of the Endangered Species Act, has issued a list of proposed and designated threatened and endangered species that are known to occur in or whose ranges overlap the CAWCS study area. Two endangered plant species and four endangered vertebrates which are known or suspected to occur in the study area come under this designation. The Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*) and the Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*), through occurring in or near the study area, are not known to occur in any affected site area.

The peregrine falcon (*Falco peregrinus anatum*) is a wide-ranging endangered transient species which may use major segments of the Salt-Verde drainage, but which has not been reported in the affected site areas during the CAWCS. The Gila topminnow (*Poeciliopsis o. occidentalis*) is listed as endangered and is a species of interest to the State of Arizona because it may be in jeopardy in Arizona in the foreseeable future. This species was reintroduced into Tule Creek upstream of Lake Pleasant; the population was recently found to be in good condition. Other topminnow are known to occur at Seven Springs and Hidden Water; both areas are in the CAWCS study area but outside of the affected site areas.

The bald eagle (*Haliaeetus l. leucocephalus*) and the Yuma clapper rail (*Rallus longirostris yumanensis*) occur at affected site areas. There are six bald eagle breeding areas in the CAWCS study area, of which five are within affected site areas. Bald eagle preferred habitat includes cliffs and large trees near flowing segments of the Salt-Verde drainage where the species feeds primarily on fish. Preferred foraging perches are in mesquite, cottonwood, and willow trees along the rivers, and cliffs above the rivers. The Yuma clapper rail has been observed in the confluence site area. Immature birds and as many as four adults have been reported in cattail marsh habitat at the Salt-Verde confluence. Several sightings have also been reported for the Gila drainage downstream of Phoenix and at Picacho Reservoir.

In addition to the species receiving Federal protection, the Arizona Game & Fish Department directs special management protection to species which are threatened or unique in Arizona. These species have been designated by the Arizona Game & Fish Commission (10 December, 1982) as threatened native wildlife in Arizona. The species have been categorized into four groups, the following are known or are likely to occur, or could be reintroduced, within the CAWCS area.

Group I wildlife are considered extinct in Arizona but are known to occur elsewhere in the United States. The desert pupfish (Cyprinodon m. macularius) is the only such species.

Group II wildlife includes species whose occurrence in Arizona approaches extinction. They include woundfin (Plagopterus argentissimum), bald eagle, gray hawk (Buteo nitidus), and river otter (Lutra canadensis sonora). The kin subspecies of river otter (L.c.lataxina) has been reintroduced on the Verde River by the Arizona Game & Fish Department.

Group III wildlife species whose continued presence in Arizona could be in jeopardy in the foreseeable future include: Colorado River roundtail chub (Gila robusta robusta), Gila chub (Gila intermedia), razorback sucker (Xyrauchen texanus), Gila topminnow, sonoran mud turtle (Kinosternon sonoriense), desert tortoise (Gopherus agassizii), Mexican garter snake (Thamnophis rufinpunctatus), desert bighorn (Ovis canadensis nelsoni). Bird species include osprey (Pandion haliaetus carolinensis), Mississippi kite (Ictinia mississippiensis), common black-hawk (Buteogallus a. anthracinus), peregrine falcon, and Yuma clapper rail. The razorback sucker, Gila topminnow, and desert bighorn have been reintroduced to the CAWCS area.

Group IV wildlife includes species which occupy habitats that have been susceptible to modification, or are threatened to the extent that their welfare may worsen in the future. Such species include great egret (Casmerodium albus egretta), snowy egret (Egretta thula brewsteri), black-crowned night heron (Nycticorax n. hoactle), and black-bellied whistling-duck (Dendrocygna autumnalis fulgens). All of these species are dependent on aquatic/riparian habitat and are known to occur in the CAWCS area.

(6) Management and Special Use Areas

Major special use and protected areas in the study area are managed by the U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (FWS), U.S. Bureau of Land Management (BLM), and Arizona Game and Fish Department (AGFD). These include USFS habitat rehabilitation sites along the Salt and Verde Rivers; designated wintering areas for bald eagles and peregrine falcons; restricted access priority areas located in vicinities of bald eagle territories, marsh habitat which may harbor the Yuma clapper rail, 14 game management units, the Roosevelt Lake Wildlife area for waterfowl, the Three Bar Research area, and fisheries of the major reservoirs and perennial streams maintained by the AGFD; and the Lower Salt River Recreation Area managed by the USFS in the Salt-Verde confluence area.

b. Water Quality

There is a wide range in the quality of the various sources of water in the study area. For example, a 1979 Maricopa Association of Governments publication (Groundwater Quality in the Major Basins of Maricopa County) reports a total dissolved solids (TDS) level of 243 mg/l in an Aguila area well and a TDS level of 22,300 mg/l in an Agua Calinete-Hayden area well. Pumped average groundwater quality in the service area is documented in the Reclamation's EIS Water Allocations & Water Service Contracting, Central Arizona Project INT FES 82-7. Surface water quality records show TDS ranging from 220 mg/l in the Verde River below Bartlett Dam to over 4,300 mg/l in the Gila River near Kelvin, Arizona. Generally, however, the quality of CAP Colorado River water delivered to users in central Arizona will be of poorer quality than most local surface supplies that are presently being used and will be of better quality than currently used ground water.

Since the CAP intake is located on the Bill Williams Arm of Lake Havasu, CAP water is assumed to be similar in quality to water quality of the Colorado River at Parker Dam until influenced by regulatory storage mixing with local surface waters. Water quality data for the Colorado River at Parker Dam is presented on Table III-2.

Studies to determine the effects of aqueduct evaporation on total dissolved solids indicate an average increase of 1 to 3 percent which is considered insignificant.

The acceptability of water quality is ultimately determined by the designated use. The majority of water currently used in the study area is for either agricultural or municipal and industrial (M&I) use. State and Federal regulated water constituent standards are presented in Water Quality Impacts, Section IV.B.2.

Much of the CAP water will be used to reduce ground water pumping for irrigation purposes. Recently ground water levels have been dropping 3 to 8 feet per year in the service area. By importing about 65 million acre-feet of additional water into central Arizona over the 50-year repayment period of the project, CAP deliveries will slow this rate of decline. In many cases the ground water used for crop irrigation is higher in TDS than the imported CAP water. The infiltration of irrigation water may carry dissolved minerals that could reach the water table and raise the TDS level of the ground water. The general effects associated with salt accumulation in ground water is documented in Reclamation's EIS, Water Allocations & Water Service Contracting, INT FES 82-7. Due to limited research, and the complexity of ground water recharge and movement of dissolved minerals, site-specific technical analysis is not practical over an area as large and diverse as the CAP service area; however, no adverse impact on soil productivity from application of Colorado River CAP water is expected (INT FES 82-7).

Table III-2

SURFACE WATER QUALITY, COLORADO RIVER BELOW PARKER DAM[a]
(mg/l, unless otherwise noted)

	Constituent	No. of Samples	Minimum	Average	Maximum
	Alkalinity as $CaCO_3$	156	98.0	128.	150.
D	Arsenic	1	0.00400	0.00400	0.00400
T	Arsenic	56	BDL	0.00284	0.00500
D	Barium	1	BDL	BDL	BDL
T	Barium	57	BDL	0.135	0.500
	Bicarbonate	145	120.	156.	177.
T	Boron	65	0.0500	0.196	0.360
D	Cadmium	7	BDL	0.000286	0.00100
T	Cadmium	65	BDL	0.00462	0.0130
	Calcium	146	73.0	85.6	100.
T	Carbon (organic)	59	1.90	4.55	14.0
	Carbonate	139	BDL	0.0288	4.00
	Chloride	166	75.0	94.5	140.
	Chromium (Hexa)	1	0.00100	0.00100	0.00100
T	Chromium	58	BDL	0.00357	0.0200
D	Copper	1	BDL	BDL	BDL
T	Copper	57	BDL	0.00793	0.0290
T	Cyanide	58	BDL	0.000862	0.0200
	Oxygen (dissolved)	109	5.10	8.53	11.7
	Fecal Coliforms (cols/100 ml)	49	0.990	4.78	41.9
D	Fluoride (84.7°)	127	0.200	0.378	0.500
	Hardness (total, as $CaCO_3$)	166	290.	339.	380.
	Hardness (noncarbonate)	165	170.	211.	243.
T	Iron	57	0.0300	0.159	0.550
D	Lead	9	BDL	0.00144	0.00400
T	Lead	57	BDL	0.0408	0.100
	Magnesium	146	26.0	30.9	40.0
T	Manganese	58	BDL	0.0208	0.0400
T	Mercury	58	BDL	0.0000431	0.000600
T	Nitrate (as N)	1	0.170	0.170	0.170
	pH (pH units)	202	7.10	7.95	8.80
T	Phosphorus (as P)	66	BDL	0.0258	0.100
	Potassium	139	4.50	5.21	6.80
D	Selenium	1	0.00300	0.00300	0.00300
T	Selenium	58	BDL	0.00279	0.00500
	Specific Conductance (µ℧/cm)	700	950.	1120.	1720.
D	Silver	1	BDL	BDL	BDL
T	Silver	58	BDL	0.00350	0.0100
	Sodium	119	90.0	107.	120.
	Sodium Adsorption Ratio (no units)	119	2.20	2.54	2.88
	Sulfate	167	240.	309.	380.
	Dissolved solids (180°C)	636	602.	722.	848.
	Turbidity (JTU)	43	1.00	2.58	10.0
D	Zinc	9	BDL	0.00889	0.0200
T	Zinc	57	BDL	0.0239	0.310
	Phenolics	62	BDL	0.00127	0.00700

Note: D = Dissolved Fraction; T = Total Recoverable; BDL = Below Detection Level

[a]Environmental Protection Agency STORET Data Retrieval System, March 1981 invent version. Run made on August 24, 1981 using data for the period of record October 1968 - June 1981. All constituent levels shown rounded to three significant figures.

The major water quality impacts of the proposed regulatory storage alternatives will result from the reservoir mixing or exchanges of CAP and local sources of water. These impacts involve the introduction of Colorado River water into local surface waters, changing the concentrations of constituents in the CAP and local source waters, and increasing the potential for eutrophication downstream from or in the storage reservoir. Risk of eutrophication as computed for the Confluence and New Waddell Reservoirs is documented in Hydrology Supporting Document (USBR, 1982h).

Tables III-3, III-4, III-5, and III-6 present the water quality data referenced during CAWCS for local surface water sources which might be affected by regulatory storage mixing. The Agua Fria River water quality data have fewer sample analyses and, therefore, are not as representative as the information on the other water sources.

These data were obtained by the Arizona Department of Health Services from the Environmental Protection Agency (EPA) STORET (storage and retreival) water quality data system. Most of the STORET data were collected by the U.S. Geological Survey (USGS), which conducts regular sampling and laboratory testing at the sites shown on the tables. Some early data were collected from other sources. The data collection is a continuing process which has recently been expanded to include two new stations near Lake Pleasant to establish baseline data for the proposed regulatory storage reservoir.

Trihalomethane (THM) is produced when water which is high in dissolved organic materials undergoes normal disinfection with chlorine at domestic water treatment plants. THM production is dependent on the amount of organic compounds in the water, the amount of chlorine used in disinfection, and the length of time the chlorine is in contact with the water prior to final use. THM is carcinogenic in nature and the EPA has established a maximum contaminant limit (MCL) of 0.1 mg/l for treated domestic water. The Southern Nevada Water System (SNWS) applies chlorine disinfection to Colorado River water from Lake Mead and delivers the treated water to several cities including Las Vegas. The SNWS has reported THM levels at the 0.1 mg/l MCL and are considering alternative water disinfection methods for the Colorado River water. M&I users of SRP water have also observed THM levels approaching the MCL. This is believed to be a result of the high levels of dissolved organic materials in both of these water sources. The potential therefore exists for producing THM at M&I water treatment facilities which receive Colorado River water. This potential exists for any CAP M&I users of Colorado River water regardless of which plan is implemented.

c. Recreation

Within the CAWCS study area, water-related recreation opportunities are extremely popular among residents, as is evident by the intense use of existing reservoirs and streams. The Arizona Statewide Comprehensive Outdoor Recreation Plan (1978) and other sources were used to inventory stream- and reservoir-oriented recreation resources and facilities in a five-county region of central Arizona so that future conditions and project-related impacts could be determined. The five-county region of

Table III-3

SURFACE WATER QUALITY, AGUA FRIA RIVER AT ROCK SPRINGS[a]
(mg/l, unless otherwise noted)

	Constituent	No. of Samples	Minimum	Average	Maximum
	Alkalinity as $CaCO_3$	4	140.	175.	190.
D	Arsenic[b]	2	0.00900	0.0100	0.0110
T	Arsenic	4	0.00900	0.0133	0.0160
D	Barium[b]	2	0.0650	0.0730	0.0810
T	Barium	4	<0.100	<0.100	0.100
	Bicarbonate	0	--	--	--
T	Boron	4	0.0900	0.165	0.230
D	Cadmium[b]	2	<0.00300	<0.00300	<0.00300
T	Cadmium	4	<0.00100	<0.00150	0.00200
	Calcium	4	39.0	50.8	58.0
T	Carbon (organic)	4	2.50	4.10	5.20
	Carbonate	0	--	--	--
	Chloride	2	32.0	36.0	40.0
	Chromium (Hexa)	0	--	--	--
T	Chromium	4	0.00300	0.00725	0.0190
D	Copper[b]	2	0.00700	0.00750	0.00800
T	Copper	4	0.00700	0.0138	0.0290
T	Cyanide	4	<0.0100	<0.0100	<0.0100
	Oxygen (dissolved)	4	8.60	8.88	9.10
	Fecal Coliforms (cols/100 ml)	4	4.00	36.3	120.
D	Fluoride (84.7°)	4	0.300	0.325	0.400
	Hardness (total, as $CaCO_3$)	4	160.	215.	240.
	Hardness (noncarbonate)	4	23.0	41.3	54.0
T	Iron	4	0.0600	2.04	6.40
D	Lead[b]	2	0.00200	0.00200	0.00200
T	Lead	4	0.00100	0.00425	0.00800
	Magnesium	4	16.0	21.8	25.0
T	Manganese	4	0.0100	0.0850	0.270
T	Mercury	4	<0.000100	<0.000100	<0.000100
T	Nitrate (as N)	2	3.20	3.85	4.50
	pH (pH units)	4	8.30	8.43	8.60
T	Phosphorus (as P)	4	0.0900	0.150	0.180
	Potassium	4	1.60	1.98	2.30
D	Selenium[b]	2	<0.00100	<0.00100	<0.00100
T	Selenium	4	<0.00100	<0.00100	0.00100
	Specific Conductance (μ℧/cm)	4	420.	582.	676.
D	Silver[b]	2	<0.00100	<0.00100	<0.00100
T	Silver	4	<0.00100	<0.00100	<0.00100
	Sodium	4	25.0	37.8	45.0
	Sodium Adsorption Ratio (no units)	4	0.900	1.20	1.40
	Sulfate	4	53.0	85.0	100.
	Dissolved solids (180°C)	4	257.	358.	401.
	Turbidity (NTU)	4	0.600	31.6	110.
D	Zinc[b]	2	<0.0120	<0.0120	<0.0120
T	Zinc	4	0.0200	0.0325	0.0600
	Phenolics	0	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- Data Not Available

[a] U.S. Geological Survey from U.S. Bureau of Reclamation unpublished data, 1982; period of record January-April 1982. All constituent levels shown rounded to three significant figures.

[b] Samples taken below Lake Pleasant.

Table III-4

SURFACE WATER QUALITY, VERDE RIVER BELOW BARTLETT DAM[a]
(mg/l, unless otherwise noted)

	Constituent	No. of Samples	Minimum	Average	Maximum
	Alkalinity as $CaCO_3$	328	28.0	185.	350.
D	Arsenic	16	0.00500	0.0121	0.0180
T	Arsenic	15	0.00700	0.0133	0.0210
D	Barium	6	BDL	0.0550	0.100
T	Barium	6	BDL	0.100	0.200
	Bicarbonate	520	34.0	236.	427.
T	Boron	1	0.190	0.190	0.190
D	Cadmium	16	BDL	0.00156	0.0140
T	Cadmium	16	BDL	0.00619	0.0100
	Calcium	541	19.0	42.5	75.0
T	Carbon (organic)	23	1.80	4.20	9.60
	Carbonate	399	BDL	1.57	15.0
	Chloride	352	2.00	18.8	130.
	Chromium (Hexa)	0	--	--	--
T	Chromium	16	BDL	0.00375	0.0100
D	Copper	16	BDL	0.00275	0.00700
T	Copper	16	0.00300	0.00888	0.0200
T	Cyanide	0	--	--	--
	Oxygen (dissolved)	21	8.60	11.6	17.8
	Fecal Coliforms (cols/100 ml)	31	1.00	8.35	99.0
D	Fluoride (84.7°)	210	BDL	0.340	0.800
	Hardness (total, as $CaCO_3$)	540	79.0	212.	413.
	Hardness (noncarbonate)	519	BDL	18.9	182.
T	Iron	71	BDL	0.192	3.50
D	Lead	16	BDL	0.00300	0.0120
T	Lead	16	0.00400	0.0714	0.100
	Magnesium	541	6.40	25.7	55.0
T	Manganese	16	BDL	0.0900	0.380
T	Mercury	16	BDL	0.000263	0.00260
T	Nitrate (as N)	3	0.0200	0.0967	0.140
	pH (pH units)	512	6.80	8.01	8.80
T	Phosphorus (as P)	53	BDL	0.206	0.400
	Potassium	219	1.30	3.39	7.40
D	Selenium	16	BDL	0.000750	0.00300
T	Selenium	15	BDL	0.000600	0.00100
	Specific Conductance (µ℧/cm)	522	150.	510.	929.
D	Silver	6	BDL	BDL	BDL
T	Silver	6	BDL	BDL	BDL
	Sodium	502	4.20	30.4	290.
	Sodium Adsorption Ratio (no units)	502	0.210	0.880	8.21
	Sulfate	350	11.0	52.9	107.
	Dissolved solids (180°C)	482	109.	314.	550.
	Turbidity (JTU)	39	1.00	83.3	2800.
D	Zinc	16	BDL	0.00700	0.0300
T	Zinc	16	0.0100	0.0356	0.200
	Phenolics	0	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- Data Not Available; BDL = Below Detection Level

[a]Environmental Protection Agency STORET Data Retrieval System. Run made on February 16, 1980 using data for the period of record December 1950 - September 1979. All constituent levels shown rounded to three significant figures.

Table III-5

SURFACE WATER QUALITY, SALT RIVER BELOW STEWART MOUNTAIN DAM[a]
(mg/l, unless otherwise noted)

	Constituent	No. of Samples	Minimum	Average	Maximum
	Alkalinity as $CaCO_3$	323	15.0	130.	189.
D	Arsenic	16	0.00200	0.00338	0.00600
T	Arsenic	15	0.00100	0.00387	0.00700
D	Barium	7	BDL	0.0771	0.200
T	Barium	7	BDL	0.100	0.200
	Bicarbonate	385	18.0	160.	230.
T	Boron	2	0.140	0.185	0.230
D	Cadmium	16	BDL	0.000813	0.00400
T	Cadmium	16	BDL	0.00669	0.0100
	Calcium	406	36.0	50.4	420.
T	Carbon (organic)	20	2.20	4.79	18.0
	Carbonate	162	BDL	0.358	35.0
	Chloride	303	70.0	234.	610.
	Chromium (Hexa)	0	--	--	--
T	Chromium	16	BDL	0.00188	0.0100
D	Copper	16	BDL	0.00250	0.00600
T	Copper	16	BDL	0.00868	0.0200
T	Cyanide	0	--	--	--
	Oxygen (dissolved)	20	1.60	6.61	13.7
	Fecal Coliforms (cols/100 ml)	28	1.00	22.0	470.
D	Fluoride (84.7°)	182	0.200	0.380	1.10
	Hardness (total, as $CaCO_3$)	404	121.	180.	270.
	Hardness (noncarbonate)	400	BDL	49.4	113.
T	Iron	27	BDL	0.187	2.10
D	Lead	16	BDL	0.00663	0.0600
T	Lead	16	BDL	0.0743	0.100
	Magnesium	406	5.50	13.7	28.0
T	Manganese	16	BDL	0.0625	0.170
T	Mercury	16	BDL	0.0000438	0.000400
T	Nitrate (as N)	3	BDL	0.0533	0.160
	pH (pH units)	396	4.50	7.74	9.10
T	Phosphorus (as P)	46	0.0100	0.223	8.30
	Potassium	185	2.40	5.83	42.0
D	Selenium	16	BDL	0.000188	0.00100
T	Selenium	15	BDL	0.000267	0.00200
	Specific Conductance (µ℧/cm)	405	505.	1140.	2340.
D	Silver	7	BDL	BDL	BDL
T	Silver	7	BDL	0.00171	0.0100
	Sodium	377	47.0	161.	382.
	Sodium Adsorption Ratio (no units)	377	1.29	5.13	10.4
	Sulfate	299	32.0	51.4	360.
	Dissolved solids (180°C)	362	316.	635.	1300.
	Turbidity (JTU)	33	1.00	2.91	10.0
D	Zinc	16	BDL	0.0160	0.120
T	Zinc	16	0.0100	0.0331	0.100
	Phenolics	0	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- Data Not Available; BDL = Below Detection Level

[a]Environmental Protection Agency STORET Data Retrieval System. Run made on February 16, 1980 using data for the period of record December 1950 - September 1979. All constituent levels shown rounded to three significant figures.

Table III-6

SURFACE WATER QUALITY, SALT RIVER PROJECT WATER[a]
(mg/l, unless otherwise noted)

	Constituent	No. of Samples[b]	Minimum[c]	Average[d]	Maximum[c]
	Alkalinity as $CaCO_3$	323	15.0	154.	350.
D	Arsenic	16	0.00200	0.00761	0.0180
T	Arsenic	15	0.00100	0.00792	0.0210
D	Barium	6	BDL	0.0676	0.200
T	Barium	6	BDL	0.100	0.200
	Bicarbonate	385	18.0	193.	427.
T	Boron	1	0.140	0.187	0.230
D	Cadmium	16	BDL	0.00113	0.0140
T	Cadmium	16	BDL	0.00648	0.0100
	Calcium	406	19.0	47.0	420.
T	Carbon (organic)	20	1.80	4.54	18.0
	Carbonate	162	BDL	0.879	35.0
	Chloride	303	2.00	141.	610.
	Chromium (Hexa)	0	--	--	--
T	Chromium	16	BDL	0.00268	0.0100
D	Copper	16	BDL	0.00261	0.00700
T	Copper	16	BDL	0.00877	0.0200
T	Cyanide	0	--	--	--
	Oxygen (dissolved)	20	1.60	8.76	17.8
	Fecal Coliforms (cols/100 ml)	28	1.00	16.1	470.
D	Fluoride (84.7°)	182	BDL	0.363	1.10
	Hardness (total, as $CaCO_3$)	404	79.0	194.	413.
	Hardness (noncarbonate)	400	BDL	36.3	182.
T	Iron	27	BDL	0.189	3.50
D	Lead	16	BDL	0.00507	0.0600
T	Lead	16	BDL	0.0731	0.100
	Magnesium	406	5.50	18.9	55.0
T	Manganese	16	BDL	0.0743	0.380
T	Mercury	16	BDL	0.000138	0.00260
T	Nitrate (as N)	3	BDL	0.0720	0.160
	pH (pH units)	396	4.50	7.86	9.10
T	Phosphorus (as P)	46	BDL	0.216	8.30
	Potassium	185	1.30	4.78	42.0
D	Selenium	16	BDL	0.000430	0.00300
T	Selenium	15	BDL	0.000410	0.00200
	Specific Conductance (µ℧/cm)	405	150.	869.	2340.
D	Silver	6	BDL	BDL	BDL
T	Silver	6	BDL	0.000975	0.0100
	Sodium	377	4.20	105.	382.
	Sodium Adsorption Ratio (no units)	377	0.210	3.30	10.4
	Sulfate	299	11.0	52.0	360.
	Dissolved solids (180°C)	362	109.	497.	1300.
	Turbidity (JTU)	33	1.00	37.5	2800.
D	Zinc	16	BDL	0.0121	0.120
T	Zinc	16	0.0100	0.0342	0.200
	Phenolics	0	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- Data Not Available; BDL = Below Detection Level

[a] Environmental Protection Agency STORET Data Retrieval System. Run made on February 16, 1980 using data for the period of record December 1950 - September 1979. All constituent levels shown rounded to three significant figures.

[b] Minimum number of samples from Salt or Verde data.

[c] Minimum and maximum are for the Salt or Verde Rivers and could be experienced if the other river was not flowing.

[d] Weighted average based on USGS flow records resulting in a 43 percent Verde and 57 percent Salt mix at the confluence of the two rivers.

Maricopa, Pima, Pinal, Gila, and Yavapai Counties was defined as the affected area to assess comparative water-related activities accessible to portions of the regional population.

Within the region, popular stream-oriented activities include stream fishing, swimming, tubing (river floating), camping, and picnicking. Reservoir-oriented activities include boat fishing, swimming, powerboating, waterskiing, non-powerboating, camping, and picnicking.

Over 9,000 campsites are found in the region, ranging from developed campsites with picnic tables, fire rings, running water, community showers, and electrical hookups to undeveloped campsites with only a cleared area to pitch a tent. Many campground facilities are located near or adjacent to study area lakes and reservoirs. Statewide, between 14 and 16 percent of all households participate in camping. Approximately 2,716,000 maximum annual recreation days (see glossary under "recreation day") are associated with existing developed campsites.

A total of 11,600 picnic sites are found within the region. Statewide, over 30 percent of all households participate in picnicking activities. The total number of maximum annual recreation days associated with the picnic areas in the region is approximately 5.5 million.

Swimming in lakes and rivers in the region is, for the most part, a non-structured recreation activity and does not necessarily depend on a beach or other facilities. Statewide participation rates for lake and river swimming indicate that 17 percent of all households participate in this activity. According to the Arizona Outdoor Recreation Coordinating Commission (AORCC), a total of 51 improved or developed swimming sites are found in the five-county region. An estimated 2 million maximum annual recreation days are associated with lake and river swimming.

Over 985 miles of fishable stream exist within the region. Specific shoreline facilities are not usually associated with stream fishing activities. Approximately 1 million maximum annual recreation days are associated with stream fishing in the region.

In recent years, tubing has become very popular among valley residents of all ages, but especially those in the 16 to 30 age bracket. A survey conducted along the Salt River during the summer of 1981 by the Corps of Engineers estimated that visitation along the Salt River for tubing was greater than 1 million. Because of lower stream flows, tubing on the Verde River is not as intensive. A total of 34.3 miles are estimated to be available for tubing within the five-county region. Maximum annual recreation days associated with tubing miles total over 2,200,000.

A relatively small proportion of the population (about 7 percent) in the region participates in boating activities. Boating resources within the five-county region consist of eight major lakes: Apache, Bartlett, Horseshoe, Canyon, Lake Pleasant, Roosevelt, Saguaro, and San Carlos. The total number of usable surface acres for recreation associated with these lakes is approximately 35,000. Maximum annual recreation days for all boating activities including fishing, powerboating, non-powerboating, and waterskiing currently total approximately 2 million.

d. Cultural Resources

(1) Prehistoric Resources

The CAWCS study area has been occupied for the last 13,000 years, of which only the last 300 years have been recorded in written form. The earliest evidence for human populations in the study area dates to about 11000 B.C. The Paleo-Indians who lived at the time appear to have been mainly hunters who concentrated on large, and now mostly extinct, fauna such as mammoth, bison, and horse. Sites reflecting this occupation are rare, and a high priority is placed by the archaeological community on finding and excavating such remains. No Paleo-Indian sites have been recorded in the CAWCS site areas.

At about 8000 B.C., and into the Christian Era, the hunting emphasis was gradually replaced by an Archaic culture that emphasized the harvesting and collection of wild plant foods. While hunting continued in importance, there was a shift to the capture of small, rather than large, fauna. No definite Archaic sites have been recorded in affected site areas although some nondiagnostic lithic artifact scatters may date from this period.

At about 300 B.C, the Hohokam cultural tradition began, marked by the addition of ceramic vessels to the artifact inventory and by the adoption of a greater emphasis on agriculture. The central Hohokam area is roughly equivalent to the combined limits of the Gila River Indian Reservation and the Phoenix metropolitan area. This area saw the development of extensive irrigation networks, higher population density, and a more complex level of political organization. The Hohokam occupation extends to varying degrees into the mountains and deserts surrounding the central area. It includes Lake Roosevelt to the east, the Tucson Basin to the south, Horseshoe Dam and Waddell Dam to the north, and Gila Bend to the west.

Other related cultural groups recognized in the CAWCS study area include the Patayan, Sinagua, and Salado. These groups are less well defined than the Hohokam.

By about A.D. 1400, the Hohokam tradition disappears from the archaeological record. When Spanish explorers arrived in the American Southwest, they reported villages of Piman Indians living along the Gila River. These people were possibly the descendants of the Hohokam although their population size, area of occupation, and social complexity was much less than that of the preceding Hohokam.

The Hohokam tradition, which dominated the CAWCS study area, provides an opportunity to examine different models for the development of complex social and political systems. These prehistoric resources provide a rare opportunity to examine the interrelated effects of trade and irrigation agriculture on the growth of political elites. The Hohokam irrigation network is unusual in the New World due to its large size and complexity.

Although thousands of sites dating from the Hohokam era are present in the affected site areas, archaeologists emphasize the study and/or preservation of large Hohokam sites, because they occur in relatively small numbers and there is considerable internal variability. Large archaeological sites in the CAWCS area, such as Tonto National Monument, Casa Grande, and Pueblo Grande, make impressive tourist attractions and contain a wealth of information on the rise and fall of the Hohokam social system.

(2) Historic Resources

Historic cultural resources or sites within the CAWCS study area reflect the general patterns and historic trends of land use which characterized the region. In order to describe regional history, it is useful to recognize three historical periods to which the study area historic sites may be attributed.

Many of the historic sites which have been recorded within the study area are of major importance as evidence of a dynamic state and local cultural heritage. The significance of several of the sites has been recognized through their entry in the National Register of Historic Places, an inventory of sites considered important at a local, regional, or national level. Numerous other sites have been identified which are eligible for nomination to the National Register.

(a) Pre-Territorial (1650 to 1863) Period

Non-Indian intrusions into the study area before 1863 were both sporadic and temporary in nature. Fur trappers worked along the Verde and Gila Rivers during the period before about 1850; explorers and other travelers traversed the area using the river courses as travel routes through central Arizona. While sites representing this period exist in the CAWCS area, no sites from this period have been identified in affected site areas.

(b) Territorial-Settlement Period (1863-1912)

Permanent settlement within the study area began with the establishment of Camp McDowell, later Fort McDowell, on the Verde River in 1865. Fort McDowell was abandoned by the military in 1890. The military reservation was then turned over to the Interior Department in 1891 for disposal. A portion of the lands which comprised the original Camp McDowell Military Reservation was sold to non-Indian settlers. On September 15, 1903, President Roosevelt, by executive order, set aside the lands of the former Camp McDowell Military Reservation that had not been legally settled upon and to which no valid claims could be attached. The Federal government then bought out the rights of 14 squatters and 21 valid settlers who had claims to lands within the military reserve. The entire area that originally comprised the old Camp McDowell Military Reservation was then set aside for the Yavapai Indians. By the 1870s, Salt River Valley communities such as Phoenix, Mesa, Tempe, and Lehi were established as the area in general was explored, settled, and developed. By 1880, homesteads, farms, and ranches had been located along most of the major drainages. With

the construction of major canals during the 1880s and 1890s, and of Roosevelt Dam and the associated Granite Reef Diversion Dam between 1905 and 1911, the groundwork was established for extensive irrigation agriculture. The development of a railroad transportation system during the period from about 1880 until 1910 contributed a final stimulus to the area's development. Historic sites characteristic of these events and activities are present at each of the affected site areas.

(c) Statehood-Early Modern Development (1912-1930)

Activities within the area during the first two decades after Arizona statehood (1912) were, by and large, a continuation and elaboration of existing and developing trends. Agricultural activities increased throughout this period due to a series

of dam construction projects, including the Ashurst-Hayden Diversion Dam (1922), Mormon Flat Dam (1925), Horse Mesa Dam (1927), Carl Pleasant Dam (now Waddell Dam) (1927), and Stewart Mountain Dam (1930). New towns, such as Litchfield Park (1916), Chandler (1912), Gilbert (1910), and Tolleson (1910), which were primarily agriculture-oriented, were created during the transition from territory to state. A number of historic sites attributable to this period, including construction camps for the dams, have been recognized at each of the affected site areas.

e. Social Resources

CAWCS plans would affect the communities, individuals, and families, who are subject to flooding along the Salt and Gila Rivers from Granite Reef Dam to Gillespie Dam and the people who would be relocated because of construction and reservoir inundation in the site areas. The social implications of changes in recreation resources and facilities are analyzed in the EIS supporting document Social Impacts and Effects of CAWCS Plans (Dames & Moore, 1982b), but social impacts of recreation were scoped out of the EIS because they were not considered significant factors.

The affected flooding area includes communities within the study area. These are the cities of Phoenix, Tempe, Mesa, the communities of Buckeye and Holly Acres, and the Salt River Pima-Maricopa Indian Community and the Gila River Indian Community. Phoenix, Mesa, and Tempe are urban centers and residential areas, while Buckeye, Holly Acres, Salt River Pima-Maricopa Indian Community and Gila River Indian Community are rural agricultural communities.

Action plans described in this EIS would require relocations in three locations: the Fort McDowell Indian Community, Roosevelt Lake, and KA Ranch.

The Fort McDowell Indian Community is approximately 25 miles northeast of Phoenix. Established in 1903, the current population of the reservation is 374 (Fort McDowell Office of Economic Development Planning, 1980), the majority of whom are Yavapai. Residents would be required to relocate if a dam were constructed at the confluence of the Salt and Verde Rivers.

Roosevelt Lake is approximately 75 miles from the Phoenix metropolitan area. Some residents from each of the following communities would be required to relocate if a new or enlarged dam were built at Roosevelt Lake. Population of these communities is:

- North Bay Estates (approximately 60 residents)-Roosevelt Lake Estates (approximately 360 residents)
- Rockhouse Farm (approximately 50 residents)
- Roosevelt Gardens East (approximately 130 residents)

Of the total population of these communities, approximately 50 percent are part-time residents, living at the lake only on weekends or during part of the year.

2. Other Resources

a. Air Quality

The EPA and the Arizona Department of Health Services (ADHS) have set primary and secondary standards for various air quality constituents. Primary standards define the maximum pollutant levels allowable to protect the public health with an adequate margin of safety; secondary standards define the maximum pollutant levels allowable to protect the public welfare from any known or anticipated adverse effects. The state standards, which are generally comparable to the federal standards, are maximum pollutant levels that the ADHS considers to be in the best interest of the health of the general public. Both the National Ambient Air Quality Standards (NAAQS) and the Arizona state standards deal primarily with six pollutants. An area in which any NAAQS is exceeded, as shown by monitored data, is classified as a "non-attainment" area with regard to the offending pollutant. The state is required to reduce the ambient level of this pollutant within a specified period of time. A large portion of the study area is included in the Phoenix metropolitan area which has been designated a non-attainment area for carbon monoxide (CO), ozone (O_3), and total suspended particulates (TSP).

Ambient air quality data have been collected within the study area by government agencies and private industries. Most of the data, however, are from the Phoenix metropolitan area with only limited data from outlying areas. The following section describes the air quality of the study area in 1980 relative to each of the six designated pollutants.

Carbon Monoxide (CO): Virtually all of the CO data are from the Phoenix Metropolitan Area. The one-hour Federal and state standard was not violated at any location. However, the 8-hour standard was violated at a number of locations. The Phoenix Metropolitan Area has been designated as non-attainment for CO.

Non-methane Hydrocarbons (NMH): The Federal and state standard was grossly violated in 1980 at the one Phoenix monitoring site where data were collected. Because hydrocarbons play a key role in the chemical formation of ozone, the standard is used as a guide in devising plans to

achieve the ozone standard. Therefore, although the NAAQS has been violated, the Phoenix metropolitan area has been designated non-attainment for oxidants (ozone) rather than NMH.

Nitrogen Dioxide (NO_2): NO_2 data were collected at two Phoenix locations in 1980. The Federal and state standard was not violated at either of the sites.

Ozone (O_3): The Federal and state standard was violated at approximately half of the locations monitored. The majority of the locations are within the Phoenix metropolitan area, which has been designated non-attainment for O_3.

Total Suspended Particulates (TSP): Numerous violations of the Federal and state standards occurred in 1980. The EPA has classified the Phoenix metropolitan area as non-attainment for TSP.

Sulfur Dioxide (SO_2): None of the Federal or state standards were violated in the Phoenix area in 1980.

b. Aesthetics

The visual landscape of the CAWCS area includes the city and suburbs of Phoenix, lush green irrigated farmland, and the Arizona desert.

The terrain of the study area can be characterized by mountain ranges and steep barren slopes. Frequently, these slopes become massive, exotically shaped cliffs formed from rocks of various colors. The rugged terrain is often separated by broad, gently sloping, alluvium-filled valleys. Flowing rivers and intermittent streams meander through the desert landscape. Along the rivers, riparian vegetation adds a contrast with the earth colors and sparse vegetation of the desert. Visually these rivers and the shade of riparian vegetation are strong elements of the central Arizona landscape. Several large man-made lakes also provide a pleasing visual experience.

c. Noise

Typical background ambient sound levels (in decibels) for various study area land uses are displayed in Table III-7. The EPA has suggested an annual day-night sound level (L_{dn}) of less than 55 dB as being requisite to protect public health and welfare.

d. Geology/Soils

Most of the study area is included in the Basin and Range Physiographic Province. The northeastern part of the area is in the Transition Zone which separates the Basin and Range Province from the Colorado Plateau. The Basin and Range is characterized by mountain ranges that are distinctly longer than they are wide, generally parallel to other ranges, with steep slopes and rugged topography. The mountain ranges are usually separated by near-flat to gently sloping valleys or basins which have been filled with alluvium. The Transition Zone is characterized by a topography which is more rugged than that of the Plateau; however, altitudes are generally lower in the Transition Zone.

Table III-7

AMBIENT SOUND LEVELS BY LAND USE TYPE

Land Use	Day-Night Ambient Sound Level (L_{dn}) in dB
Urban Residential Near to Highway	75-85
Urban Residential Hi-Rise	65-85
Urban Shopping Center	55-70
High Density Single Family Urban Residential	50-65
Suburban Residential	35-60
Suburban Residential at City Outskirts	45-60
Small Town Residential	40-55
Farm	30-45
Open Land (except agricultural)	15-45

Various igneous, sedimentary, and metamorphic rocks ranging in age from Precambrian to Quaternary are exposed within the study area. The area has been subjected to a number of geologic processes including folding, faulting, intrusions, deposition, and erosion. Modern landforms are, in part, a result of the Basin and Range orogeny which extended from early or middle Miocene time into the Pliocene.

Historic seismic activity in Arizona has ranged from moderate in some areas to virtually nonexistent in others. Of the recorded epicenters in Arizona, very few have had a magnitude of 5.0 or greater on the Richter scale.

The study area is characterized by broad valleys underlain by permeable alluvial deposits hundreds to even thousands of feet thick and by abruptly rising mountains which typically consist of crystalline rocks of low permeability. Within these areas, particularly in portions of Pinal and Maricopa Counties, where the state's population and agriculture are centered, water levels have been declining since 1923. The decline is due to water withdrawal in excess of the volume of recharge. With water level declines on the order of 200 to 300 feet over the years, the dewatered zone has become compacted, the land surface has subsided, alluvial deposits have been subjected to stress, and earth fissures have formed, usually near the margins of basins adjacent to mountains. Often there is some vertical displacement across these cracks. The cracks quickly widen due to erosion by surface water and usually form gully-like features.

Although there are no earth fissures known to occur at the CAWCS site areas, they do occur within the general study area and the potential for their formation is high in areas where ground water levels continue to decline.

There are many known localities of metallic and nonmetallic minerals, nonferrous base, and precious metals throughout the study area. A majority of the ore bodies are located within the mountainous region, but the alluvial basins contain abundant sources of sand and gravel and other minerals.

Because of their quality, growing season, and moisture supply, some of the soils in the study area are able to produce sustained high agricultural yields by modern farming methods. The Soil Conservation Service has mapped these areas of prime farmland for a portion of the study area. In 1980 there were an estimated 620,000 acres of prime farmland within the CAWCS area.

e. Land Resources

Existing generalized land use and landownership patterns within the CAWCS study area are described below.

(1) Existing Land Use Patterns

Land use patterns within the 13,400-square-mile CAWCS study area are shown in Figure III-2. The CAWCS study area is predominantly rangeland, with approximately 76 percent of land classified in this category. Agricultural lands comprise approximately 12 percent of the total CAWCS area. They lie primarily west and southeast of the Phoenix metropolitan area.

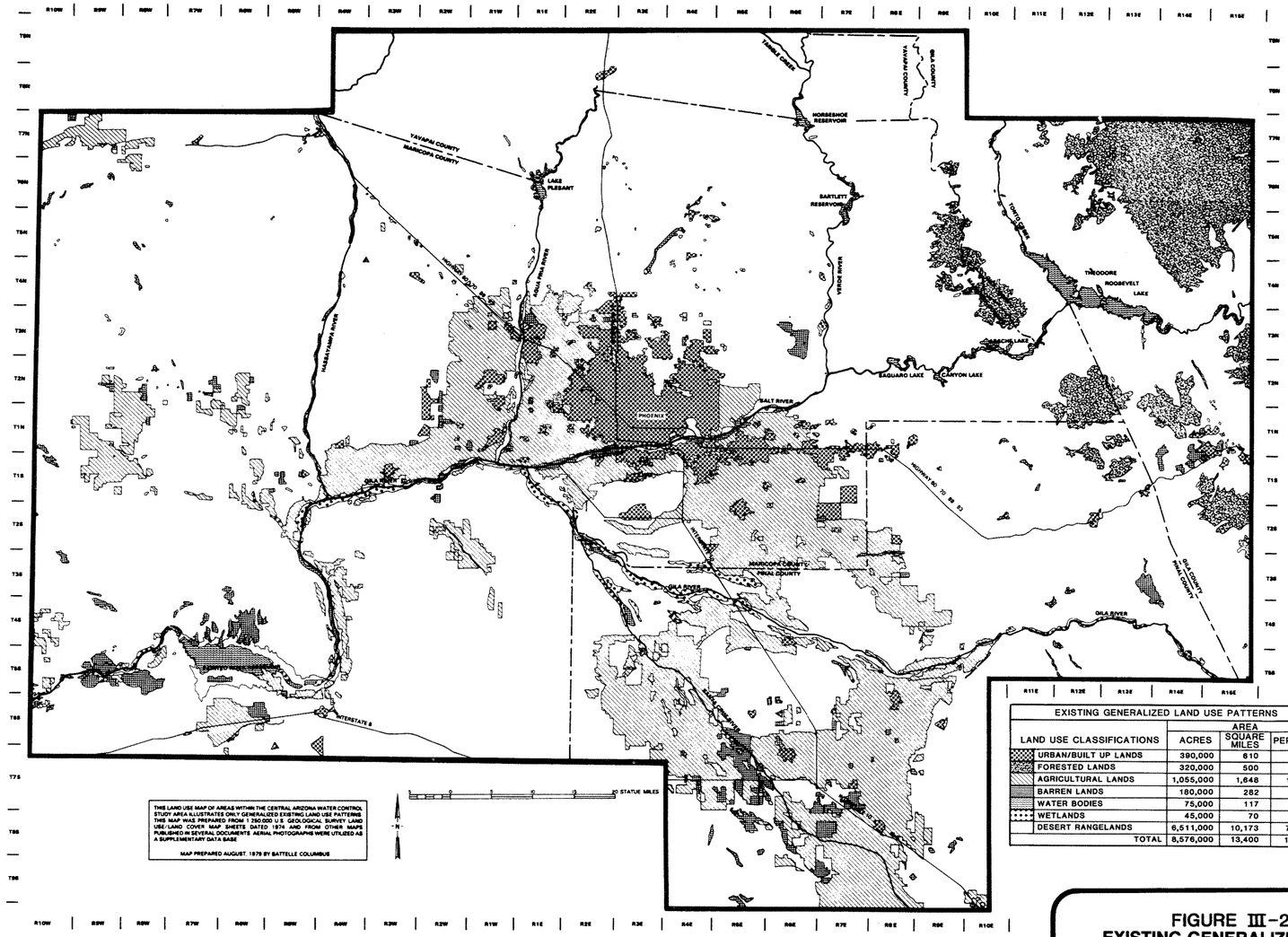
Urban/built-up lands comprise approximately 5 percent of the total CAWCS area. The major urban and built-up lands are located within the City of Phoenix and the adjacent Cities of Tempe, Mesa, Scottsdale, Paradise Valley, Fountain Hills, Glendale, Peoria, Sun City, Surprise, El Mirage, and Youngtown.

Four other minor land use/land cover classifications found within the study area include forest lands, barren lands, surface water bodies, and narrow riparian wetland areas as indicated on Figure III-2.

(2) Landownership Patterns

General surface landownership patterns for the CAWCS area are shown in Figure III-3. Approximately 70 percent of lands remain in public ownership or are Indian reservations. These lands are predominantly desert rangeland. The privately-owned lands, mostly located in the central part of the study area, are predominantly urbanized or agricultural.

The U.S. Forest Service manages about 23 percent of the land within the CAWCS area, including portions of two Tonto National Forest Wilderness areas, the Mazatzal and Superstition. National Resource



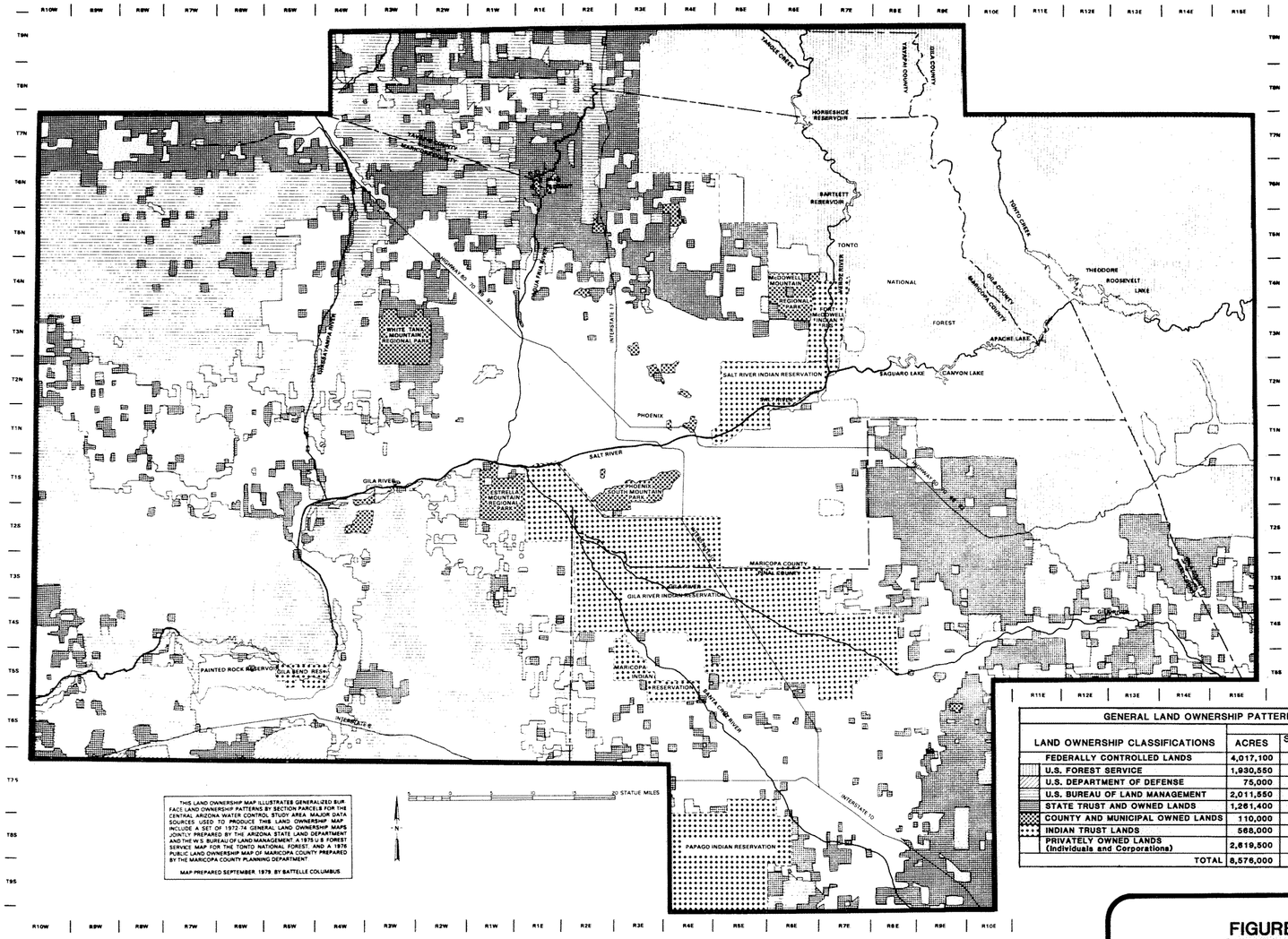
THIS LAND USE MAP OF AREAS WITHIN THE CENTRAL ARIZONA WATER CONTROL STUDY AREA ILLUSTRATES ONLY GENERALIZED EXISTING LAND USE PATTERNS. THIS MAP WAS PREPARED FROM 1:250,000 U.S. GEOLOGICAL SURVEY LAND USE/LAND COVER MAP SHEETS DATED 1974 AND FROM OTHER MAPS PUBLISHED IN SEVERAL DOCUMENTS. AERIAL PHOTOGRAPHS WERE UTILIZED AS A SUPPLEMENTARY DATA BASE.

MAP PREPARED AUGUST, 1978 BY BATTELLE COLUMBUS

EXISTING GENERALIZED LAND USE PATTERNS

LAND USE CLASSIFICATIONS	AREA ACRES	AREA SQUARE MILES	AREA PERCENT
URBAN/BUILT UP LANDS	390,000	610	4.6
FORESTED LANDS	320,000	500	3.7
AGRICULTURAL LANDS	1,055,000	1,648	12.3
BARREN LANDS	180,000	282	2.1
WATER BODIES	75,000	117	0.9
WETLANDS	45,000	70	0.5
DESERT RANGELANDS	6,511,000	10,173	75.9
TOTAL	8,576,000	13,400	100%

FIGURE III-2
EXISTING GENERALIZED LAND USE PATTERNS



THIS LAND OWNERSHIP MAP ILLUSTRATES GENERALIZED SURFACE LAND OWNERSHIP PATTERNS BY SECTION PARCELS FOR THE CENTRAL ARIZONA WATER CONTROL STUDY AREA. MAJOR DATA SOURCES USED TO PRODUCE THIS LAND OWNERSHIP MAP INCLUDE A SET OF 1972-74 GENERAL LAND OWNERSHIP MAPS JOINTLY PREPARED BY THE ARIZONA STATE LAND DEPARTMENT AND THE W.S. BUREAU OF LAND MANAGEMENT, A 1975 U.S. FOREST SERVICE MAP FOR THE TONTO NATIONAL FOREST, AND A 1976 PUBLIC LAND OWNERSHIP MAP OF MARICOPA COUNTY PREPARED BY THE MARICOPA COUNTY PLANNING DEPARTMENT.

MAP PREPARED SEPTEMBER, 1979, BY BATTELLE COLUMBUS

GENERAL LAND OWNERSHIP PATTERNS

LAND OWNERSHIP CLASSIFICATIONS	ACRES	AREA SQUARE MILES	PERCENT
FEDERALLY CONTROLLED LANDS	4,017,100	6,276	46.8
U.S. FOREST SERVICE	1,930,550	3,016	22.5
U.S. DEPARTMENT OF DEFENSE	75,000	117	0.9
U.S. BUREAU OF LAND MANAGEMENT	2,011,550	3,143	23.4
STATE TRUST AND OWNED LANDS	1,261,400	1,971	14.7
COUNTY AND MUNICIPAL OWNED LANDS	110,000	172	1.3
INDIAN TRUST LANDS	568,000	888	6.6
PRIVATELY OWNED LANDS (Individuals and Corporations)	2,619,500	4,093	30.5
TOTAL	8,576,000	13,400	100%

FIGURE III-3
GENERAL LAND OWNERSHIP PATTERNS

Lands controlled by the Bureau of Land Management also comprise approximately 23 percent of the total study area. The majority of these lands are consolidated blocks of mountains and foothills located in the western part of Maricopa County. Williams and Luke Air Force Bases and the Florence Military Reservation controlled by the U.S. Department of Defense account for approximately 1 percent of the total CAWCS area.

The Arizona State Land Department and several other state agencies have administrative responsibilities for managing approximately 15 percent of land within the CAWCS area. The majority of the State Trust Lands within the study area are located north and southeast of the Phoenix urban area. The State Land Department generates revenues from these lands by leasing the lands for grazing, mineral, homesite, agricultural and other purposes. Under provisions of the recently enacted Urban Lands Management legislation, the Land Department now engages in the long-term lease of State Trust Lands near urban areas for private development (Arizona Revised Statutes, Title 37; Arizona State Land Department).

County and municipally owned lands constitute slightly over 1 percent of the total CAWCS area. Almost all of these lands are unspoiled nature preserve parklands within the Maricopa County and City of Phoenix park systems.

Five Indian reservations comprise approximately 7 percent of the study area. These are the entire Fort McDowell, Salt River, Gila River, and Ak-Chin Indian Reservations, and a portion of the Papago Indian Reservation. Most Indian reservation lands are primarily open rangelands generally used for farming or grazing purposes, but increasingly, the Indian communities are leasing unused community lands to the general public for commercial, housing, agricultural, recreational and industrial development.

Privately owned lands, totalling approximately 31 percent of the CAWCS area, are mostly located within the Phoenix urbanized area and to the southeast and west of the City of Phoenix. The smaller parcels of privately owned land located within or near urban areas are primarily used for residential, commercial, industrial, recreational, and public utility purposes. The larger parcels of privately owned lands located outside of the urban areas are predominantly used for agriculture.

C. Description of Affected Site Areas

1. New/Modified Stewart Mountain Site Area

The existing Stewart Mountain Dam, located on the Salt River approximately 10 miles upstream from the confluence of the Salt and Verde Rivers, was constructed in 1930 as part of the SRP system for water storage and hydroelectric purposes.

The entire area which would be affected by construction of New Stewart Mountain Dam is located within the boundaries of the Confluence site area (see Figure III-1). The description of the New Stewart Mountain affected site area is, therefore, included in the description of the Confluence site area.

2. Cliff Site Area

a. Geographic Setting

The Cliff Dam and Reservoir site is located on the Verde River between two existing dams: Horseshoe Dam, constructed in 1946, and Bartlett Dam, constructed in 1939 (see Figure III-1). Horseshoe Dam was constructed by the Phelps Dodge Copper Corporation for water reclamation purposes and is currently operated by the Salt River Project.

The approximately 52,800-acre site lies exclusively within the boundaries of the Tonto National Forest. Access is provided to this area by Cave Creek Road.

The eastern boundary of the Mazatzal Wilderness Area lies approximately 3 miles north and east of the proposed Cliff Dam site. About 14 miles downstream from the proposed Cliff Dam site is Bartlett Dam. The upper reservoir limits at maximum design capacity lie approximately 1 mile downstream from the Cliff Dam site.

b. Biological Resources

The Verde River and its tributaries drain mountainous terrain within the Cliff site area. The area borders on the transition between scrub oak chaparral and paloverde-mixed cacti desert. Temperate riparian forests occur along the Verde River flood plain. Table III-8 presents acreages and ranges for biotic community types within the Cliff site area.

(1) Riparian/Wetland Communities

Mature cottonwood/willow forests grow along the Verde River and its tributaries upstream from Horseshoe Reservoir. These riparian forests support a full complement of wildlife species including large mammals. In addition, stands of cottonwood/willow upstream from Horseshoe Reservoir are used by the bald eagles which nest at Chalk Mountain. Mesquite woodlands also occur at the site, primarily downstream from Horseshoe Dam. A great blue heron rookery exists in cottonwood trees downstream from Horseshoe Dam near the KA Ranch.

(2) Other Terrestrial Communities

The paloverde-mixed cacti community type is the predominant habitat of the surrounding hillsides throughout the site. North-facing slopes of many washes support dense stands of shrubs and desert trees such as acacia and hackberry. Ten springs occur in the Cliff site area. The Chalk Mountain area provides nesting habitat for bald eagles and hawks.

(3) Perennial Stream/Riverine Communities

The Verde River is an unregulated stream upstream from Horseshoe Reservoir and is subject to wide fluctuations in flow.

Table III-8

ACREAGE AND PERCENT RANGE OF BIOTIC COMMUNITY SERIES AND ASSOCIATIONS AT THE CLIFF SITE AREA

	Symbol	Percent	Acres
Desert upland:			
Paloverde-mixed cacti series	PC	86.3	45,550
Blue paloverde-ironwood association	CB/RA	3.9	2,030
Riparian and wetland types:			
Fremont cottonwood-Goodding willow association	CW/PS	1.0	550
Mixed broadleaf series	MB	0.2	100
Velvet mesquite association	MS/PJ	1.7	880
Saltcedar association	SD/TC	0.02	10
Saltcedar-mixed scrub association	SD/SC	0.02	10
Human-dominated types:			
Agricultural lands	AG	0.2	130
Other resource categories:			
Lake (typical year high)		3.8	2,000
Lake (typical year low)		1.2*	610*
Flowing stream (miles)			20*
Nonvegetated lands		2.9	1,530
Total		100.0	52,790

*Not included in the total.

Source: Second Level Environmental Inventory, Dames & Moore, 1982.

Although upstream portions of the Verde are characterized as mature heterogeneous stream, there are few deep pools or riffles in the reach occurring within the affected site area. Native stream fishes (desert and Gila suckers, longfin dace) and introduced game species (bass, carp, catfish) occur both upstream and downstream from the dam. Approximately 20 miles of perennial stream occur within the Cliff site area.

(4) Reservoir Aquatic Communities

Horseshoe Reservoir is subject to extensive drawdown under the current operation schedule which severely reduces fish spawning. Fishes of the family centrarchidae (crappie, largemouth and smallmouth bass, sunfishes) are the major groups in which severe reductions in spawning success occurs. However, during drawdowns, the river supports vegetative growth in the bed of the reservoir, creating habitat for waterfowl and shorebirds.

(5) Threatened and Endangered Plants and Wildlife

Bald eagles nest along the Verde River in the area of Chalk Mountain. The breeding pair is believed to use the riparian forest and flowing river between Horseshoe Reservoir and Tangle Creek. The Chalk Mountain breeding area is the least productive of five bald eagle breeding areas in CAWCS site areas due to frequent inundation of nest sites.

Among Arizona special status wildlife, the desert tortoise, black hawk, osprey, and black-crowned night heron have been noted in the Cliff site area. The Arizona Game and Fish Department has recently reintroduced the river otter in the Tangle Creek vicinity.

(6) Management and Special Use Areas

The Cliff site area is used for grazing administered by the Tonto National Forest. The Forest Service will also establish approximately 180 acres of cottonwood habitat at four rehabilitation sites along the Verde River. Riparian habitat upstream from Horseshoe Reservoir is considered wintering area for both bald eagles and peregrine falcons. The Mazatzal Wilderness Area and contiguous area recommended for inclusion in the wilderness system are adjacent to the Cliff site area. The Lime Creek area adjacent to the Cliff site is being reevaluated by the Forest Service for roadless area designation.

c. Recreation

(1) Stream-Oriented Recreation

Existing stream-oriented recreation resources and facilities in the Cliff site area are within the Tonto National Forest and are managed by the U.S. Forest Service. Stream-oriented resources include 19.7 miles of stream on the Verde River, approximately half of which are above Horseshoe Dam. One stream-oriented recreation area is located just below Horseshoe Dam.

The total number of maximum annual recreation days attributed to stream-oriented activities at the Cliff site is 19,468. Fishing, camping, and picnicking are the primary recreation activities. These activities occur at both developed and nondeveloped sites on the Verde River.

(2) Reservoir-Oriented Recreation

Existing reservoir-oriented resources within the Cliff site area center around Horseshoe Reservoir. Horseshoe Reservoir has water storage for irrigation as its primary function. Because of this, the level of the reservoir fluctuates widely. The reservoir-oriented recreation condition at the Cliff site was evaluated based on a surface area of 1,327 acres at Horseshoe Reservoir. This acreage represents the average level of the reservoir during the recreation season (April to October) of a typical year.

Access to Horseshoe Reservoir is limited to a two-lane gravel road, thereby restricting the types of boats that can reach the reservoir. According to the U.S. Forest Service, most boating use at Horseshoe Reservoir is for fishing. There are currently no physical facilities for reservoir-oriented recreation within the Cliff site area (Horseshoe Reservoir). The total number of maximum annual recreation days for reservoir-oriented recreation at the Cliff site area is 59,464.

d. Cultural Resources

(1) Prehistoric Resources

Within the Cliff site area boundaries there are estimated to be approximately 1,465 prehistoric archaeological sites which cover a combined area of roughly 1,500 acres.

Several categories of site types were used to describe the archaeological resources in the CAWCS area. The first type of site is the artifact scatter of which approximately 475 are predicted to occur. This type of site is characterized by the presence of pottery fragments and/or lithic fragments or tools on the surface of a site. Surface architecture is generally absent; in a few cases, these sites are found to contain remains of Hohokam pithouses. Such sites functioned as habitation units occupied by families of different sizes for varying lengths of time. In the majority of cases, however these scatters are referred to as limited activity sites: areas where specialized tasks were performed such as plant and/or animal procurement or processing, raw material extraction, or tool manufacturing. These types of sites would have been occupied for a shorter time period than were the pithouses.

The second type of site is one which has evidence of surface architecture. These are commonly called pueblos and reflect more permanent occupations than do limited activity sites. This class of sites was divided into five groups based on the number of rooms found at each site. Each of these different sized pueblo sites served a different function in the prehistoric settlement hierarchy. Sites with only one room (345 predicted)

are the most common in the Cliff site area followed by sites with 2-5 rooms (460 predicted), 6-20 rooms (130 predicted), 21-100 rooms (10 predicted), and greater than 100 rooms (3 predicted). The very large sites, greater than 100 rooms, are the least common at the Cliff site area, and were no doubt of special significance. These sites also contain more nonlocal materials such as decorated pottery from the north and worked shell from the south.

Two other types of sites include petroglyph sites (less than 5 predicted to occur) and agricultural sites (30 predicted to occur). Petroglyph sites refer to sites consisting only of rock art and which lack artifacts or surface rooms. A distinction is made between agricultural sites, or systems, and agricultural features. An agricultural site consists of 5 or more individual water-soil control features, such as terraces, check dams, or gridded gardens, which are spatially related; few, if any, artifacts are present on the surface of the site. These sites are often quite large in areal extent, and many have more than 25 individual water soil control features. If a site has more than 5 water-soil control features, but also has structures on the surface, the site is classified according to the number of rooms as this category more accurately reflects the site function. Thus, the water soil control feature category represents features associated with another type of site.

Occurring with sites in the Cliff site area are a number of special features such as trash mounds (90 predicted), ball courts (2 known to exist), and water and soil control devices (1,270 predicted). Trash mounds are extremely valuable to archaeologists, as they provide an enormous amount of information on subsistence, trade goods, nutrition, and prehistoric environmental conditions. Ball courts are very rare (only one is known to exist in the Cliff site area) and are associated with the larger sites.

There is some evidence documenting human occupation in this area as early as 2000 B.C. with continual occupation up through historic times. Previous research has suggested that the groups which occupied this area prehistorically established trade networks with people living farther north and south. Evidence also exists for the presence of at least two different cultural groups in the Cliff site area during prehistoric times. Thus, the resources in this area present the opportunity to study patterns of both local and regional exchange and interaction.

Some of the sites in this area have been vandalized, but as an archaeological district the prehistoric sites in the Cliff site area have significant information potential.

(2) Historic Resources

Seventeen historic sites are located within the Cliff site area. Nine of the 17 sites have significant scientific or historic value. Three of the nine sites are related to water control functions and six sites have an agricultural function.

Relatively early initial intrusions by non-Indians in the Cliff site area were transitory in nature. The earliest known was that of

a fur trapping party led by Ewing Young who trapped along the Verde River in 1829. The military presence was only occasional and troops traveled along the Verde River through the Cliff site area on a relatively infrequent basis. Generally, the Verde River seems to have been used very little as a north-south transportation or communication route during the historic period.

Agricultural interest was limited, primarily because of the rugged terrain and the creation of the Tonto National Forest in 1905 which restricted access to suitable land for farming. Only two homesteads, both part of the KA Ranch (now Johnson Ranch), were patented, one in 1919 and one in 1922. The 1919 homestead was patented by J. Marion Sears and includes the ranch buildings of the KA Ranch. Although the homestead was patented in 1919, it was first occupied in 1887. The 1922 homestead was patented by Frank Lopez and eventually acquired by the KA Ranch. The remnants of two buildings related to apparently unpatented homesteads situated on Ister Flat were identified. They may date to the World War I period.

Shepherding in the Horseshoe Dam area had its roots in the late nineteenth century. Two relatively late manifestations of this activity are located within the Cliff site area. Near the north end is the Verde River Sheep Bridge built in 1940 by Dr. R. O. Raymond, who began grazing sheep in the area in 1926. The bridge was listed on the National Register of Historic Places in 1978. Associated with the bridge is a small cluster of ranch buildings now in ruin.

Construction of Horseshoe Dam brought substantial change to the area in the mid-1940s. The dam was designed, along with Bartlett Dam, to store water from the Verde River. The immediate environs of the dam contain a number of sites associated with the main structure. Construction took place during the years 1944-1946 and was financed by the Defense Plant Corporation, a Federal agency, for the Phelps Dodge Copper Company. Associated with the dam are extensive remains of a large and complex construction camp.

e. Social Resources

There are no communities in the Cliff site area.

KA Ranch, located 1 mile south of the existing Horseshoe Dam, would be inundated by Cliff Reservoir. The ranch has been in existence since 1887. It includes 212 acres of family-owned land used for growing feed and for other ranching operations. Additionally, the family has obtained grazing permits from the Forest Service for use of 36,848 acres of Tonto Forest land in the vicinity of the ranch. Two people live on the ranch year round. In addition, five to seven ranch hands reside there part-time. During the summer months, nine additional family members live at the ranch. Nearest services are 20 miles away in Cave Creek.

f. Other Resources

(1) Air Quality

No air quality data are available from the vicinity of the Cliff site area. A combination of dust from recreation-related traffic and the relatively high potential for wind erosion make an occasional violation of total suspended particulates (TSP) standards a possibility.

(2) Aesthetics

The Cliff site area extends southward to include a portion of the Bartlett Reservoir and northward to 7 miles upstream from Horseshoe Reservoir. The Verde River in the area between the two reservoirs has clusters of mature cottonwoods and other riparian vegetation along the river banks. On the west shore, approximately 2 miles below Horseshoe Dam, are green fields, grazing cattle, large mature trees, and buildings of the KA Ranch. With the river as a foreground, this ranch enhances the visual quality of the site area by creating a strong contrast to the surrounding desert landscape. The Horseshoe Reservoir often has a large drawdown leaving only a very small lake with a steep unvegetated shoreline. The general terrain of the Cliff site area is characterized by rough mountains and steep valleys. Other than the KA Ranch, little evidence of human habitation is evident.

(3) Noise

Day-night sound levels in the Cliff site area are typically below 55 dB. The day-night sound level of 55 dB is compatible with the EPA's long-term goal for residential areas. Jeep and motorbike activities along local trails contribute to the maximum sound levels within the area.

(4) Geology/Soils

The topography of the Cliff site area is steep, very rugged, and highly dissected by drainages which join with the Verde River. The area includes Precambrian granite and pyroxenite, Tertiary lake deposits and volcanics, and Quaternary basalt and alluvium. The damsite is underlain by alluvium and Precambrian granite. The granite is extensively fractured and faulted, and varies from coarse to relatively fine grained with no distinct contact between the two.

The Cliff Dam site is located in a region of low seismicity so a large damaging earthquake is not expected. Although the area has low rates of tectonic activity, the largest random earthquake (i.e. no causative fault identified) that is postulated for the seismotectonic province in which Cliff Dam site occurs, would have a magnitude of 5.5. Studies of the major faults in the area indicate that earthquakes as large as 6.5 are capable of occurring in the seismotectonic province. A potentially active fault has recently been located to the west of Horseshoe Reservoir.

Uranium occurrences have been noted at Chalk Mountain, Lime Creek, and near Horseshoe Dam, and there has been limited mineral exploration in the area; however, development of claims is not known to have occurred.

The soils of the site area vary from clayey, sandy, loamy, gravelly to rocky. Within the site area, there are approximately 130 acres of prime farmland located at the KA Ranch.

(5) Land Resources

Except for the KA Ranch, all of the lands in the vicinity of the Cliff site are Tonto National Forest lands controlled and managed by the Forest Service for wildlife habitat, water storage, recreation, and livestock grazing. The major land use features currently located within the Cliff site area are the Horseshoe Dam and the 2,800-acre Horseshoe Reservoir which would be replaced by Cliff Dam and Reservoir. No other significant developments have occurred in the vicinity of the Cliff site area given the predominantly public landownership pattern.

3. Verde River Dams Modifications Site Area

The Verde River Dams Modifications site area encompasses 75,690 acres including all 52,790 acres of the Cliff site area and an additional 22,900 acres of the Bartlett Dam and Reservoir area. The description presented here addresses only those factors which differ from the Cliff site area.

a. Geographic Setting

The Verde River Dams Modifications site area is located on the Verde River and consists of two existing dams, Horseshoe Dam and Bartlett Dam. The eastern boundary of the Mazatzal Wilderness Area lies approximately three miles east of Horseshoe Dam. Bartlett Dam is located 24 miles downstream of Horseshoe Dam.

b. Biological Resources

Table III-9 presents acreages and ranges for biotic community types within the Verde River Dams Modifications site area.

(1) Riparian/Wetland Communities

The riparian/wetland communities are the same as described in the Cliff site area.

(2) Terrestrial Communities

Terrestrial communities are as described in the Cliff site area.

Table III-9

ACREAGE AND PERCENT RANGE OF BIOTIC COMMUNITY SERIES AND ASSOCIATIONS AT THE VERDE RIVER DAMS MODIFICATIONS SITE AREA

	Symbol	Percent	Acres
Desert upland:			
Paloverde-mixed cacti series	PC	85.3	64,550
Blue paloverde-ironwood association	CB/RA	4.0	3,040
Riparian and wetland types:			
Fremont cottonwood-Goodding willow association	CW/PS	0.8	570
Mixed broadleaf series	MB	0.1	100
Velvet mesquite association	MS/PJ	1.3	970
Saltcedar association	SD/TC	0.01	10
Saltcedar-mixed scrub association	SD/SC	.01	10
Human-dominated types:			
Agricultural lands	AG	0.2	130
Other resource categories:			
Lake (typical year high)		6.3	4,780
Lake (typical year low)		2.0*	1,530*
Flowing stream (miles)			21*
Nonvegetated lands		2.0	1,530
Total		100.0	75,690

*Not included in the total.

(3) Perennial Stream/Riverine Communities

The perennial stream/riverine communities are the same as described in the Cliff site area except there are approximately 21 miles of perennial stream.

(4) Reservoir Aquatic Communities

In addition to the reservoir aquatic communities of the Cliff site area, Bartlett Reservoir is a relatively more stable reservoir than Horseshoe. It is one of Arizona's major sports fisheries.

(5) Threatened and Endangered Plants and Wildlife

In addition to the threatened and endangered plants and wildlife described in the Cliff site area, bald eagles nest along the Verde River downstream of Bartlett Dam. This breeding area has been more productive than the Chalk Mountain breeding area.

(6) Management and Special Use Areas

Management and special use areas are as described for the Cliff site area.

c. Recreation

(1) Stream-oriented Recreation

Existing stream-oriented resources in the Verde River Dams Modifications site area include 1 mile of stream below Bartlett Dam in addition to those resources described in the Cliff site area. Recreational use for this mile is estimated to be 16,000 annual recreation days.

(2) Reservoir-Oriented Recreation

In addition to the reservoir oriented recreation at Horseshoe Reservoir described in the Cliff site area, Bartlett Reservoir in the Verde River Dams Modifications site area receives a high amount of recreational use. Reservoir-oriented recreational use at Bartlett Reservoir is 158,730 annual recreation days, 72,150 of these are on the water surface and 86,580 on land.

d. Cultural Resources

(1) Prehistoric Resources

Verde River Dams Modifications site area encompasses the 52,790 acres within the Cliff area described above plus an additional 22,900 acres. This combined area would include the 1464 prehistoric archaeological sites covering approximately 1,500 acres that are estimated to be within the Cliff area. An additional 292 sites covering about 265 acres are predicted to be within the area surrounding Bartlett. The total of 1,756 sites are estimated to encompass about 1,750 acres of archeological remains.

Only limited sample surveys (about 12 percent coverage) were conducted within the Bartlett area, but the types and proportions of sites present are assumed to be generally similar to those for the Cliff area described above. The exception would be due to the fact that the existing Bartlett Reservoir has inundated the prime terrace locations where the larger types of sites are typically located. Although one additional ball court feature, which is usually indicative of a large pit house village, has been recorded in the Bartlett area, it is expected that few others, if any, of the larger site classes would be present within the additional area at Bartlett.

(2) Historic Resources

In addition to the 17 historic sites within the Cliff area an additional 3 sites are known to be present within the Bartlett area. These include Bartlett Dam itself, a saddle dam south of the main dam, and the construction camp complex used when the dam was originally constructed between 1936 and 1939. Because total survey of the Bartlett area has not been made additional historic sites have not been identified. The history of land use in the area would indicate that relatively few, if any, historic sites are unrecorded.

e. Social Resources

Social resources are the same as those described in the Cliff site area.

f. Other Resources

(1) Air Quality

No air quality data are available from the vicinity of the Verde River Dams Modifications site area. A combination of dust from recreation-related traffic and relatively high potential for wind erosion makes an occasional violation of total suspended particles (TSP) standards a possibility.

(2) Aesthetics

The aesthetic qualities of the Verde River Dams Modifications site area are as described for the Cliff site area with the addition of Bartlett Reservoir. Bartlett Reservoir is a relatively stable reservoir without the substantial drawdowns that are associated with Horseshoe Reservoir.

(3) Noise

Noise levels in the Verde River Dams Modifications site area are the same as at the Cliff site area.

(4) Geology/Soil

The foundation of Horseshoe Dam consists of dipping interbedded basalts, tuffs, and agglomerate. Bartlett Dam is underlain by coarse-grained and fine-grained granites with alluvium and talus deposits occurring along the dam axis. Geologic conditions are as described for the Cliff site area.

(5) Land Resources

Land resources are as described for the Cliff site area.

4. New/Modified Roosevelt Site Area

a. Geographic Setting

The New/Modified Roosevelt Dam site area encompasses the existing Roosevelt Dam and Reservoir, located at the confluence of Tonto Creek and the Salt River about 75 miles east of Phoenix (see Figure III-1). Roosevelt Dam was constructed in 1911 for water storage and is currently operated by the Salt River Project. Roosevelt Lake has an approximate 17,000-acre surface area and an 88-mile shoreline at maximum design capacity. Primary access routes to the Roosevelt damsite area are State Routes 88 (Apache Trail), 188, and 288. The affected site area for construction of New/Modified Roosevelt Dam includes approximately 81,000 acres.

b. Biological Resources

The Roosevelt site area has two somewhat dissimilar drainages feeding into Roosevelt Lake. The Salt River flows from the east through a deeply incised, narrow canyon, while Tonto Creek flows from the north through a broader valley where riparian forests are well developed. The surrounding hillsides are part of the Paloverde-mixed cacti community. Table III-10 presents acreages and ranges for biotic community types within the Roosevelt site area.

(1) Riparian/Wetland Communities

Riparian forests and woodlands are primarily confined to Tonto Creek and the Salt River. Tonto Creek supports stands of mature cottonwood, willow and mesquite which harbor many resident and migrating bird species. Salt-cedar is prevalent along the Salt River within the site area.

(2) Other Terrestrial Communities

The upland habitat type is the Paloverde-mixed cacti community; the blue Paloverde-ironwood association occupies large washes in the site area and several alluvial benches on the perimeter of Roosevelt Lake. Wildlife is abundant; coyote, deer and javelina have been noted in the site area during CAWCS surveys. Springs are present along the perimeter of the

Table III-10

ACREAGE AND PERCENT RANGE OF BIOTIC COMMUNITY SERIES AND ASSOCIATIONS AT THE ROOSEVELT SITE AREA

	Symbol	Percent	Acres
Desert upland:			
Paloverde-mixed cacti series	PC	69.3	56,130
Blue paloverde-ironwood association	CB/RA	4.4	3,540
Riparian and wetland types:			
Fremont cottonwood-Goodding willow association	CW/PS	0.5	380
Velvet mesquite association	MS/PJ	2.0	1,650
Saltcedar association	SD/TC	1.1	880
Saltcedar-mixed scrub association	SD/SC	0.2	170
Human-dominated types:			
Agricultural lands	AG	0.2	120
Other resource categories:			
Lake (typical year high)		17.9	14,520
Lake (typical year low)		14.7*	11,930*
Flowing stream (miles)			15*
Nonvegetated lands		4.4	3,580
Total		100.0	80,970

*Not included in the total.

Source: Second Level Environmental Inventory, Dames & Moore, 1982.

lake and in the Salt River channel downstream of Roosevelt Dam. The abundant cliff habitat along the Salt River harbors localized populations of specialized plants and animals.

(3) Perennial Stream/Riverine Communities

The Salt River and Tonto Creek constitute 15 miles of perennial stream within the site area when Roosevelt Lake is at 2,094 foot elevation. Riverine fishes occurring on the Salt River include native and introduced species. The Arizona Game and Fish Department has reintroduced the razorback sucker in the reach upstream of Roosevelt Lake and reintroductions of the Gila topminnow have been initiated at tanks and springs in the vicinity. Tonto Creek is subject to occasional cessation of flow. Fish that occur are essentially the same species that occur in Roosevelt Lake.

(4) Reservoir Aquatic Communities

Roosevelt Lake is a large and important self-sustaining fishery resource in central Arizona. The reservoir is relatively stable in that it is only occasionally subjected to severe drawdown conditions. The fish population is predominantly introduced species. As in many other central Arizona impoundments, the lakebed is made up of rocky substrates overlain by sediment conveyed by the main feeder streams.

(5) Threatened and Endangered Plants and Wildlife

A bald eagle breeding area is located near the confluence of Pinal Creek and the Salt River, upstream of Roosevelt Lake. The eagles are known to forage upstream of the nest site and downstream from the Medler Point vicinity to Roosevelt Lake.

The osprey, black-crowned night heron, desert tortoise, and Gila monster which are State of Arizona special status species, occur in the vicinity of Roosevelt Lake. The razorback sucker has been reintroduced to the Salt River upstream of Roosevelt Lake. The Gila topminnow has been reintroduced to springs and lakes in the Tonto National Forest. Desert bighorn have been introduced to the Three-Bar Wildlife Area and are known to occur in the Roosevelt Lake vicinity.

(6) Management and Special Use Areas

Grazing allotments around Roosevelt Lake are managed by the Tonto National Forest. The Tonto Creek end of the lake and vicinity are considered wintering areas for the bald eagle and peregrine falcon. A variety of waterfowl is known to winter at the lake, and portions of the shoreline are closed to public access in the winter. Access to the Pinal Creek nesting area will be curtailed in the future, and habitat improvement such as planting cottonwood trees is being considered.

The Arizona Game and Fish Department manages a waterfowl refuge located on the northeast and west shorelines of the Tonto arm of the lake primarily for migratory waterfowl. The Three-Bar Wildlife Area

also borders the lake and the Salt River downstream of Roosevelt Dam providing excellent habitat for wildlife.

c. Recreation

(1) Stream-Oriented Recreation

Existing stream-oriented recreation resources and facilities in the Roosevelt site area are within the Tonto National Forest and are managed by the Forest Service.

Within this area are a total of 14.9 stream miles. The Salt River accounts for 9.5 miles of stream and Tonto Creek represents the remaining 5.4 stream miles. No stream-oriented facilities have been developed by Tonto National Forest in the Roosevelt site area. Stream fishing activity within the Roosevelt site area accounts for 7,979 annual recreation days.

(2) Reservoir-Oriented Recreation

The recreation use potential of Roosevelt Lake is somewhat diminished by fluctuating water levels and inaccessibility. For the purposes of impact assessment, the surface area of the lake that exists at least 50 percent of the time during the recreation season has been used. This area equals 13,341 surface acres.

Ten recreation areas are managed by Tonto National Forest at Roosevelt Lake. Dispersed camping and fishing are the primary recreation activities at these areas.

The total number of annual recreation days for reservoir-oriented recreation at Roosevelt is 349,477.

d. Cultural Resources

(1) Prehistoric Resources

At the Roosevelt site area there are estimated to be approximately 1,480 prehistoric archaeological sites which cover an area of roughly 2,780 acres.

Sites predicted to occur in the area include 460 artifact scatters. Pueblo sites at Roosevelt include one room sites (490 predicted to occur), 2-5 room sites (290 predicted to occur), 6-20 room sites (175 predicted to occur), 21-100 room sites (45 predicted to occur), and sites with greater than 100 rooms (5 predicted to occur). Many of the one room sites are small (4 square meters) and have a very low artifact density indicating they were probably not used as permanent living quarters. The larger sites (sites with more than 20 rooms) at Roosevelt tend to be located along the larges drainages which flow into the Salt River.

Two other types of sites include petroglyph (1 predicted to occur) and agricultural sites (10 predicted to occur). Special features include an estimated 215 trash mounds and 1,780 individual water and soil control devices.

There is evidence indicating the earliest occupation in Tonto Basin occurred between 5000 B.C. and 1000 B.C. (Huckell, 1973). The major occupation, however, seems to have started with the Colonial Period of the Hohokam which dates from A.D. 500 to A.D. 900. This period marks the start of the sedentary occupation of Tonto Basin. The next major occupation ranges from A.D. 1100 to A.D. 1400 and is attributable to the Salado (Fuller et al, 1976). Less is known about the time period from A.D. 900 to A.D. 1100. Some sites have been recorded which date to this time interval, but the Hohokam-Salado transition is poorly understood. Work by Doyel (1977), however, supports a continual occupation of the basin. Between A.D. 1400 and A.D. 1450, the Salado abandoned the area for reasons which are still unclear.

The current condition of the archaeological resources in the Roosevelt site area is considered fair to poor. Sites with noticeable architectural features have been vandalized with equipment ranging from shovels to bulldozers and front-end loaders. Certain sites have also been disturbed by recreation activities, fluctuations in the water level, and permanent inundation.

The sites in the Roosevelt site area form a data base which is one of the most complex and at the same time poorly understood in central Arizona. Located strategically between the Hohokam area to the southwest and the Mogollon area to the north and east, the prehistoric occupants of this area served a crucial function in regional economic and socio-political activities. Of equal importance, intra-regional indicators such as site size, number of rooms at a site, and artifact diversity suggest a network of independent competing communities who were internally organized. These sites also reflect a wider diversity of architectural styles than is usually observed in the Southwest. For these reasons, the prehistoric cultural resources in the Roosevelt site area, as an archaeological district, have significant information potential.

(2) Historic Resources

Sixty historic period sites are recorded within the Roosevelt site area. All but three of these are considered significant because of their scientific or historic value. Agricultural sites and water control sites, mainly from the Roosevelt Dam construction period, constitute 72 percent of the historic resources at Roosevelt. Water control functions can be assigned to 22 sites and structures. These include Roosevelt Dam (a National Historic Landmark), the power canal and its several related sites, Government Hill, and a number of construction camps and their appurtenant trash disposal areas. Twenty-one sites are associated with agricultural pursuits, primarily ranching and both patented and unpatented homesteading. Five transportation-related sites and structures include an 1881 road, Highway 188 constructed in 1905-1907, and a 1920 truss bridge. Nine sites are included in a miscellaneous category.

Today only one historically important unincorporated village, Roosevelt, remains. One site containing a metal tank and a charcoal pile is classified as having an industrial function. Another site is the Tonto National Monument. Religion-related sites consist of a church site and the Cline family and Roosevelt cemeteries. Finally, three sites consist of trash deposits, the origin of which are uncertain.

Five of the significant sites are above the IDF area and will not be affected by the project. The Roosevelt area is characterized by a long and eventful history beginning with the Apachean occupation. It is not known when the first non-Indians entered the region, but fur trappers traveled along the Salt River on at least two separate occasions in the early 1800s. Military excursions occurred at numerous times, but only one permanent camp, Camp Reno, was established. It was built in 1867 and abandoned in 1870. During the same period, prospectors began searching for gold and other valuable minerals, but with little apparent success. No major travel routes or roads went through the area; it was bypassed by the large exploration and mapping expeditions of the mid-1800s. No sites of these early occupants and users have been discovered within the Roosevelt site area.

The first homesteader-rancher to enter the area was a hog rancher who settled in Greenback Valley in 1875. Soon, the area was blanketed with ranches and homesteads. The last patent for a homestead is dated 1924, although the site was initially settled in the 1890s.

The isolated, remote character of the Roosevelt area changed abruptly beginning about 1903 with the construction of Roosevelt Dam. The dam not only brought better roads, better communication facilities, electricity, and other amenities, but also inundated homesteads, ranches, farmlands, buildings, roads and trails, and familiar landscape. The dam construction project also brought the government and tourists.

Preparation for construction of Roosevelt Dam began in 1903. Brick and lime kilns were established, a cement mill was erected, and construction of the power canal began. The canal was not ready for use until 1906. Work on features directly related to the dam began in 1903 and work on the actual dam began in 1906. During this period, the now submerged town of Roosevelt developed. It provided hotels, cafes, a post office, and recreation facilities for management personnel, labor, government officials, and visitors during the construction period. In addition to the town of Roosevelt, large housing complexes for laborers were developed near the cement mill and by the dam contractor at Hotel Point. Nearly 2,000 individuals are said to have occupied Roosevelt during the construction period.

Upon completion of the dam in 1911, the camps broke up, construction facilities were dismantled and moved or sold, and in 1917 the Bureau of Reclamation turned over the dam and all of its facilities to what is now known as the Salt River Project.

Roosevelt Dam is listed on the National Register of Historic Places and is a National Historic Landmark. One reason for being so designated is that it is the highest masonry dam in the world.

e. Social Resources

Four communities at Roosevelt Lake would be directly affected by relocation: Rockhouse Farm, Roosevelt Lake Estates, Roosevelt Gardens East, and North Bay Estates. A large number of the people in each of these communities are part-time residents.

People living at Roosevelt Lake are geographically divided into two distinct populations: those living on the east (Globe) side and those living on the west (Payson) side of Roosevelt Lake. Residents living on the same side of the lake share facilities and participate in the same social events and community projects. Very little social interaction occurs between east- and west-side residents. Rockhouse Farm and Roosevelt Lake Estates are located on the east side, while Roosevelt Gardens and North Bay Estates are on the west side of the lake. Three ranches on the east side and ten ranches on the west side would be affected by the project.

The east-side communities differ from the west-side communities in two important ways. First, the east side is more developed than the west side. The population is denser and neighborhoods appear more residential. Second, there are more businesses on the east side and they cater primarily to the tourist trade. Lakeview Marina, located near the dam on the east side, provides a place to dock and service boats. Roosevelt Lake Resort is also located on the east side. A small gas station is located near the resort, and Spring Creek Store, a large grocery store, is about 1 mile away. In addition to these businesses, a small store is located at Rockhouse Farm.

The communities on the west side are not as developed as those on the east side of Roosevelt Lake. There are more uncleared lots and more lots without buildings, houses, or trailers. There are also fewer businesses.

There are only two small stores in the vicinity: Punkin Center Store and Angler's Inn. The Punkin Center Store, besides stocking groceries and some fishing and camping supplies, contains a lunch counter and a small bar. It serves as a central meeting place for west-side residents; however, residents generally travel to Payson for most supplies and services.

(1) Rockhouse Farm

The rural desert community of Rockhouse Farm is located on the southeast side of Roosevelt Lake, near where the Salt River enters the lake. The community and the Rockhouse general store which serves it were initially established about 17 years ago. The

property at Rockhouse Farm has been owned by the same family since the early 1930s. Forty-seven people reside at Rockhouse Farm. Of these 31 are full-time residents and 16 live there part-time. All of the residents of Rockhouse Farm live in mobile homes, virtually all of which are leased.

Nearly all of the 31 full-time residents are retired persons living on fixed incomes (pensions and/or social security). Four children live in the community, as well as a few nonretired persons, most of whom work in the Globe-Miami area.

(2) Roosevelt Lake Estates

The community of Roosevelt Lake Estates on the southeast side of the lake is located on 156 acres of private land surrounded by the Tonto National Forest. The population is estimated to be 359 of which about 60 percent (215) are full-time residents and 40 percent (144) are part-time residents. Approximately 200 of the residents are retired persons, most of whom live on fixed incomes with limited resources. Children comprise about 24 percent (87) of the population, and those school-aged children who are permanent residents are bused to the Globe-Miami area for school.

The average length of residency is about 6 years for full-time residents. About half of the residents live in houses, and half live in mobile homes. Of those who live in mobile homes, many have made them more permanent by building additions to them.

(3) Roosevelt Gardens East

Roosevelt Gardens East is located about 7 miles southeast of Punkin Center on the eastern boundary of Tonto Creek. It is a private residential community which has been developed since 1970. There are about 72 permanent and 58 part-time residents living in the community, although population numbers fluctuate. Most of the permanent residents live in houses; part-time residents live primarily in mobile homes. Of the permanent residents, most are retired individuals living on fixed incomes. The young children who are permanent residents attend school at the Punkin Center School 7 miles away. High school age children attend school in Payson.

None of the roads in the area are paved; the community is accessible only by crossing Tonto Creek. When the creek rises, residents of Roosevelt Gardens (and North Bay Estates) are temporarily cut off from the other communities.

(4) North Bay Estates

North Bay Estates is a small, relatively new community located approximately 2 miles south of Roosevelt Gardens East on the northwest side of Roosevelt Lake. Approximately 60 residents live in the community, 20 of whom are full-time. Half live in houses and half live in mobile homes, many with additions that make them more permanent. Homes in the area are typically quite large. Almost all of the 20 full-time residents are elderly, retired individuals in good health with moderate-to-high incomes. There are no children living in North Bay Estates.

(5) Profile of Roosevelt Lake Residents

While each of the four affected communities have unique features, generalizations can be made about all of the Roosevelt Lake

residents. Collectively, their most distinguishing characteristic is their commitment to a rural, independent lifestyle. They relish their isolation and the peacefulness of the rural, desert setting. Residents spend a great deal of time out-of-doors. The area is very scenic, and residents have a deep appreciation of nature. The lake is an important feature of the residents' lifestyle and their primary source of recreation.

There was concern by all residents that if they were relocated, there would be considerable expenses for which they would not be reimbursed. However, if relocations were necessary, they wished to remain in the area close to their current neighbors, where they could enjoy the independence and privacy that originally attracted them to the community.

f. Other Resources

(1) Air Quality

No air quality data other than TSP data are available from the vicinity of Roosevelt Dam. Although the data are based on a very limited number of samples, they indicate that the federal and state primary standard was probably not violated in 1980. There is no particular reason to expect that any federal or state ambient air quality standards are currently being violated in the area.

(2) Aesthetics

Visitors to the Roosevelt site area initially receive two dominant visual impressions. The first is a striking view of the 300 foot high, stone faced Roosevelt Dam anchored in a deep rock canyon. The second is a large, attractive lake with a recreation pool of over 13,000 acres. From the dam, this placid body of water, approximately 2 miles wide, stretches 10 miles to the east and a similar distance to the west. At the east end of the lake cottonwoods and other types of riparian vegetation grow in abundance. Most of the remainder of Roosevelt Lake is surrounded by sparse vegetation creating a bold distinct pattern of blue water contrasting with the various earth tone colors of the desert.

(3) Noise

Day-night sound levels are typically below 55 dB. Jeep and motorbike activities along local trails, traffic on Apache Trail (State Route 88) and the perimeter lake roads, and motorboat activities on the lake contribute to the maximum sound levels within the area.

(4) Geology/Soils

The topography of the Roosevelt site area varies from near-flat or gently sloping in the floodplains of Tonto Creek and the Salt River, to gently rolling hills adjacent to the floodplains, to very steep and rugged terrain in the mountains. Drainage of the site area is into Tonto Creek, a tributary of the Salt River, and into the Salt River from numerous

washes, gullies and creeks which dissect the surrounding hills. The area includes Precambrian granite, limestone, quartzite, conglomerate, and shale; Precambrian to Tertiary diabase; Cambrian sandstone and quartzite; Carboniferous to Devonian limestone, shale, and sandstone; Tertiary dacite, gravel, sand, and conglomerate; and Quaternary to Tertiary gravel, sand, and silt. The foundation of the existing dam consists of hard, thickly bedded, fine grained, dense, lightly jointed Precambrian quartzites and sandstones.

Although several faults have been noted in the area, there is no evidence of Quaternary movement. Roosevelt Dam is in a region of relatively low seismicity so a large damaging earthquake is not likely. However, earthquakes as large as magnitude 5.5 occurred in historic time and are characteristic of the largest random earthquake (i.e. no causative fault identified) within the seismotectonic province. Studies of the major faults in the area indicate that earthquakes as large as 6.2 may occur. Rockslides are possible in areas with steep rock slopes if there is a seismic event.

Although there are several mineral deposits within the site area boundary, current information indicates that they are abandoned. There are numerous oil and gas leases in the area but there has been limited activity and no oil or gas has been found as yet.

The soils of the site area vary from silty to clayey to sandy to gravelly in composition. There is no prime farmland within the Roosevelt site area.

(5) Land Resources

Roosevelt Dam and Roosevelt Lake are the dominant land use features in the site area. Since the construction of Roosevelt Dam in 1911, some recreational facilities have been developed on public lands on the periphery of Roosevelt Lake and limited urban/built-up areas have occurred on some small private land holdings in the general vicinity. These include the Forest Service's Horse Pasture, Porter Springs, and Windy Hill Recreational Areas and the small residential communities previously described. Except for these developments, the land area within the Roosevelt site area is open space desert rangeland which is passively used for wildlife habitat, water storage, recreation, and livestock grazing purposes.

The 80,970-acre Roosevelt site area lies exclusively within the boundaries and under the administrative control of the Tonto National Forest, Tonto Basin Ranger District. Exceptions to public landownership include inholdings of privately owned lands, lands which have been withdrawn by the Bureau of Reclamation for the existing Roosevelt Dam and Lake, and lands similarly withdrawn along the Salt River corridor for water reclamation purposes by the Salt River Project. Three other parcels within the Roosevelt site area have also been set aside as publicly-managed special use areas: the 1,120-acre Tonto National Monument, the 38,897-acre Three Bar Wildlife Management Area, and the 7,680-acre land/11,500-acre water Salt River Natural Wildlife Goose Refuge Management Area. Additionally, the segment of Tonto Creek upstream of Roosevelt Lake has been determined to meet criteria for possible Congressional designation as a wild and scenic river.

5. Confluence Site Area

a. Geographic Setting

The Confluence Dam site is located at the confluence of the Salt and Verde Rivers, approximately 3.5 miles upstream from the existing Granite Reef Diversion Dam, and approximately 25 miles northeast of Phoenix (see Figure III-1). Primary access to the site area is provided by Beeline Highway (State Highway 87), Bush Highway, and Usery Pass Road. The affected site area of Confluence Dam and Reservoir includes 70,400 acres.

b. Biological Resources

The Confluence site area, with the juxtaposition of five different riparian habitats and the convergence of two perennial streams, is considered highly important in the Southwestern United States because of its wildlife habitat diversity. Three breeding areas of the endangered bald eagle occur in the area. The endangered Yuma clapper rail and several species of Arizona listed-threatened and unique wildlife also occur at the Confluence area. Table III-11 gives acreages and ranges for biotic community types within the site area.

(1) Riparian/Wetland Communities

Cottonwood-willow forest grows on sand and gravel bars adjacent to the Salt and Verde Rivers, including a large stand called the Blue Point Cottonwoods. Mesquite woodlands occur on well-drained sandy terraces along both the Salt and Verde Rivers. These "bosques" are characterized by mature trees up to 30 feet tall and 3 feet in trunk diameter growing in savanna-like stands. The Confluence site area contains cattail marsh habitat which is used by the endangered Yuma clapper rail. Stands of salt-cedar and mixed scrub make up the other riparian habitats.

(2) Other Terrestrial Communities

The paloverde-mixed cacti community forms the prevalent biotic community of hillsides and mesas, supporting essentially the full array of Sonoran wildlife. Along washes the blue paloverde-ironwood association grows in response to greater moisture availability. Rock outcrop and cliff habitat on the south side of the Salt River are important as wildlife habitats.

(3) Perennial Stream/Riverine Communities

The Salt and Verde Rivers constitute about 31 miles of perennial stream in the Confluence site area. The Salt River contains few deep pools; the reach between Stewart Mountain Dam and the confluence is composed mostly of broad shallow riffles over a cobble bed. The Verde River grades from a cobble bed at the north end of the site area to sands and gravel at the confluence, with long quiescent stretches on the Salt River below the confluence. Both rivers are subject to wide fluctuations in flow. Both native riverine fishes and introduced species are present. Rainbow trout are stocked in the Salt River by the Arizona Game and Fish Department.

TABLE III-11

ACREAGE AND PERCENT RANGE OF BIOTIC COMMUNITY SERIES AND ASSOCIATIONS AT THE CONFLUENCE SITE AREA

	Symbol	Percent	Acres
Desert upland:			
Paloverde-mixed cacti series	PC	77.9	54,870
Blue paloverde-ironwood association	CB/RA	2.3	1,600
Riparian and wetland types:			
Velvet mesquite association	MS/PJ	10.4	7,290
Mixed scrub series	SC	0.5	370
Saltcedar association	SD/TC	0.5	330
Fremont cottonwood-Goodding willow association	CW/PS	1.3	880
Cattail series	CT	0.04	30
Human-dominated types:			
Agricultural lands	AG	0.4	300
Developed and urban lands	DV	2.2	1,540
Other resource categories:			
Lake		0.9	630
Flowing stream			(31 miles)*
Nonvegetated lands		3.6	2,560
Total		100.0	70,400

*Not included in total.

Source: Second Level Environmental Inventory, Dames & Moore, 1982.

(4) Reservoir Aquatic Communities

A portion of Saguaro Lake and the Granite Reef diversion pool are included in the site area. No lake habitat occurs in the area which would be directly affected by a dam at the confluence.

(5) Threatened and Endangered Plants and Wildlife

The Yuma clapper rail and bald eagle are endangered species that inhabit the Confluence site area. As many as 4 Yuma clapper rails have been simultaneously observed about 2 miles upstream from the confluence.

Three bald eagle breeding areas have been identified within the Confluence site: 1) the Bartlett breeding area about 2 miles downstream of Bartlett Dam on the Verde, 2) the Fort McDowell breeding area near the Sycamore Creek-Verde River confluence, and 3) the Blue Point/Stewart Mountain breeding area on the Salt River between Stewart Mountain Dam and the confluence. The eagles which use these breeding areas forage along the rivers between Stewart Mountain Dam, Sycamore Creek, and the Granite Reef Diversion Dam. According to the Fish and Wildlife Service, the Blue Point/Stewart Mountain breeding area is the most productive of the five bald eagle breeding areas present in the CAWCS study area. Arizona threatened and unique species also occur at the site. The Colorado river roundtail chub, black hawk, osprey, and black-crowned night heron have also been observed in the Confluence site area. Desert tortoise and Mississippi kite probably occur in the site area as well.

(6) Management and Special Use Areas

Natural resources on the Fort McDowell and Salt River Indian Reservations are controlled by the Indian communities, with priority use granted to resident citizens. The Tonto National Forest maintains grazing allotments bordering Saguaro Lake and the Salt River, and is engaged in habitat rehabilitation in the Blue Point vicinity and along the Verde River north of the Fort McDowell Reservation.

Public access is restricted in the Blue Point cottonwoods and cattail marsh areas on the north side of the Salt River. Mature stands of cottonwood and mesquite are considered good birding areas by the Maricopa Audubon Society; such stands on the south side of the Salt River are included in the Tonto National Forest Lower Salt River Recreation Area.

c. Recreation

(1) Stream-Oriented Recreation

Stream-oriented recreation resources at the Confluence site consist of 12.1 stream miles on the Salt River, 19.0 miles on the Verde River, and 3.8 miles on Sycamore Creek. Most recreational activity takes place on the Salt River in the Lower Salt River Recreation Area. Tubing is the primary activity along the Salt River from Stewart Mountain Dam to the

confluence with the Verde River. This represents a unique and easily accessible recreation experience that is not duplicated elsewhere in central Arizona. Within the site area, tubing is found along the lower Salt River and to a lesser extent on the Verde River where low flows restrict tubing to spring months and accounts for 2,168,000 maximum annual recreation days. Stream fishing is also common along streams within the Confluence site area.

Three stream-oriented recreation areas managed by Tonto National Forest are located along the Salt River in the Confluence site area. No public water-related recreation facilities are found on either the Salt River or Fort McDowell Indian Reservation.

A total of 2,201,114 maximum annual recreation days are associated with stream-oriented recreation in the Confluence site area.

(2) Reservoir-Oriented Recreation

Reservoir-oriented resources and facilities at the Confluence site area are centered around Saguaro Lake, located in Tonto National Forest. Saguaro Lake has an average surface area of 630 acres during the recreation season (April to October) and is very intensively used for boating; over 20,000 maximum annual recreation days are attributable to fishing, powerboating, waterskiing, and non-powerboating activities.

Three major recreation sites are located within the Confluence site area at Saguaro Lake. Swimming and picnicking are the most frequent activities of visitors. The lake area has a parking capacity of 200 cars and is often filled on weekends during summer. A total of 89,549 maximum annual recreation days are associated with reservoir-oriented recreation at the Confluence site.

d. Cultural Resources

(1) Prehistoric Resources

It is estimated that approximately 265 prehistoric sites are located in the site area covering a combined area of approximately 7,740 acres. About 200 artifact scatters are predicted to occur. Many of these sites are associated with trash mounds, and in such instances it is very likely that the remains of Hohokam-style pithouses can be found at such sites.

Pueblos, which are less common at the Confluence than at the Cliff or Roosevelt site areas, include one room sites (5 predicted to occur), 2-5 room sites (20 predicted to occur), and 21-100 room sites (less than 5 predicted).

Two other types of prehistoric resources found in the Confluence site area include petroglyph sites (20 predicted to occur) and agricultural sites (10 predicted to occur). Several Hohokam irrigation canals have been documented in the area.

Special features include an estimated 635 trash mounds. Twelve ball courts were recorded (13 predicted to occur); ball courts are more common in this area than in any of the other CAWCS site areas. They are connected with ceremonial and religious activities and have been cited as evidence of connections with parts of Mexico.

The number of sites estimated to occur in this site area is much lower than that predicted for the Cliff and Roosevelt site areas. However, while site density is between five and eight times less, the size of the sites is much larger. This is reflected in the total acreage of archaeological remains.

The current condition of the archaeological resources in the Confluence site area is fair to good. Sites have been altered as a result of vandalism, agricultural use, or erosion. Impacts resulting from recreation have been less severe than in the Roosevelt site area.

Because of their location at the confluence of two major rivers, the archaeological resources in this area are a record of unusual and unique prehistoric cultural processes. By controlling and managing trade from the east and north and implementing major irrigation projects, the prehistoric occupants of this area developed a complex level of social and political organization very different from that in other areas of central Arizona. The prehistoric resources are considered significant as an archaeological district.

(2) Historic Resources

One hundred historic sites and structures are recorded within the Confluence site area; 97 of these are considered significant because of their scientific or historic value.

Seventy of the significant sites are connected in one way or another with agriculture; 15 of these are related to irrigation and water control, and 55 are remains of small, often isolated, Indian and non-Indian farmsteads and homesteads scattered over the area. Sites, in addition to the farmsteads, include Government Ditch, Jones Ditch, Stewart Mountain Dam and construction camp, Granite Reef Dam and construction camp, and Arizona Dam and construction camp.

Transportation is represented by three sites. Eight sites which have their origin in governmental activities include six military and two Forest Service facilities. Recreation and mining are represented by one site each. Two lime kilns constructed for the production of lime for building purposes, represent an industrial function. Isolated graves and two cemeteries reflect a religious function. The Fort McDowell cemetery, dating to 1868, is still in use. Finally, nine very small sites consisting primarily of petroglyphs, are classed as miscellaneous.

The history of the Fort McDowell portion of the Confluence site area can be divided into four general periods: the pre-1865 Indian occupation, the 1865-1890 military establishment, the squatter-farmer

period of 1890-1903, and the Indian Reservation period of 1903-present. Sites from all of these periods except the first have been located. The Yavapai Indians used the area before the permanent entry of the white man in 1865 and to a limited extent afterwards until 1903 when the Fort McDowell Indian Reservation was created. The U.S. Army constructed Camp McDowell, later Fort McDowell, in 1865 and occupied it until 1890 when the fort was permanently abandoned. In addition to the buildings and structures of the fort itself, an irrigation ditch and fields were developed.

A total of 14 squatters and 21 individuals who thought they had valid claims to the land were farming within the old Fort McDowell Military Reservation when, in 1903, President Roosevelt signed an Executive Order transforming it into an Indian Reservation. With this action, the Federal Government purchased the improvements only and forced everyone to leave. Since 1903 the reservation has been managed by the Bureau of Indian Affairs and the Yavapai Indians. Until recently, farming has been a major occupation at Fort McDowell.

South of the proposed Confluence Dam site lie the remains of the Arizona Dam, the first major dam on the Salt River. It was in operation from 1895 to 1905 when it was partially destroyed by flooding. This dam provided water for irrigation, and was replaced by Granite Reef Dam in 1906-1908. Remnants of the Arizona Dam remain, as does its construction camp and associated dam tender's facilities.

The Stewart Mountain Dam was erected on the Salt River between 1928 and 1930. Upon completion of the dam, the construction camp was abandoned and many of the buildings were sold for local use. Some of them were used to develop the Saguaro Lake Guest Ranch Resort.

Along the Salt River between the historic Arizona Dam site and Stewart Mountain Dam are a number of sites reflecting the varied uses to which the area has been put. Homesteading and ranching activities, more or less contemporaneous with those at Fort McDowell, are evidenced at a number of sites on the south side of the Salt River. Very few of these were ever patented and thus very little information is available about them. All are now in the Tonto National Forest.

Mining was very limited in the area because of the lack of minerals in marketable quantities. An exception is an extensive barite mine on Coon Bluff in operation from about 1931 to 1955. Two kilns reflect a small but active business of processing limestone for the manufacture of lime on the north side of the river. Sites attributed to both the Civilian Conservation Corps (CCC) and the Forest Service were recorded, including a CCC campsite, the Blue Point Ranger Station, and the Blue Point Administrative Site.

e. Social Resources

The Fort McDowell Indian Reservation encompasses 24,680 acres of land northeast of Phoenix. The Verde River runs through the reservation and converges with the Salt River about 1.5 miles from the

southern boundary of the reservation. The current population of the reservation is reported to be 374, with most people identifying themselves as members of the Yavapai Tribe.

(1) History

The earliest evidence that the Yavapai lived in the area that includes the current reservation boundaries dates to 1539. It is likely that they occupied the area even long before that. For the last 100 years, Yavapai history has largely been defined by implemented or threatened compulsory relocation by the U.S. Government. Bloody Basin, Skeleton Cave, and Skull Valley are places in Arizona named following Yavapai encounters with the military, in which many Yavapai were killed. In 1872, the Yavapai were forced to move to Rio Verde Reservation near Camp Verde. After successfully establishing farming on the reservation, the Yavapai, in mid-winter 1875, were marched from Camp Verde to the San Carlos Reservation, a distance of 180 miles. During this March-of-Tears, as it is called by the Yavapai, many become ill and died or were killed. The Yavapai were allowed to leave San Carlos in 1889, and a group returned to their ancestral land, settling at Camp McDowell, an abandoned military post. In 1903, Theodore Roosevelt, by Executive Order, established Fort McDowell as a reservation. From 1910 until 1931 the U.S. Government made repeated attempts to remove the Yavapai from Fort McDowell to the Salt River Reservation. The tribe consistently opposed their relocation. Beginning in the early 1950s, the construction of a dam at the confluence of the Salt and Verde Rivers (first called Maxwell Dam, then Orme Dam, and finally Confluence Dam) was proposed and would have required the relocation of the Fort McDowell Community.

The tribe has strongly opposed relocation because of dam construction at the confluence. Because of residents' past experiences with compulsory relocation, and since many of the current Fort McDowell residents had relatives who participated or even died in past relocation attempts, any proposed relocation remains a volatile issue.

(2) Meaning of the Land

The land at Fort McDowell has psychological, historical, religious, and economic significance for the Yavapai. Land represents stability and is crucial to transmission of Yavapai culture. The land is viewed like a trust fund which is passed on to future generations. Land also represents security since it provides a constant source of food, water, shelter and recreation. Residents make use of its renewable resources to supplement their incomes; many cut and sell mesquite wood for firewood to supplement their incomes and basketweavers sell baskets made out of the willow, cottonwood, and devil's claw that grow on the reservation.

The land has important religious significance for the residents. There are many sites on the reservation that are considered sacred or holy, including prehistoric cultural sites. Many aspects or practices of traditional tribal religion (parts of which are incorporated into Christianity as practiced by the residents) are linked directly to specific locations on the reservation. Sacred sites are considered inviolate, and the Yavapai

believe they should not be disturbed or altered in any way. One of the most sacred of known sites at Fort McDowell is the cemetery, which could be flooded or made inaccessible by plans which include Confluence Dam and Reservoir. The importance of preserving the sacredness of the cemetery was emphasized by many residents in interviews conducted by CAWCS researchers.

While many residents rely on the land to supplement their incomes, many others rely on it for their primary source of income. The Verde River, the vegetation that exists, the flat terrain and the ample space combine to make the land at Fort McDowell extremely well suited for grazing. Currently, about 600 acres are being farmed, including an experimental tribal farming operation. The economic development consultant for the tribe projects that by the year 2000 the tribe will be farming 4,000 acres of land along with an additional 1,000 acres devoted to experimental arid crops.

Besides agriculture and livestock, there are other land-dependent sources of revenue critical to the Fort McDowell economy. The City of Phoenix's well field on the reservation generated $100,000 per year. The sand and gravel operation has a potential for generating one-half million dollars a year, according to a University of Arizona study. The current economy as well as the tribe's economic development policy hinges on the use of the valuable resources at Fort McDowell.

The significance of the land for the Yavapai was frequently reiterated in the interviews. Residents described their land as "our mother", "our heart", "our life", "our home". They expressed deep attachment to the land and said that other land would not have the same meaning for them. Residents stated that neither money or other land would adequately compensate them for the loss of the reservation.

(3) Social Organization

Fort McDowell is an extremely cohesive community. Most residents are related to each other either by birth or marriage; they share a distinct culture, a common identity and history. They are a remarkably stationary population. Most were born on the reservation and have lived there all their lives, some in the same house. The Fort McDowell community is characterized by extensive informal support networks. Residents interact frequently and many provide each other with daily support. The extended family is crucial to the social organization of the Yavapai community. Grandparents, siblings, grandchildren and cousins typically live with or nearby each other.

Besides well developed informal support networks, the Fort McDowell community also has extensive formal support systems. The community is an Indian chartered corporation as defined by the Indian Reorganization Act of June 18, 1934. The tribe is governed by a tribal council comprised of five members who are elected for two-year terms. Participation in the tribal government is high. In recent years much of the tribe's activity has revolved around their vehement opposition to relocation. Fort McDowell also supports a pre-school program, a center for the elderly, a hot-lunch program for the elderly, a health clinic as well as other programs

and facilities for community members. There are currently four churches in the community and their services and activities are well attended and play an integral role in the community organization.

(4) Quality of Life

Residents at Fort McDowell are highly satisfied living in their community. Because of their strong attachment to the community, land and tribe, theirs is not a portable lifestyle. While most residents are generally healthy, they have experienced an increase in physical and mental health problems attributed to the stress associated with their proposed relocation.

On the basis of educational levels, income, and occupation, most residents would not be ranked very high in social class. Unemployment is a serious problem for the community. The current unemployment rate is 43 percent. Of those employed half earn less than $5,000 annually (Annual Economic Development Report, 1979-80). The mean number of years of formal schooling is 11.3 years. Residents are currently working hard to improve the situation, despite the impediment of their proposed relocation.

(5) Summary Profile

In summary, the Yavapai of Fort McDowell are a people with strong cultural and personal ties to the land; their lifestyle, culture, and identity are dependent on it. They have little experience moving, and they are adamantly opposed to relocation. They constitute an extremely cohesive community and are very dependent on well-established support systems within the community. Because of these characteristics, they are a population for whom relocation would be extremely difficult.

f. Other Resources

(1) Air Quality

No air quality data are available from the vicinity of the Confluence site area; therefore, no accurate quantitative statements about the local air quality can be made at this time. The Confluence site is located near the eastern boundary of the Maricopa County Urban Planning Area (MCUPA). The area comprising MCUPA has been designated by the EPA as a non-attainment area for TSP, carbon monoxide, and ozone, which means that at least one national ambient air quality standard for each of these pollutants is being violated as shown by monitored data or modeling. However, there is no particular reason to expect that any Federal or state ambient air quality standards are currently being violated in the immediate vicinity of the site.

(2) Aesthetics

The convergence of two major rivers, the Salt and Verde, provides a visually important component in the Confluence site area. The Salt River flows unimpeded for approximately 9 miles from the

Stewart Mountain Dam to the confluence. Through relatively steep topography and prominant high rock cliffs, this stretch of the Salt River winds around bends and sharp curves. The attractive desert composition is further intensified by the mature riparian vegetation that frames each side of much of the river. Approximately 15 miles of the Verde River above the confluence is also located in this site area. Riparian vegetation flourishes along the low land on each shore of the Verde River. Adjacent to the natural riparian vegetation are many irrigated fields cultivated by the Fort McDowell Yavapai. Immediately below the confluence of the two rivers is a small lake created by the Granite Reef Diversion Dam. Mature riparian vegetation is growing on much of the shoreline of this lake.

(3) Noise

No site surveys were undertaken to determine sound levels in the area; however, based on existing literature and data, typical day-night sound levels within local undeveloped areas are estimated to be below 55 dB.

Day-night ambient sound levels (L_{dn}) at recreational areas such as Coon Bluff, Blue Point, and Saguaro Lake are estimated to range from approximately 35 to 70 dB; jeep and motorbike activities on trails and roads, vehicle traffic on Bush and Beeline Highways, and motorboating on Saguaro Lake contribute to the maximum sound levels. Peak-hour equivalent sound levels along major haul roads for sand and gravel operations at Fort McDowell are estimated to range from 48 to 61 dB based on available data regarding truck volumes; L_{dn} in the area are generally below 65 dB. An L_{dn} of 65 dB is compatible with the EPA's short-term goals for residential and noise-sensitive recreational areas.

(4) Geology/Soils

The topography of the site area consists of near-flat river channel and flood plain; gently sloping but highly dissected river terraces; low and rolling, highly dissected hills; and rugged to steep mountains. Drainage of the area is into the Verde and upper Salt Rivers, and into the lower Salt River through the Phoenix Area. The site area includes Precambrian granite and metamorphosed granite; Cretaceous sandstone, shale and conglomerate; Laramide granite; Tertiary dacite, sand, gravel, and conglomerate; and Quaternary silt, sand, gravel, and conglomerate. The foundation of the proposed dam consists of moderately to poorly indurated, weathered conglomerate with an interbed of fresh to weathered, hard to moderately hard tuff. Several faults have been mapped in the area. Recent studies indicate no evidence of Quaternary faulting near the damsite. The potential earthquake hazard is not considered serious.

There are several mineral deposits within the site area, but most mines and prospects are now abandoned. On the Fort McDowell Indian Reservation, there are an estimated 7.5 million tons of sand and gravel which could be extracted. Some of this resource is currently being mined.

The soils of the site area vary from gravelly, stony, sandy, clayey, to loamy in composition. There are approximately 680 acres of prime farmland under agricultural production on the Fort McDowell Indian Reservation. An additional 440 acres may be classified as prime farmland when a dependable water supply is made available. This is anticipated by the year 2000.

(5) Land Resources

Located within the 70,400 acre Confluence site area are portions of the Fort McDowell and Salt River Indian Reservations, McDowell Mountain Regional Park, Tonto National Forest, Arizona State Trust Lands, and the new residential communities of Fountain Hills and Rio Verde, and other privately owned parcels such as Goldfield Estates. Segments of the Granite Reef and Salt-Gila Aqueducts of the CAP, Stewart Mountain Dam/Saguaro Lake, and Granite Reef Diversion Dam/Maxwell Lake are also located in the Confluence site area.

Some small-scale residential recreational, and other urban developments have occurred in the Confluence vicinity but public (Forest Service, State of Arizona, and Maricopa County) and Indian (Fort McDowell and Salt River) landownership patterns are the chief reasons that more extensive urban developments have not occurred in this area. The land areas upstream from the Confluence Dam site along the Salt and Verde Rivers are almost exclusively Fort McDowell and Salt River Indian Reservation lands, and Forest Service lands within the Tonto National Forest. These lands, for the most part, are managed for livestock grazing, water conservation, and general recreational purposes. Limited agricultural and sand and gravel mining operations also occur on the Fort McDowell Indian Reservation.

The only developments in the immediate vicinity of the Stewart Mountain Dam, other than the dam and appurtenant facilities, are the Forest Service-maintained recreational sites and Saguaro Lake Guest Ranch. The open desert rangelands found adjacent to Stewart Mountain Dam/Saguaro lake and the riparian vegetation found along the segment of the Salt River just below the dam are also managed by the Forest Service for multiple-use purposes.

6. New Waddell Site Area

a. Geographical Setting

The New Waddell Dam site is located approximately 1/4 mile downstream from the existing Waddell Dam on the Agua Fria River about 45 miles northwest of Phoenix (see Figure III-1). The New Waddell site area includes 41,080 acres. Access to the Lake Pleasant area is via I-17 and Carefree Highway.

b. Biological Resources

The New Waddell site area is characterized by hilly terrain. Biotic communities are typical of the Sonoran Desert. Table III-12 presents acreages and ranges of these communities.

TABLE III-12

ACREAGE AND PERCENT RANGE OF BIOTIC COMMUNITY SERIES AND ASSOCIATIONS AT THE NEW WADDELL SITE AREA

	Symbol	Percent	Acres
Desert upland:			
Paloverde-mixed cacti series	PC	89.6	36,820
Blue paloverde-ironwood association	CB/RA	3.3	1,370
Riparian and wetland types:			
Velvet mesquite association	MS/PJ	0.8	310
Mixed scrub series	SC	0.1	50
Saltcedar association	SD/TC	0.5	210
Cattail association	CT	0.02	10
Human-dominated types:			
Agricultural lands	AG	0.2	70
Developed lands	DV	0.4	150
Other resource categories:			
Lake (typical year high)		4.2	1,720
Lake (typical year low)		2.0*	830*
Nonvegetated lands		0.9	370
Total		100.0	41,080

*Not included in total.

Source: Second Level Environmental Inventory, Dames & Moore, 1982.

(1) Riparian/Wetland Communities

Riparian habitat consists of stands of salt cedar, mesquite, and mixed scrub along the Agua Fria channel and tributary washes near the upper end of the lake, and along Morgan City Wash and the Agua Fria downstream from Waddell Dam. A small stand of cattail marsh habitat grows at Lower Lake Pleasant. Shorebirds and waterfowl are known to use Lower Lake Pleasant mesquite and cattail habitats.

(2) Other Terrestrial Communities

Nearly 90 percent of the area is paloverde-mixed cacti series, with the blue paloverde-ironwood association occupying the larger washes which feed into Lake Pleasant. There are five springs in the site area. The cliffs along the Agua Fria channel upstream of the lake provide important wildlife habitat for hawks and other wildlife.

(3) Perennial Stream/Riverine Communities

The Agua Fria River, Humbug Wash, and several of the springs have sufficient flow to maintain riparian vegetation, but are not stable streams for the support of fish populations except in spring-fed pools and ponds along the channel.

(4) Reservoir Aquatic Communities

The Lake Pleasant basin is composed of a decomposed granite bed over which a silt layer has been deposited by the Agua Fria River and other streams. The lake is subject to severe drawdown, but normally supports excellent populations of game fish, which also occur in Lower Lake Pleasant.

(5) Threatened and Endangered Plants and Wildlife

A raptor nest observed along the Agua Fria channel upstream from Lake Pleasant has been tentatively identified as a bald eagle nest, and unconfirmed sightings of bald eagles have been made; however, the presence of bald eagles in the site area has not been confirmed by the Fish and Wildlife Service or the Southwest Bald Eagle Recovery Team.

The Gila topminnow (a Federal listed endangered species) was introduced into Tule Creek north of Lake Pleasant in 1970. The Tule Creek population was surveyed in 1982 and found to be in relatively healthy condition.

Arizona special status species known to occur in the Lake Pleasant area include desert tortoise, osprey, peregrine falcon, great egret, snowy egret, and black-crowned night heron. The desert tortoise may breed in the site area.

(6) Management and Special Use Areas

Grazing in the site area is controlled by the Arizona State Land Department, which maintains grazing allotments. There are no other specific habitat enhancement or wildlife management areas present.

c. Recreation

(1) Stream-Oriented Recreation

There are minimal stream miles of recreational value in the site area. No stream-oriented recreation facilities exist in the site area.

(2) Reservoir-Oriented Recreation

Existing reservoir-oriented resources and facilities in the New Waddell site area are located within Lake Pleasant Regional Park. The park is intensively used by Phoenix area residents.

Reservoir-oriented resources consist of two lakes, Upper Lake Pleasant and Lower Lake Pleasant. Upper Lake Pleasant, located above Waddell Dam, is a regulatory storage reservoir and therefore fluctuates considerably (from a high of 1,640 acres to a low of 747 acres). For at least 50 percent of the recreation season,
Upper Lake Pleasant has a surface area of 1,280 acres. Motorized boats are permitted on the lake; however, it is also used extensively for sailboating activities. Lower Lake Pleasant has a surface area of only 75 acres. Located below Waddell Dam, this lake is used primarily for fishing and swimming, as motorized boats are not permitted.

Reservoir-oriented facilities at the upper lake consist of picnicking, camping and fishing facilities. At the lower lake, facilities include picnic tables and a beach. Construction of additional facilities is currently underway at Lake Pleasant Regional Park.

Annual recreation days for all reservoir-oriented activities at the New Waddell site area total 168,646.

d. Cultural Resources

(1) Prehistoric Resources

At the New Waddell site area, there are estimated to be approximately 120 prehistoric archaeological sites covering approximately 190 acres.

The most common site type at New Waddell is the artifact scatter, of which 70 are predicted to occur. Pueblos at New Waddell include one room sites (25 predicted to occur), 2-5 room sites (10 predicted to occur), and 6-20 room sites (5 predicted to occur). Sites with puebloan architecture tend to be smaller at the New Waddell site area than those in the

Cliff and Roosevelt site areas. The one exception may be the Beardsley Canal site which has been partially destroyed through a variety of cultural and natural factors.

Also occurring in the New Waddell area are approximately 10 petroglyph sites. Special features are estimated to include approximately 5 trash mounds and 70 individual water and soil control devices which are found in association with the types of sites described above.

In general, the sites in the New Waddell area reflect an adaptation to a mountainous uplands region on the northern margin of the Hohokam area. Evidence indicates that trade networks were established between this area and the Salt River Valley. While the resources in this area are not unique, they do represent a largely unstudied data base and have significant information potential as an archaeological district.

(2) Historic Resources

Fifteen historic period sites and structures are recorded within the New Waddell site area; 11 sites reflect significant scientific or historic values. These sites can be grouped into a number of categories. The Mitchell Springs Ranch is associated with agriculture, the Phoenix-Prescott Wagon Road is transportation related and a lime kiln is associated with industrial production of lime. Eight sites and structures are related to water control and use including the 1893 diversion dam, the Carl Pleasant (Waddell) Dam, the Beardsley Canal, and three associated construction camps.

The earliest historical activity in the New Waddell site area appears to have been that of prospectors and miners in the 1860s and 1870s; however, the level of mining endeavor was never great. Beginning in the 1870s, transportation routes to and from population centers and mining areas near Wickenburg and Prescott were gradually established. Many of these roads ran along or crossed the Agua Fria in the New Waddell site area. The most important of these were a stage route from Wickenburg to Phoenix which was in existence at least by the late 1870s and the Phoenix to Prescott Wagon Road which had been constructed by 1894. The community of Frog Tanks, also known as Pratt, was a stopping place along these north-south transportation routes. It appears to have been established in late 1889 or early 1890 on the Agua Fria River by William Pratt, a miner. Ranching activities in the New Waddell site area began in the 1870s. Today, only one ranch, the Mitchell Springs site, is represented by physical remains located within the site area. Only four individuals filed on homesteads from about 1916 to 1928.

During the heyday of Frog Tanks, certain activities began which would ultimately come to dominate the cultural landscape of the area. These activities began as relatively small-scale schemes to provide water for irrigation purposes and ended with construction of the Carl Pleasant Dam. The first such scheme was that of the Agua Fria Water and Land Company established on November 10, 1888 by six individuals including William A. Hancock, one of the founders of Phoenix, Arizona. By 1891 the company had proposed to erect two reservoir dams and a diversion dam on the Agua Fria

River; however, the project barely progressed beyond the planning stage. Later, W. H. Beardsley of Ohio arrived on the scene and obtained control of the company. In 1893 he formed the Agua Fria Construction Company to actually begin to build the dams. Work began on the diversion dam and canal in 1893 and proceeded haltingly until 1895 when the project ceased. The construction work camp, known as Camp Dyer, was situated on the east side of the dam.

After over three decades of personal struggle to finance the construction of a dam on the Agua Fria River with private funds, Beardsley formed the Beardsley Land and Investment Company in 1925 and, with the financial support of Donald C. Waddell, a financier and investor, began construction of the dam. At the same time, the Maricopa County Municipal Water Conservation District No. 1 was formed to regulate the use of water from the dam. When the dam was completed in 1927, it was the highest multiple arch dam in the United States. It remains the key element in the largest privately funded irrigation system in Arizona.

Along with the building of the Carl Pleasant (Waddell) Dam, the 1893 diversion dam and the Beardsley Canal were finally completed. Both dams and the canal have remained essentially unmodified since construction. The diversion dam is the oldest such structure in central Arizona still in use.

e. Social Resources

No people in the New Waddell site area would be affected by relocation or flood reduction; therefore, no description of the social setting of the site area is presented.

f. Other Resources

(1) Air Quality

No air quality data are available from the vicinity of Lake Pleasant; however, a portion of the lake is included in the MCUPA which has been designated by the EPA as a non-attainment area for TSP, carbon monoxide, and ozone.

(2) Aesthetics

A large portion of this site is occupied by Lake Pleasant Regional Park. Desert vegetation continues down to the shoreline of Upper Lake Pleasant except where riparian vegetation exists in the upper areas of the lake. Lower Lake Pleasant is bordered by riparian vegetation including many large cottonwood trees. Lake Pleasant is a visually-important and well used recreational facility surrounded by the interesting character of the Arizona desert.

(3) Noise

The Lake Pleasant area is minimally developed. The primary area to be affected by noise includes the residential area

approximately 1 mile south of the dam in the vicinity of Lake Pleasant Inn, consisting of fewer than 50 acres. The secondary area consists of those lands within 3 miles of Lake Pleasant, under public ownership and not developed. Day-night sound levels are typically below 55 dB.

(4) Geology/Soils

The topography of the area varies from near-flat to the south and east of Lake Pleasant, to rolling hills and low ridges at the north end of the lake, to fairly steep and highly dissected terrain to the west. The area includes Precambrian metamorphic rocks, Tertiary volcanics and sediments, and Quaternary alluvium. The foundation of the proposed New Waddell Dam site consists of interbedded andesite, tuff, tuffaceous sandstone, and conglomerate.

There are numerous faults within the site area; however, there is no evidence of Quaternary movement near the damsite. There have been no recorded earthquakes originating from this area so a large damaging earthquake is not expected. Although the area has low rates of tectonic activity, the maximum earthquake capable of occurring on the numerous small faults in the seismotectonic province range from 5.5 to 6.5.

Uranium-bearing strata are relatively widespread and have been exposed by tributaries to the Agua Fria River at the northern part of Lake Pleasant. Claims were filed in portions of this area; however, subsequent exploration programs failed to reveal unusual amounts of uranium. Recently, there has been mineral activity by groups and individuals exploring for various precious metals, and several oil and gas leases have been filed. To date (1982) no oil or gas have been found.

The soils of the site area vary in composition from loamy, clayey, sandy, to gravelly. There are approximately 70 acres of prime farmland located in the site area.

(5) Land Resources

The Waddell Dam/Lake Pleasant area is primarily an open desert rangeland area which, except for some recreational facilities and service buildings within Lake Pleasant Regional Park, is used for wildlife habitat, water storage, recreation, and livestock grazing purposes. The 41,080-acre New Waddell site area is primarily comprised of State Trust Lands controlled by the Arizona State Land Department, with some small privately owned parcels and National Resource Lands controlled by BLM. Lake Pleasant Regional Park, which is operated by the Maricopa County Parks and Recreation Department on lands leased from the Arizona State Land Department, covers approximately 14,382 acres, of which 5,686 acres are in Maricopa County and 8,696 acres are in Yavapai County.

7. Downstream Area

a. Geographical Setting

Areas downstream from CAWCS alternative dam sites on the Salt and Verde Rivers are affected by flooding. Additional development opportunities in these areas may result from the implementation of upstream flood control structures. For these reasons, the Salt and Gila River flood plain through metropolitan Phoenix is considered an affected area. The downstream area includes a 42-mile segment of the Salt River flood plain below the Granite Reef Dam extending through the City of Phoenix to the Salt/Gila River confluence, and a 32-mile segment of the Gila River flood plain between the Salt/Gila River confluence and Gillespie Dam (see Figure III-1).

b. Biological Resources

Human intervention, cessation of historic perennial flows, and subsequent ecological disturbance have greatly modified the riparian habitat within the Salt River channel in the downstream area.

(1) Riparian/Wetland Communities

In the reach from Granite Reef Dam to 91st Avenue, only a few small patches of riparian habitat exist where wastewaters are discharged to the channel. Downstream of 91st Avenue stands of cottonwood, willow, mesquite and cattail are sustained by more consistent flows from irrigation tailwaters and from the 91st Avenue wastewater treatment plant. Great blue herons and a number of waterfowl species, as well as a variety of songbirds, use these riparian habitats. Salt-cedar woodlands have replaced much of the historically more extensive mesquite and cottonwood forests along this reach.

(2) Other Terrestrial Communities

Much of the nonriparian habitat within the upstream reach of the channel is composed of sparse stands of shrub species from the blue paloverde-ironwood desert wash association. In its present degraded condition, such habitat is not conducive to supporting a viable, diverse wildlife community. The creosotebush-bursage series is the predominant desert upland type outside the channel; saltbush scrub and paloverde-mixed cacti communities also occur.

Agricultural and urban areas also occupy large parts of the upstream reach outside the main channel. A variety of rodents and insect- and grain-eating birds are attracted to the agricultural areas.

(3) Perennial Stream/Riverine Communities

Perennial flows are sustained for about 4 miles below the 91st Avenue treatment facility. Carp and mosquitofish make up the bulk of the fish population, but bass and other species are periodically carried down when releases are made from upstream impoundments.

(4) Reservoir Aquatic Communities

There are no reservoirs in the downstream area. Lacustrine (lake) habitat in the channel is essentially nonexistent except where water-filled depressions, like old gravel pits, exist. These small, short-lived ponds sustain few, if any, fish or other wildlife.

(5) Threatened and Endangered Plants and Animals

Numerous sightings of the Yuma clapper rail have been recorded in the reach downstream of 91st Avenue. No endangered plant or other endangered vertebrate species have been reported for the downstream area.

(6) Special Use and Management Areas

The Fred J. Weiler Greenbelt accounts for nearly all the Federal land in the reach between the Salt-Gila confluence and Gillespie Dam. The Arizona Game and Fish Department manages more than 2,000 acres of land, including the 400-acre Robbins Butte Wildlife Area, as habitat for game species such as Gambel's quail and dove. The reach between 91st Avenue and the Salt-Gila confluence is included in the Maricopa Audubon Society's Christmas Bird Count area.

c. Recreation

Recreation resources and facilities in the downstream area are predominantly urban in character. Very little, if any, water-oriented recreation exists in this area.

d. Cultural Resources

(1) Prehistoric Resources

Portions of the downstream area were subjected to a sample survey. All sites located on this survey were characterized by only a few surface artifacts. Surface architecture was lacking in all cases. The records search conducted prior to the fieldwork indicated the presence of numerous large Hohokam sites as well as smaller sites, but, in most cases, little or no evidence of these sites was present on the surface. Artifacts and structures associated with these sites are most probably buried under several feet of alluvium.

Despite the fact that these sites have been impacted by a variety of natural and cultural factors, the prehistoric resources in this area have the potential of providing information relevant to the prehistory of the Salt-Gila River Valley and central Arizona.

(2) Historic Resources

A total of 123 historic sites have been identified in historical records for the downstream area. Eleven of these 123 sites are known to be present due to their notation in recent archaeological and historic site inventories; an additional 63 sites may be present. (This total

number of sites which may be present is somewhat misleading since at least 6 sites consist of multiple features or dwellings of from 7 to 100 in number.) The remaining 49 sites have probably been destroyed due to flooding and historical land use activities.

The majority of sites thought to be present within the downstream area consist of houses which were occupied by early residents of Phoenix, Tempe, and Mesa. A few house sites may date from the 1870s, 1880s, and 1890s and would reflect the initial Anglo settlement of the Salt River Valley. Other site types represented include a cemetery, wells, "Indian Huts" on the Salt River Indian Reservation, early wagon roads, irrigation canals, bridges, a horse race track, mineral prospects, stone quarries, and a dam.

e. Social Resources

The affected area comprises the portion of the metropolitan area of central Arizona which most directly experiences problems associated with flooding in the Salt and Gila Rivers. Communities located in the area have experienced flooding three times in recent years: March 1978, December 1978, and February 1980.

The current population in the 200-year flood inundation area is estimated to be 36,700 persons, which constitutes 2 percent of the 1980 Maricopa County population of 1,508,000. The eastern and western extremities are in a rural, agricultural setting. The central sector contains both residential neighborhoods and mixed residential-industrial commercial use.

Communities located in the downstream site area that have experienced problems associated with flooding are:

- City of Mesa
- City of Tempe
- City of Phoenix
- Holly Acres Subdivision
- Salt River Pima-Maricopa Indian Community
- Gila River Indian Community
- Buckeye Area

Mesa, Tempe, and Phoenix are urban areas, while Holly Acres, the Salt River Indian Community, the Gila River Indian Community, and Buckeye are rural areas.

(1) City of Mesa

Mesa, situated in Maricopa County immediately to the east of Tempe along the southern bank of the Salt River, is the third largest city in Arizona and one of the ten fastest growing cities in the United States. The current Mesa population within the 200-year flood inundation area is estimated to be 10,000 people, or 6 percent of the 1980 estimated population of 153,000. A portion of the area, adjacent to the southern bank

of the Salt River, is agricultural land. The remaining area is characterized by diverse residential groups including "first home" families, older, established neighborhoods, and some higher cost homes.

(2) City of Tempe

The City of Tempe, home of Arizona State University (ASU), is a community of approximately 107,000 people, situated immediately east of Phoenix. Tempe lies on both banks of the Salt River and portions of the community are susceptible to flooding. The current population residing within the 200-year flood inundation area is estimated to be 1,300, or 1 percent of the total population. The area that would be affected by a 200-year flood is characterized by mixed housing types. Single-family and mobile home units account for one-third each, and multi-family units account for the rest.

(3) City of Phoenix

The City of Phoenix, capital of the State of Arizona, had a 1980 population of 790,000 and is the largest municipality in the State of Arizona. The City of Phoenix is a very fast-growing community and, as a major urban area, is highly complex.

Phoenix is bisected by the Salt River. Major enterprises, including Sky Harbor International Airport, several large construction companies, and numerous business concerns are in the Salt River flood plain. Approximately 20,000 persons currently reside within the 200-year flood inundation area boundaries, or 3 percent of the total estimated 1980 population. Population in the 200-year flood inundation area has been decreasing, as have the number of dwelling units. Housing units in this area are predominantly rental units, and are at the lower end of the housing value scale.

(4) Holly Acres Area

Holly Acres is an area composed of residential subdivisions within an otherwise agricultural area located approximately 20 miles southwest of downtown Phoenix in Maricopa County. These unicorporated communities cover 12 square miles directly adjacent to the north bank of the Gila River between 115th Avenue and El Mirage Road, near the confluence of the Salt, Gila, and Agua Fria Rivers. Five subdivisions are located in the area with approximately 400 total residential units and a population of 1,500. The general area has been settled for approximately 15 years. There are several commercial enterprises located in the area.

The subdivision of Holly Acres, containing 50 to 60 homes, has sustained the most extensive flood damage in recent years. The vast majority of dwellings located within the Holly Acres subdivision are relatively new, less than 8 years old.

(5) Salt River Pima-Maricopa Indian Community

The Salt River Pima-Maricopa Indian Community is situated in eastern Maricopa County, immediately east of Scottsdale and north of Tempe and Mesa. The community encompasses 50,000 acres of land and has a population of approximately 3,200 community members and 900 non-Indian residents. The community is divided into two districts, Salt River and Lehi. The districts are separated from one another by the Salt River. The Verde River enters at the northeast portion of the community. The southeast portion of the community (Lehi) has a population of approximately 320 persons, or 8 percent of the community's total population, and is the only area located in the 200-year flood inundation area.

(6) Gila River Indian Community

The Gila River Indian Community is a Pima-Maricopa community which straddles the Gila River and encompasses 372,000 acres of land. The population of the community is 7,500. The community is divided into seven districts. The 200-year inundation area of the Gila River Indian Community is characteristic of the agricultural setting which typifies District 7. The district has recently directed its efforts to expanding its agricultural base as part of an overall emphasis toward greater self-sufficiency.

(7) Buckeye Area (Including Towns of Arlington, Palo Verde and Liberty)

The Town of Buckeye is located 31 miles west of Phoenix in an expansive valley between the White Tank Mountains on the north and the Maricopa Mountains to the south. Buckeye is situated near the Gila River below its confluence with the Salt. The river is gradually shifting northward each time it floods with the potential for affecting the entire community. Buckeye is a major producer of agricultural crops and cattle.

(8) Infrastructure

In addition to the seven communities described above, a number of area-wide infrastructure systems are located in the Salt River flood plain. These include automobile, air, and rail transportation routes and equipment, public utility lines and towers, telecommunication lines, and numerous business operations.

Major highways in and around the flood plain include the Beeline Highway, the Maricopa Freeway, and Interstates 10 and 17. In addition, a number of transportation routes connect Phoenix with its suburbs, running directly through the flood plain area. There are 29 road crossings in the flood plain, of which 15 are bridge crossings, and the remainder are "dip" or surface crossings.

Air and rail facilities bordering the flood plain include Sky Harbor International Airport and the Southern Pacific Railroad yard and accompanying tracks and equipment. Both facilities are located in Phoenix.

Public utilities that are in or border the flood plain include 2 wastewater treatment plants, 2 sewage treatment plants, 5 sewage lines, 6 water lines, 14 power transmission lines, 12 natural gas lines, 11 telephone lines, and numerous active landfills.

The types of businesses located in the flood plain include light manufacturing, supply houses, scrap yards, sand and gravel mining operations, and wholesale facilities.

Business, public utility, and transportation losses as a result of prior flooding have amounted to several million dollars.

f. Other Resources

(1) Air Quality

Much of the downstream area is located within the MCUPA, which has been designated a nonattainment area for carbon monoxide, ozone, and TSP. Ambient concentrations of other pollutants are expected to be below standard levels.

Site-specific data are unavailable for the remainder of the downstream area located outside the MCUPA. However, a limited amount of data from Buckeye indicate that sulfur dioxide and ozone standards are not being violated; TSP standards probably are being violated.

(2) Aesthetics

The Salt River below the Granite Reef Diversion Dam is dry for most of the year, revealing a wide shallow riverbed of rocks and small boulders. Bridges and dry river road crossings connect the north side with the south portion of the metropolitan area. During the spring when snow is melting in the mountains, water may flow in this section of the river. The Salt River joins the Gila River near the west side of Phoenix. This western portion of the river receives effluent from wastewater treatment plants which results in a green tangled band of low riparian vegetation that extends down the river to Gillespie Dam.

(3) Noise

Day-night sound levels for this area range from 35 dB in open areas to as high as 85 dB at areas adjacent to major arterials. Since the affected area is largely composed of urban land uses which are characterized by heavier traffic volumes than other CAWCS site areas, much of this area experiences L_{dn} exceeding the EPA's long-term goal of 55 dB.

(4) Geology/Soils

The topography of the downstream area is nearly flat in the floodplains of the Salt and Gila Rivers. Throughout most of the area, the river is braided and has a broad flood plain; the river channel is restricted near Granite Reef Dam, at Tempe Butte, and at the southwest end of

the Buckeye Hills. Rocks exposed within the site area include Precambrian granite gneiss, schist, and granite; Laramide granite; Tertiary andesite; Quaternary to Tertiary sand, gravel, and conglomerate; and Quaternary basalt, silt, sand, and gravel. There have been no recorded earthquakes originating from this area, although some earthquakes of mild intensities have been reported in the general Phoenix area. A large damaging earthquake is not expected in the area. Because earth fissures resulting from ground subsidence from water table declines have been noted near this area, there is a possibility that some earth fissures may form.

There are numerous sand and gravel deposits which are actively mined along the Salt River, particularly in and near the Phoenix area. Some sand and gravel are also extracted from the Gila River. The mining of sand and gravel is an important industry in the area; Maricopa County currently produces more than 50 percent of the total amount of sand and gravel mined in the state.

The soils of the downstream area vary from loamy, clayey, gravelly, to cobbly. Some of these soils are suitable for classification as prime farmland and have been mapped by the Soil Conservation Service.

(5) Land Resources

The segment of the Salt River flood plain just below Granite Reef Dam to Gilbert Road is mostly undeveloped open desert land. Several sand and gravel mining operations are located in the river channel downstream from Gilbert Road. Extensive urban development has encroached upon the flood plain in some locations within the cities of Phoenix, Mesa, and Tempe. From approximately 23rd Avenue west to the Salt/Gila confluence the Salt River flood plain includes scattered residential and industrial uses and extensive agricultural areas, particularly on the south side of the channel.

Downstream from the confluence of the Salt and Gila Rivers, riparian and phreatophytic vegetation abound in the river channel and along the flood plain. The Maricopa County Flood Control District has initiated an interim project to develop and maintain a cleared and graded 1,000-foot-wide corridor within the floodway of the Salt and Gila Rivers from 91st Avenue to Gillespie Dam until more adequate flood control can be provided by the implementation of a CAWCS alternative and/or other measures. Segments of the flood plain have been set aside as parts of the Fred J. Weiler Greenbelt, Casey Abbott Semi-Regional Park, Robbins Butte State Game Management Area, and the Arlington State Wildlife Area. Outside of the defined river channel, irrigation agricultural croplands are the predominant land use in the Gila River flood plain from downstream of the Salt/Gila confluence through the Arlington Valley. Some clusters of residential development, such as Holly Acres, are also located within this segment of the flood plain.

IV. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

IV. ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

This chapter includes a description of the environmental consequences of the alternative plans, focusing on the significant resource categories identified during scoping. This description summarizes the analysis in a large number of CAWCS supporting documents, including Stage III Methodology for Environmental Quality Assessment, Environmental Impacts and Effects of Plans (7 vols.), Social Impacts and Effects of CAWCS Plans, and Economics-Financial Supporting Document. A brief precis of each major supporting document is provided at the end of the reference list.

All the information in this chapter is extracted from the supporting documents, and therefore these documents should be consulted for more detailed information. A set of the supporting documents is available at the following Bureau of Reclamation locations: Arizona Projects Office, Phoenix Arizona; Engineering and Research Center, Denver, Colorado; Lower Colorado Regional Office, Boulder City, Nevada; and Office of the Commissioner, Washington, D.C.

A. Methodology

During CAWCS, methodologies were developed to meet the specific purposes of each of the stages in the study. For example, in Stage II of the study, when a large number of elements were evaluated, the methodology emphasized the development of adequate information to make decisions among a large array of alternatives. Detailed field surveys were not conducted for use during Stage II, and the impact assessment focused on using one or two indicators in a resource category to assess the impact.

At the beginning of Stage III, methodologies were developed that could be used for detailed evaluations of plans and that would provide the level of detail needed for preparation of the environmental impact statement. The methodologies balanced the need for detail against the requirement that the impacts be assessed for entire plans, so that they could be compared to each other. Since each plan contains at least three elements (dams), the methodologies provided a way to aggregate impacts and report the overall impact of the plan. Temporary, localized impacts were deemphasized with this approach, since the objective was to assess in detail the significant impacts that distinguished among the plans.

A detailed description of the methodologies used in the Stage III assessment may be found in the Stage III Methodology for Environmental Quality Assessment and Social Impacts and Effects of CAWCS Plans (Chapter 1).

1. Impact Assessment

The procedure for assessing impacts of the plans involved aggregating impacts of the elements (Cliff, New/Modified Roosevelt, New/Modified Stewart Mountain, Confluence, New Waddell Dams, Verde River Dams Modifications) that compose the plans. A more complete discussion of the separate impacts for each element may be found in the environmental, social, and economic supporting documents cited above.

The impact assessment methodology consisted of a series of steps whereby environmental conditions without the project were compared to conditions with the project. The measured difference between the two conditions for a factor (i.e., stream-oriented recreation) is the impact. The baseline condition without the project is a projection of all the relevant environmental factors into the year 2000. This future-without condition would occur if there was no project action and is therefore the condition associated with Plan 8, the No Action Alternative. The condition that would occur with each of the action alternatives (Plans 1, 2, 3, 6, 7) was compared against this future-without condition to arrive at the impact.

All aspects of project action were considered in assessing impacts, including construction activities such as borrow, roads, vegetation clearing, materials hauling, reservoir inundation, operation/maintenance, and secondary use. The project actions described in Chapter II detail the actions included in the impact assessment. Areas and facilities included in the assessment are shown on Plates 1 through 10.

A major source of environmental impact is reservoir inundation. Within a given reservoir, space can be dedicated for sediment, replacement storage (if the reservoir replaces an existing reservoir), new conservation, flood control, and flood surcharge. Reservoir impacts vary by environmental resource and depend on the frequency and duration of inundation. Figure IV-1 shows the various pools used in the CAWCS impact assessment and indicates the frequency of inundation associated with each. The precent of time pools are at various elevations over the life of the project is shown in Appendix C.

While all of the pools in a reservoir were used to assess impacts, the typical-year was used to "anchor" the assessment in most of the resource evaluation. The typical year scenario represents conditions that are expected to occur during most years when normal operations of all water delivery systems occur and normal runoff is experienced on both the local and Colorado River watershed. There would be no flooding or abnormal low flows in a typical year. CAP water users would take their allocations by priority and there would be no failures in any delivery systems. The typical-year variation in pool level (from high in the spring to low in late summer) describes the annual water fluctuation that affects a number of resources, including vegetation, fisheries, recreation, prehistoric and historic remains, and water quality.

Conservation pools and flood storage pools above the typical-year high pool fill less than annually. The conservation pools include replacement pools, new conservation for CAP, and regulatory storage for CAP. In the CAWCS analyses, the top of all types of conservation pools is indicated as the Maximum Storage Pool (MSP) elevation. The flood pools vary dramatically in size depending on the amount of storage available when the reservoir begins to fill with flood waters. The 200-year flood pool was used in CAWCS to indicate the maximum flood retention pool.

Many of the dams in CAWCS plans have been sized to suppress extraordinarily large floods by storing flows temporarily in flood surcharge space, rather than passing the flows over enlarged spillways. The area where these flows could theoretically be stored is the Inflow Design Flood (IDF) area. Impacts of IDF inundation are treated hypothetically in most resource

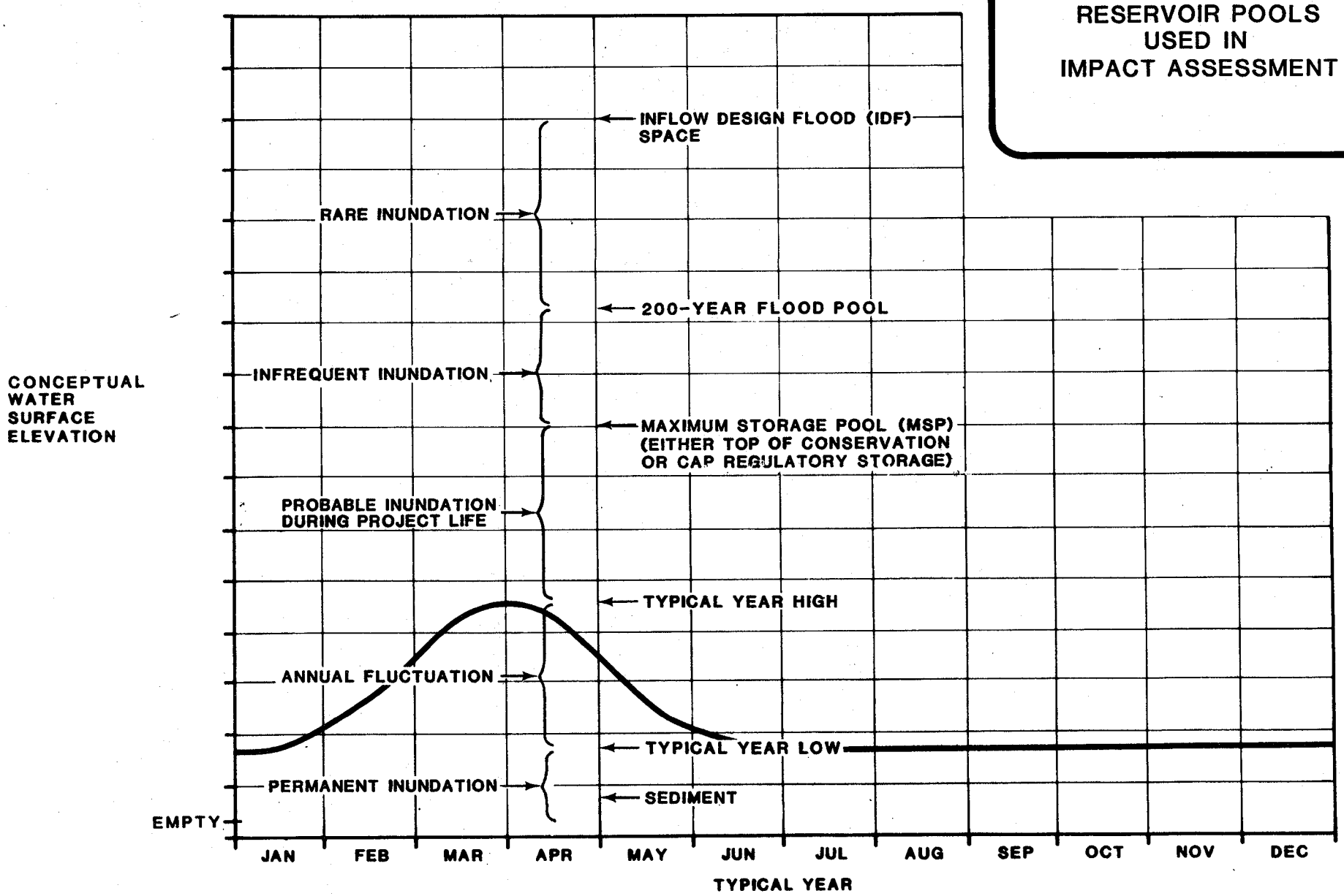

RESERVOIR POOLS
USED IN
IMPACT ASSESSMENT
INFLOW DESIGN FLOOD (IDF)
SPACE
RARE INUNDATION
200-YEAR FLOOD POOL
INFREQUENT INUNDATION
MAXIMUM STORAGE POOL (MSP)
(EITHER TOP OF CONSERVATION
OR CAP REGULATORY STORAGE)
PROBABLE INUNDATION
DURING PROJECT LIFE
TYPICAL YEAR HIGH
ANNUAL FLUCTUATION
TYPICAL YEAR LOW
PERMANENT INUNDATION
SEDIMENT
CONCEPTUAL
WATER
SURFACE
ELEVATION
EMPTY
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
TYPICAL YEAR

FIGURE IV-1

evaluations because a flood of this magnitude would occur very rarely, if ever.

All pools in the reservoir could conceivably affect resources, but the probability of impact decreases with pools higher than the typical-year high pool. For this reason, most impact descriptions in the EIS present typical-year impacts as the most probable and permanent of the reservoir impacts. The impacts of other pools are usually shown as a range, to indicate the potential extent of impact associated with the project.

For all resources, the same pools were used to make without-and with-project comparisons. For example, the typical-year future-without pool at Horseshoe Reservoir was compared to the typical-year future-with pool at Cliff Reservoir to calculate losses and gains in stream miles and habitat acreage. The pools used in the analysis are indicated in each of the impact evaluations in Section B of this Chapter.

2. Effects Evaluation

While the impact is the measured difference between future-without and future-with conditions for a factor, the effect is the interpretation of the significance of the impact. Effects were determined on the basis of the impact's direction (beneficial or adverse), duration (short-term or long-term), magnitude (degree of change), and the quality of the affected resource. Beneficial effects indicate that the quality of the resource is improved; adverse effects indicate the quality is degraded. Depending on the characteristics of the impact, one of the following effect levels has been assigned:

- Insignificant (I): small, ephemeral change, usually affecting a low-quality resource
- Significant Beneficial (SB): major improvement in a condition, usually long-term and affecting a high-quality resource
- Beneficial Flag (BF): extraordinary beneficial change in a unique, protected, or very high-quality resource
- Significant Adverse (SA): major degradation of a condition, usually long-term and affecting a high-quality resource
- Adverse Flag (AF): extraordinary adverse change in a unique, protected, or very high-quality resource

Criteria for determining effects were developed for each resource category during Stage III. The criteria were reviewed with agency representatives and professionals in the resource area. In most cases, several meetings were held to review and finalize the criteria. For some resource areas, no quantified numerical criteria could be agreed upon by the committee, but the effects were assigned by consensus. The process used to establish criteria and the criteria for each resource area are described in the Stage III Methodology for Environmental Quality Assessment.

3. Conceptual Mitigation

Mitigation concepts were developed for the impacts in each of the resource areas. These concepts are workable mitigation measures that could reduce or avoid impacts if implemented. They are conceptual, rather than specific, because they were developed to apply equally to impacts of all plans. The mitigation concepts provide a way to estimate the degree to which the impacts can be mitigated, and therefore provide another point of comparison among plans. For example, application of a mitigation concept to the impact of one plan could reduce the impact significantly, but it might not reduce the impact for another plan. The potential for mitigation is therefore indicated in a traceable and quantifiable way through the use of mitigation concepts.

With the selection of Plan 6 as the agency proposed action, Reclamation has developed a specific mitigation program. This process has begun, but the program is not complete. Section C. of this chapter describes the mitigation program for Plan 6.

B. Impacts of Plans

1. Biological Resources

a. Methodology

The Stage III methodology for biological resources focuses on six resource factors: 1) Riparian/Wetland Biotic Communities, 2) Other Terrestrial Biotic Communities, 3) Perennial Stream/Riverine Aquatic Communities, 4) Reservoir Aquatic Communities 5) Threatened and Endangered Plants and Wildlife, and 6) Management and Special Use Areas. These factors "capture" impacts to highly valued resources of riparian habitat, flowing perennial stream, and threatened and endangered species, and they permit an explicit means for assessing impacts to significant biological resources.

Data on vegetation and wildlife were compiled on the various biotic communities of the CAWCS area and were presented in the First Level Environmental Inventory (November 1979) and updated in the Second Level Environmental Inventory (April 1982). Baseline cover-type maps were prepared as Mylar overlays on 7-1/2 and 15 minute topographic maps of the site areas. Cover-type acreages were estimated by planimetric work, and faunal surveys were conducted in representative cover types to determine vertebrate wildlife composition. In addition, projections were made as to the future-without condition of the biotic resource base (see Regional Future Without the Project and Environmental Impacts and Effects of Plans).

The analytical procedure for calculating quantitative impact (i.e., the magnitude) models the difference in the resource condition with and without the project over a set of target years representing the proposed life of the project. A set of benchmark target years was established to quantify the baseline resource condition (baseline, calendar year 1980 and 1985), construction phase (1985 through 1990), and operation (post-1990 as target years 2000, 2030, and 2100). For example, construction impact

represents the integral change between 1985 and 1990 for impacts computed as follows:

I_i = Fw-Fw/o where
I_i = impact for target year i
Fw = resource measure for future with the project at target year i
Fw/o = resource measure for future without the project at target year i

The future-with condition precedes the future-without condition in the equation and thus the direction of impact is also computed simultaneously with the magnitude of impact.

Habitat acreage, miles of perennial stream, lake surface acres, acres of preferred habitat of endangered species, and range resource in animal-unit-months (AUMs) were used as the quantitative measures for computing I_is. Impacts were quantified and detailed for the target year 2000, with an estimate made as to the magnitude and duration of the impact to 2100.

The delineation of the site area for the Verde River Dams Modifications increased the total acres slightly in the various habitats for the future-without-the-project. However, these increases did not affect the determination of impacts. To avoid confusion the acreages for Plan 8 were not changed, future-without acreages for Plan 9 are presented in parentheses.

Conceptual mitigation recommendations were developed with coordinated support of the biological advisory team. Prioritized levels of mitigation are as follows: 1) mitigation through modification of proposed operation and feasible changes in construction activities, 2) institution of plan mitigation projects directed toward habitat modification and wildlife enhancement, 3) interagency coordination toward existing and proposed conservation, land management, and fish and wildlife management programs, and 4) special effort toward land acquisition or other forms of compensation to offset impacts which cannot be mitigated through other levels of effort.

Residual impacts were computed as the quantitative difference between the unmitigated impact and the quantitative mitigation effort.

Effects were assigned to unmitigated and mitigated impacts using criteria developed in consultation with the biological advisory committee (see Stage III Environmental Quality Assessment Methodology, Section 2.0).

Data generated for the impact analyses were also used as the quantitative input for the Habitat Evaluation Procedure (HEP) that was conducted under the direction of the Fish and Wildlife Service, Phoenix Office. The HEP analysis is being used to develop specific mitigation

measures for fish and wildlife impacts on Plan 6. A report documenting the HEP analysis and mitigation recommendations is in preparation by the Fish and Wildlife Service.

The status of threatened and endangered species was investigated and an assessment of project-related impacts to these species was completed in compliance with Section 7 of the Endangered Species Act. Findings are documented in A Biological Assessment of Endangered Species (November 1982). The U.S. Fish & Wildlife Service's biological opinion, based on the biological assessment, regarding project impacts to endangered species is included in Appendix F.

b. Types of Impacts to Biological Resources

Plan actions could directly modify biological resources through construction, inundation, and dam operation. Planned recreational facilities, new and improved roads, and larger lakes are expected to attract greater numbers of people into the site areas with the subsequent effect of habitat loss and human encroachment on wildlife (including the possibility of increased poaching and disturbance of nesting raptors, etc.). The direct impacts represent primarily quantitative gains or losses of resources. Indirect impacts represent changes to resource quality. For example, the quality of desert habitat would be affected by the probable decrease in numbers of long-lived cacti within 100-year flood pools.

(1) Construction and Inundation Impacts

Construction impacts (disruption of soil surface and removal of vegetation for borrow areas, clearing, roads and facilities, etc.)were evaluated for all site areas. Inundation impacts were evaluated for four reservoir pools and, therefore, four levels of potential impact. These are: 1) the characteristic impoundments for a typical year, 2) the impoundments at maximum storage capacity (MSP), 3) the 200-year flood pool, and 4) the maximum Inflow Design Flood (IDF) area (see Figure IV-1).

Although vegetation would be cleared to the MSP level during construction of reservoirs in all plans, some habitat recovery could take place within the zone between the typical-year high pool and the MSP. The recovery vegetation would consist largely of low-quality mixed scrub and salt-cedar habitats, however. Although growth of recovery vegetation would partially offset the acreage loss of riparian/wetland habitat, the low habitat quality of mixed scrub vegetation would not fully compensate for loss of high quality cottonwood-willow, mesquite woodlands, and cattail marsh.

The typical-year scenario is a condition which is expected to be frequent and long in duration (Appendix C); therefore, the influence of lake inundation, drawdown, and release characteristics would have a direct and long-standing effect on biological resources. During typical-year operation, reservoir drawdown would result from winter storage and summer releases; hence the drawdown would occur during the productive biological season and would affect fish spawning and essentially eliminate sustained plant growth in and near the typical-year pool zone. The phenomenon

of bathtub ring (habitat hiatus) would occur at the reservoirs because of the typical drawdown operation. During years of sufficient runoff, reservoirs are expected to fill to the MSP level. This would be a less frequent condition than typical-year storage; water levels are expected to exceed the typical-year high less than 25 percent of the time in most cases (see Appendix C).

The probability of an occurrence of the 200-year flood in any given year is very low, so that impacts in this pool would be infrequent. Finally, the IDF area event is extremely rare, and the impact to biological resources is essentially hypothetical; therefore, direct project related impacts within the IDF area are not discussed in this section.

(2) Dam Operation Impacts

The operation of the dams in alternative plans would affect biological resources by altering flows on the rivers. While the inundation of perennial stream represents quantitative impact, alteration of flows would affect the quality of stream aquatic communities. Cessation or reduction of flows in the river could affect fish reproduction and movement.

Dam operation would also modify flows by curtailing peak flood flows that cause channel scouring. Scouring is a rejuvenating process whereby old stands of cottonwood and willow are destroyed, but new seedlings are established on newly cleared alluvial terraces. Reduction in scouring would, therefore, diminish this dynamic process and more stands would age beyond maturity and possibly die out.

Reservoir fluctuations resulting from dam operation would negatively affect fish spawning if drawdown of greater than two inches per day occurs during the spawning season.

c. Conceptual Mitigation

Conceptual mitigation measures for impacts to biological resource factors were developed by Reclamation in conjunction with the Fish and Wildlife Service, the Arizona Game and Fish Department, and other involved agencies. Mitigation measures presented below were developed to provide a basis for comparing the alternative plans. The detailed mitigation plan for Plan 6, the Agency Proposed Action, was developed in accordance with the Federal Fish and Wildlife Coordination Act. Commitments to the mitigation plan developed for Plan 6 are presented in Section IV.C.

Reclamation has developed conceptual mitigation plans that emphasize the full array of project objectives. Direct project mitigation represents conceptual measures which focus on reducing or avoiding adverse impacts. These conceptual measures, if implemented, would modify the project design and operation to alleviate or avoid biological resource impacts. For example, reduction of planned release rates during the spawning season would reduce impact on fish reproduction in the reservoirs.

Contingent project mitigation activities are additional measures which, if implemented, would offset impacts resulting from plan implementation. For example, revegetating the old Horseshoe Lake bottom with cottonwood, willow, and mesquite would enhance the quality of the riparian habitat over that expected through natural ecological succession.

There are a number of management programs in effect or proposed in the CAWCS area such as the Forest Service Habitat Rehabilitation Plan and the Arizona Game and Fish Department fish and wildlife management program. The interagency management level of mitigation would emphasize coordinated and cooperative management measures between the various conservation and land-management agencies and Reclamation. The measures proposed for this level of mitigation include support to augment existing management effort as well as new plans which could be implemented through cooperative agency effort.

Land acquisition or other forms of compensation are intended to offset impacts which cannot be mitigated through other levels of effort.

Table IV-1 summarizes the mitigation measures proposed for the six resource categories. The composite mitigation expected from these measures is presented in the following section and was used to assess residual impacts.

d. Riparian/Wetland Communities

(1) Direct and Indirect Impacts

(a) Plan 8

The site areas will have approximately 11,760 acres (12,020 acres for Plan 9) of riparian habitat in the year 2000. Some currently existing riparian habitat will be lost as a result of agricultural development on the Fort McDowell Indian Community lands. The Forest Service will plant approximately 270 acres of cottonwood and willow trees on alluvial benchs at several selected habitat rehabilitation sites on both the Salt and Verde Rivers. Riparian habitat will probably be enhanced by development of the Rio Salado project in the Salt River bed through Tempe; however, diversion of wastewater effluent downstream of 91st Avenue for the Palo Verde nuclear plant will degrade riparian habitat quality in the downstream reach. This effluent will, however, maintain salt-cedar bosques. Maricopa County Flood Control District will continue to clear salt-cedar from a 1,000-foot-wide channel in the Salt and Gila Rivers between 91st Avenue and Gillespie Dam.

Acreages of riparian and wetland communities in the site areas in the future-without-the-project and impacts of Plan 8 are shown in Table IV-2.

Table IV-1

CONCEPTUAL MITIGATION FOR BIOLGOCIAL RESOURCES

	BIOLOGICAL RESOURCE FACTOR					
Level of Mitigation	Riparian/ Wetland	Other Terrestrial	Perennial Stream	Reservoirs	Endangered Species	Special Use
Direct Mitigation	To promote growth of cottonwood-willow and wetland habitat, delay and/or reduce water releases from Cliff, Roosevelt, and Waddell Reservoirs to <2 inches/day at onset of wetland growing season and cottonwood bloom (mid-April to mid-May); applies for all plans.		To improve quality of riverine aquatic communities, assure flows in Salt and Verde Rivers ≥50 cfs for all Plans except 7; ≥200 cfs for Plan 7.	As a means to improve fish spawning habitat, when feasible reduce drawdown rate to <2 inches per day from mid-April to mid-May at Cliff Reservoir for all Plans and Waddell Reservoir for Plans 6 and 7.	To maintain foraging habitat and fish prey base, assure minimum flow described under perennial stream.	
Contingent Project Mitigation	Implement cottonwood habitat rehabilitation at Cliff site in old Horseshoe lake bed. Applies to all plans, except Plan 9. Reclaim 20 acres cattail marsh downstream of Granite Reef Diversion Dam. Applies to all plans.	To improve quality of range habitat (paloverde-mixed cacti and blue paloverde ironwood habitat), reclaim denuded sites lying adjacent the MSP pool. Applies to sites not reclaimed during construction and involves all reservoirs in all plans.	Establish bank cover and cobble ditches for pools and riffles on Verde and Salt Rivers upstream of Cliff and Roosevelt Reservoirs and elsewhere along perennial stream in the CAWCS area. Applies to all plans.	Do not clear the conservation pool; or modify clearing and add brush piles for fish spawning of all reservoirs in all plans. Construct coffer dams for fish spawning habitat at Cliff for all Plans, at Waddell Reservoir for Plans 6 and 7.	Implement cottonwood, cattail marsh rehabilitation; as a means of protecting bald eagle breeding control public access to bald eagle breeding areas at Cliff and Roosevelt. Applies to all plans.	Substitute dispersed recreation at Cliff Reservoir to reduce disturbance to wildlife. Applies to all plans.
Inter-Agency Management	Support U.S. Forest Service cottonwood habitat rehabilitation program and range management for cottonwood/mesquite. Applies to all plans.	Cooperative range management improvements: Coordinate with BLM at Waddell, Plans 6 and 7. Coordinate with U.S. Forest Service at Cliff and Roosevelt (all plans) and Confluence (Plan 3).	Coordinate with Salt River Project on maintaining flows in Salt and Verde Rivers. Applies to all plans.	Fish stocking of all reservoirs in all plans. Support operation and management of coffer dams with Arizona Game and Fish Department.	Support the U.S. Fish and Wildlife Service Endangered Species Recovery Plans for bald eagle, peregrine falcon, Yuma clapper rail, and Gila topminnow. Applies to all plans.	Coordination with land management and conservation agencies; improve range management. Applies to all plans. Set aside Salt-Verde area same as with riparian/ wetland. Applies to all plans except Plan 3.

Table IV-1 (Continued)

	BIOLOGICAL RESOURCE FACTOR					
Level of Mitigation	Riparian/ Wetland	Other Terrestrial	Perennial Stream	Reservoirs	Endangered Species	Special Use
Land Acquisition and Compensation	Acquire take line easements for habitat improvement and wildlife conservation at all reservoirs. Purchase private holdings along Tonto Creek for establishing cottonwood-willow and wetland habitat. Lease land at Piccacho Reservoir for waterfowl foraging habitat. Coordinate with BLM and assist Arizona Game & Fish Dept. in developing waterfowl habitat in Fred J. Weiler Greenbelt on Gila River. Applies to all plans.	Same as with riparian/ wetland.		Support construction of a fish hatchery on the Waddell delivery canal. Assist Arizona Game & Fish Dept. with operation (Plans 6 and 7 only).	Same as with riparian/wetland land requisition.	Redelegate take line easements for special resources use at Three Bar and Roosevelt Wildlife Area (all plans). Fund management and wildlife research programs of the U.S. Fish and Wildlife Service and Arizona Game and Fish Dept.

Table IV-2

ACREAGE OF RIPARIAN/WETLAND COMMUNITIES--IMPACTS OF PLAN 8

Acres of Habitat[a]	Cliff	Roosevelt	Confluence/ Stewart Mountain	New Waddell	Total
Existing Condition	1,550 (1,660)	3,080	8,900	580	14,110 (14,370)
Future-Without (Plan 8) Condition	1,680 (1,790)	3,080	6,420	580	11,760 (12,020)
Impact	+130	0	-2,480	0	-2,350

[a]Includes cottonwood willow, mixed broadleaf, mesquite, salt-cedarsalt-cedar mixed scrub, mixed scrub, and cattail habitats. For acreages by habitat type see Environmental Impacts and Effects of Plans.

(b) Plans 1, 2, 3, 6, 7, and 9

Impacts to riparian/wetland communities, as well as mitigation and residual impacts, are summarized in Table IV-3. The greatest quantitative loss of riparian/wetland habitat would occur with Plan 3 due to the inclusion of Confluence Reservoir. The Confluence Reservoir would inundate the cottonwood-willow and mesquite forest at the Salt-Verde confluence. Some 60 percent of the cottonwood-willow habitat of the Confluence area would be inundated. All of the cattail marsh would be lost. All of these habitats support essentially all of the riparian-obligate wildlife of central Arizona including the great blue heron, Harris hawk, black hawk, Bell's vireo, various warblers, and other wildlife.

Losses of high quality riparian communities in Plans 1, 2, 6, and 7 primarily along the Verde River between Horseshoe Dam and Cliff Dam would be partially offset by growth of mixed-scrub and salt-cedar-mesquite habitat expected as the successional community types that would grow in the typical year high-to-MSP zones of the reservoirs, particularly in the bed of Horseshoe Reservoir. However, the habitat quality of cottonwood-willow habitat lost in Plans 1, 2, 6, and 7 would not be recovered by mixed-scrub and salt-cedar growth at Horseshoe Reservoir. Recovery of cottonwood, willow, mesquite, and cattail marsh would occur only in a typical year to MSP zone where inundation would be infrequent. The concomitant loss of wildlife at the Cliff site (e.g., a heron nest in the Horseshoe Dam to Cliff Dam segment of the Verde River) in Plans 1, 2, 6, and 7, and additional losses of wildlife at the Waddell site area (Plans 6 and 7) are an unavoidable consequence of habitat destruction. Riparian mixed scrub habitat in Morgan City Wash would

Table IV-3

RIPARIAN/WETLAND COMMUNITIES--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

Plan/Site Area	Typical Year I (acres)	Typical Year M (acres)	Typical Year R (acres)	MSP I (acres)	200-Year Flood I (acres)
Plan 1					
Cliff	-640	360[a]	-390	-780	-1040
Roosevelt	+130	100	+230	-440	-1170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-510	480	-140	-1220	-2210
Plan 2					
Cliff	-200	670[a]	+220	-580	-580
Roosevelt	+160	100	+260	-410	-410
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-40	790	+500	-990	-990
Plan 3					
Cliff	-110	940[a]	+580	-780	-1040
Roosevelt	+130	100	+230	-440	-1170
Confluence/Stewart Mountain	-2310	20	-2290	-2730	-2730
Waddell	0			0	0
Total	-2290	1060	-1480	-3950	-4940
Plan 6					
Cliff	-110	940[a]	+580	-780	-1040
Roosevelt	+130	100	+230	-440	-1170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	-130		-130	-450	-450
Total	-110	1060	+700	-1670	-2660
Plan 7					
Cliff	-510	520[a]	-150	-780	-1040
Roosevelt	+520	100	+620	-440	-1170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	-130		-130	-450	-450
Total	-120	640	+360	-1670	-2660
Plan 9					
Verde River Dams Modifications	0	0	0	0	0
Roosevelt	+130	100	+230	-440	-1170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	-130	0	-130	-450	-450
Total	0	120	120	-890	-1620

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impact Mitigation would establish high quality habitat (cottonwood-willow, mesquite and cattail) in excess of that expected by natural recovery; this would produce net gains in total riparian habitat for Plans 2, 6, and 7. However, mitigation would not recover all the high quality habitat lost, so that the effect on high quality riparian wetland would remain adverse for all plans except Plan 6. For more detailed information on gains and losses by habitat type see Environmental Impacts and Effects of Plans.

[a]At Cliff Reservoir a portion of the total mitigation would replace low quality habitat with high quality habitat, and would not result in a quantitative gain.

be subjected to flood flows during spillway releases from New Waddell Dam. This would be an infrequent event (approximately a 200-year flood event), and habitat recovery is expected.

Furthermore, some of the existing cottonwood forest along the Salt and Verde Rivers downstream of Bartlett and Stewart Mountain Dams would be outside the modified scouring zone and would not, therefore, be susceptible to the rejuvenating scouring process previously described.

In Plan 9 riparian habitat would remain intact at the Verde River Dams Modifications site, except for construction losses in the borrow area. Opportunities for vegetation recovery are limited to sites in the typical year high to MSP inundation zones at Roosevelt and Waddell Reservoirs.

(2) Mitigation

Conceptual mitigation strategies for riparian and wetland communities are described in Table IV-1. The objectives of these mitigation measures are to recover acreage of high quality resources lost as a result of the project and to improve the quality of remaining riparian/wetland habitat over that which would occur through natural ecological succession. Because mitigating cannot quantitatively eliminate project-induced impacts to high quality riparian/wetland habitat, only qualitative enhancement of the resource can be achieved in much of the site areas. The opportunity for mitigation good quality riparian habitat in the Horseshoe Basin is precluded in Plan 9.

(3) Residual Impacts

Residual impacts to riparian/wetland communities are shown on Table IV-3.

e. Other Terrestrial Communities

(1) Direct and Indirect Impacts

(a) Plan 8

The site areas will have approximately 195,000 acres of other terrestrial habitat (shrubland and paloverdemixed cacti desert) in the year 2000, as shown in Table IV-4.

(b) Plans 1, 2, 3, 6, 7, and 9

Impacts to other terrestrial communities, as well as mitigation and residual impacts, are summarized on Table IV-5. The nonriparian communities that would be altered by construction and/or subjected to occasional flood storage inundation include mainly paloverde-mixed cacti, and blue paloverde-ironwood habitat. These community types cannot tolerate inundation of more than several days, and the full species complement would probably not occur within the flood storage zone at less than the 200-year

flood level, due to the maturation rates of the dominant cacti. This habitat type would be completely eliminated below the MSP level in areas inundated more than about 5 percent of the time. The least impact to this habitat type is expected in Plans 2 and 9 because reservoir pools would be nearly the same size as at present. Plans 6 and 7 both include a large storage pool at New Waddell Reservoir and would have the highest impact. However, because the losses involve only a small percentage of the total amount of this habitat type present in the site areas, the effect in all plans is considered insignificant.

Table IV-4
OTHER TERRESTRIAL COMMUNITIES - IMPACTS OF PLAN 8

Acres of Habitat[a]	Cliff	Roosevelt	Confluence/ Stewart Mountain	New Waddell	Total
Existing Condition	47,580 (67,590)	59,670	56,470	38,190	201,910 (223,460)
Future-Without (Plan 8) Condition	47,500 (67,510)	59,670	49,170	38,140	194,480 (216,030)
Impact	-80	0	-7,300	-50	-7,430

[a]Includes paloverde-mixed cacti and blue paloverde-ironwood associations.

(2) Mitigation

Conceptual mitigation strategies for terrestrial communities are outlined in Table IV-1. The objectives of these mitigation measures are to improve the quality of the habitat within the IDF area to be acquired by Reclamation. This would include overall reductions in grazing and seeding of areas peripheral to the maximum storage pool. Opportunities to reclaim desert vegetation lost through inundation are somewhat limited, however, due to the intolerance of the dominant plant species (saguaro cactus and paloverde) to periodic inundation. No enhancement of the resource is, therefore, expected.

(3) Residual Impacts

Residual Impacts are shown on Table IV-5. No quantitative gains in resource can be made through mitigation. However, the quality of the remaining resources could be improved.

Table IV-5

OTHER TERRESTRIAL COMMUNITIES--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

Plan/Site Area	Typical Year I (acres)	Typical Year M (acres)	Typical Year R (acres)	MSP I (acres)	200-Year Flood I (acres)
Plan 1					
Cliff	-1970	(50)[a]	-1970	-1280	-4000
Roosevelt	-1270	(2350)	-1270	-1400	-4640
Confluence/Stewart Mountain	-20		-20	-20	-20
Waddell	0			0	0
Total	-3260	(2400)	-3260	-2700	-8660
Plan 2					
Cliff	+420	(260)	+420	+910	+910
Roosevelt	-870	(2350)	-870	-1000	-1000
Confluence/Stewart Mountain	-10		-10	-10	-10
Waddell	0			0	0
Total	-460	(2610)	-460	-100	-100
Plan 3					
Cliff	-1300	(720)[a]	-1300	-1280	-4000
Roosevelt	-1270	(2350)	-1270	-1400	-4640
Confluence/Stewart Mountain	-3430	(280)	-3430	-3710	-3710
Waddell	0			0	0
Total	-6000	(3350)	-6000	-6390	-12350
Plan 6					
Cliff	-1300	(720)[a]	-1300	-1280	-4000
Roosevelt	-1270	(2350)	-1270	-1400	-4640
Confluence/Stewart Mountain	-20		-20	-20	-20
Waddell	-8470	(160)	-8470	-6460	-6460
Total	-11060	(3230)	-11060	-9160	-15120
Plan 7					
Cliff	-1970	(50)[a]	-1970	-1280	-4000
Roosevelt	-3080	(540)	-3080	-1400	-4640
Confluence/Stewart Mountain	-20		-20	-20	-20
Waddell	-8470	(160)	-8470	-6460	-6460
Total	-13540	(750)	-13540	-9160	-15120
Plan 9					
Verde River Dams Modifications	-70		-70	-70	-70
Roosevelt	-1270		-1270	-1400	-4640
Confluence/Stewart Mountain	-20		-20	-20	-20
Waddell	-8470		-8470	-6460	-6460
Total	-9830		-9830	-7950	-7950

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impact

[a]Numbers in parentheses are areas peripheral to maximum storage pools in which recovery of desert vegetation could be enhanced through seeding of shrubs and/or grasses. This represents a qualitative rather than quantitative gain in resource, and does not reduce the quantitative residual impact.

f. Perennial Stream/Riverine Communities

(1) Direct and Indirect Impacts

(a) Plan 8

A total of 66 miles of perennial stream lie within the Confluence, Cliff, Roosevelt, and New Waddell site areas. Approximately 137 miles of perennial stream are within the CAWCS area boundaries. Present operating criteria on the SRP-controlled reaches of the Salt and Verde Rivers upstream of the confluence do not guarantee minimum flows for fish and wildlife benefits. This condition is expected to continue in the future. On average in these reaches, there are 106 days per year of flows equal to or less than 50 cfs on the Salt River, and 61 days per year on the Verde River.

Table IV-6 shows miles of perennial stream and riverine communities in the future-without-the-project and impacts of Plan 8.

TABLE IV-6
PERENNIAL STREAM/RIVERINE COMMUNITIES - IMPACTS OF PLAN 8

Perennial stream miles	Cliff	Roose-velt	Confluencence Stewart Mountain	New Waddell	Total
Existing Condition	20 (21)	15	31	0	66 (67)
Future-Without (Plan 8) Condition	20 (21)	15	31	0	66 (67)
Impact	0	0	0	0	0

(b) Plans 1, 2, 3, 6, 7, and 9

Impacts of plans, as well as mitigation and residual impacts, are summarized in Table IV-7. Loss of perennial stream is regarded as a significant impact due to the limited amount of perennial stream in Southwestern deserts. Perennial streams support riverine aquatic communities, riparian habitat, and wildlife including the endangered Yuma clapper rail and bald eagle.

The typical-year inundation represents the most likely recurrent event affecting stream loss. Plan 3 accounts for the greatest loss of stream due to the inclusion of Confluence Reservoir. Enlarging Lake Pleasant at the New Waddell site would not inundate perennial streams, thus the typical-year impact would be the same in Plans 2 and 6. With more storage planned at Cliff Reservoir in Plans 1 and 7, the impacts of these two plans are similar. In all plans except Plan 9, however, the net river mileage change at Cliff Reservoir represents loss of 6 miles of high-quality river between Horseshoe and Cliff Dams and recovery of river in

Table IV-7

PERENNIAL STREAM/RIVERINE COMMUNITIES--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

	Typical Year			MSP	200-Year Flood
	I (miles)	M (miles)	R (miles)	I (miles)	I (miles)
Plan 1					
Cliff	-3[a]	(17)[b]	-3	-5	-7
Roosevelt	0			-1	-5
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	-3	(17)	-3	-6	-12
Plan 2					
Cliff	+1[a]	(21)[b]	+1	-1	-1
Roosevelt	0			-1	-1
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	+1	(21)	+1	-2	-2
Plan 3					
Cliff	+1[a]	(21)[b]	+1	-5	-7
Roosevelt	0			-1	-5
Confluence/Stewart Mountain	-17	(14)	-17	-18	-18
Waddell	0			0	0
Total	-16	(31)	-16	-24	-30
Plan 6					
Cliff	+1[a]	(21)[b]	+1	-5	-7
Roosevelt	0			-1	-5
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	+1	(21)	+1	-6	-12
Plan 7					
Cliff	-2[a]	(18)[b]	-2	-5	-7
Roosevelt	0			-1	-5
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	-2	(18)	-2	-6	-12
Plan 9					
Verde River Dams Modifications	0	(0)	0	0	0
Roosevelt	0			-1	-5
Confluence/Stewart Mountain	0				0
Waddell	0				0
Total	0	(0)	0	-1	-5

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impacts.

[a]At Cliff Reservoir 6 miles of perennial stream habitat will be lost downstream of Horseshoe Dam in Plans 1, 2, 3, 6 and 7. However, stream habitat will be gained in the reach formerly occupied by Horseshoe Reservoir. Impacts are the combined losses and/or gains in perennial stream. Stream habitat is not gained in Plan 9.

[b]Numbers in parentheses are miles of river in which qualitative improvements such as bank stabilization and flow augmentation could be made. Quantitative loss of stream miles cannot be mitigated.

the exposed Horseshoe lakebed. Seven miles would be recovered in Plans 2, 3, and 6; 3 and 4 miles, respectively, would be recovered in Plans 1 and 7. The quality of riverine habitat within the recovered segment would eventually improve as channel silt and sand wash downstream, but the perennial stream initially would be subjected to erosion and high turbidity, which creates poor habitat for most riverine aquatic life. With Plan 9 there would be no change in the amount of perennial stream.

(2) Mitigation

Conceptual mitigation for impacts to perennial stream/riverine communities is outlined on Table IV-1. Since mitigation of lost stream mileage is not feasible within the affected site areas, these conceptual mitigation measures are aimed at improving the quality of habitat in the remaining reaches of river. Stream habitat improvements as given in the conceptual mitigation table would not change the unmitigated effects. Plan 7, with sustained minimum flows, is the best option for this factor, and provides the only opportunity for fish and wildlife enhancement.

(3) Residual Impacts

Residual impacts are displayed in Table IV-7.

g. Reservoir Aquatic Communities

(1) Direct and Indirect Impacts

(a) Plan 8

Approximately 14,000 surface acres of habitat are available in Horseshoe Lake, Roosevelt Lake, Saguaro Lake, and Lake Pleasant; 35,000 surface acres of habitat are available within the CAWCS area. SRP lakes and Lake Pleasant do not have guaranteed minimum pools for fish and wildlife and recreation but, historically, reservoirs on the Salt River have maintained some minimum pools. This condition is expected to continue in the future.

Typical-year low reservoir surface acres in the future-without-the-project are expected to be 610 acres allocated to the Cliff site area, 11,930 acres at Roosevelt, 630 acres at Confluence site area, and 830 acres at New Waddell site area.

(b) Plans 1, 2, 3, 6, 7, and 9

Impacts of plans, as well as mitigation and residual impacts are summarized on Table IV-8. The gain of lake habitat has been assessed as the increase in typical-year low-pool surface acreage which would create a minimum pool to ensure a fish population carryover. However, the beneficial gain in lake habitat would be adversely affected where drawdown rates during the spawning season exceed 2 inches per day; rates greater than 2

Table IV-8

RESERVOIR AQUATIC COMMUNITIES--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

Plan/Site Area	Typical Year I (acres)	Typical Year M (acres)	Typical Year R (acres)	MSP I (acres)	200-Year Flood I (acres)
Plan 1					
Cliff	+400		+400	+2520	+5900
Roosevelt	0			+2350	+6510
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	+400[a]		+400	+4870	+12410
Plan 2					
Cliff	-360		-360	+100	+100
Roosevelt	0			+2350	+2350
Confluence/Stewart Mountain	0			0	0
Waddell	0			0	0
Total	-360[a]		-360	+2450	+2450
Plan 3					
Cliff	+130		+130	+2520	+5900
Roosevelt	0			+2350	+6510
Confluence/Stewart Mountain	+2950	(1850)[b]	+2950	+8850	+8850
Waddell	0			0	0
Total	+3080[a]		+3080	+13720	+21260
Plan 6					
Cliff	+130		+130	+2520	+5900
Roosevelt	0			+2350	+6510
Confluence/Stewart Mountain	0			0	0
Waddell	+1770	(1540)[b]	+1770	+6390	+6390
Total	+1900[a]		+1900	+11260	+18800
Plan 7					
Cliff	+980	(1030)[b]	+980	+2520	+5900
Roosevelt	+940		+940	+2350	+6510
Confluence/Stewart Mountain	0			0	0
Waddell	+1770	(1540)[b]	+1770	+6390	+6390
Total	+3690[a]		+3690	+11260	+18800
Plan 9					
Verde River Dams Modifications	0		0	0	0
Roosevelt	0		0	+2350	+6510
Confluence/Stewart Mountain	0		0	0	0
Waddell	+1770	(1540)[b]	+1770	+6390	+6390
Total	+1770		+1770	+8740	+12900

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impact.

[a]Impacts represent the net loss/gain of typical-year low pools, which are the resource for sustaining fisheries.

[b]Numbers in parentheses are the surface areas of USBR design minimum pools. Mitigation involves reduction of drawdown rates to <2 inches in 1 day from mid-April to mid-May and would improve fish spawning habitat in the reservoirs.

inches per day are not conducive to productive fish spawning, and effectively eliminate spawning success in the group of species which includes bass, crappie, and the sunfishes.

The water quality at Waddell Reservoir would change due to Colorado River water delivery and subsequent mixing. Among the water quality parameters affecting the fishery, increases in total dissolved solids (TDS) appears to be the most important. Dissolved oxygen, turbidity, and pH would approximate baseline conditions at least within levels of tolerance of the sport fish occurring in Lake Pleasant. TDS would increase to a mean 722 ppm, which exceeds the limits of optimal tolerance (100 to 350 ppm) for the bass, crappie, catfish, and other sport fishes. However, fish surveys and studies conducted on the lower Colorado River and Lake Havasu (where CAP water will be withdrawn) indicate that these species reproduce and maintain viable populations (USFWS, 1980; Talbout, 1982; Lyces, 1982). Therefore, although the expected increase in TDS at Lake Pleasant would exceed the optimal range, reproduction is expected to continue, and in terms of viability, the critical factor which would influence spawning is reservoir drawdown rather than increased TDS.

Plan 7 would produce significant beneficial gains in surface acreage and typical-year low storage in excess of Reclamation-design minimum pools at Cliff and Lake Pleasant. This means that pools of 10,000 af and 5,000 af would be maintained (in excess of sediment) at Cliff Reservoir and Lake Pleasant, respectively. Increased TDS would, however, compromise some of the benefit gained from the enlarged Lake Pleasant in Plan 7 insofar as spawning is concerned.

Plan 3 would also increase pool acreage substantially, but only one minimum pool (7,000 af) would be gained, at Confluence Reservoir. Cliff Reservoir in Plans 1, 2, 3, and 6 would not maintain sufficient storage to maintain a minimum pool. Drawdown rates on Lake Pleasant would be approximately 5 inches per day. Roosevelt Lake drawdown would be 1.3 inches per day in all plans, the same condition which occurs in Plan 8. Horseshoe and Bartlett Reservoirs would remain as 9.2 and 1.5 inches per day respectively drawdown in Plan 9.

The Lake Pleasant sport fishery and the riverine fishery in the Salt-Verde drainage upstream of Granite Reef Diversion Dam are relatively isolated from potential contamination resulting from the introduction of predatory and competitive species which could be conveyed from the Colorado River via the CAP aqueduct. Intra-system contamination is also a potential hazard; white bass in Lake Pleasant, if conveyed into the regulated reach of the Salt-Verde system, would be effective picsivorous predators on the native and sport fish populations. It is not presently known whether Colorado River species would be conveyed or survive in the CAP aqueduct, whether they would be introduced into either Lake Pleasant or the Salt-Verde system, or what the effects of such introduction would be. Reclamation is conducting studies to determine whether the potential conveyance and introduction of tilapia, striped bass, and other predatory species represents a possible hazard to the central Arizona sport fisheries (see Appendix B).

(2) Mitigation

Conceptual mitigation measures for reservoir aquatic community impacts are described in Table IV-1. The objectives of these measures are to improve spawning conditions and to sustain fish populations. If the conceptual mitigation measures are implemented, particularly modification of drawdown rates, fish and wildlife enhancement would occur.

(3) Residual Impacts

Residual impacts are displayed in Table IV-8.

h. Threatened and Endangered Plants and Wildlife

(1) Direct and Indirect Impacts

(a) Plan 8

Six endangered species occur in the CAWCS study area, four of which occur in the vicinity of the site areas. These four are the bald eagle, peregrine falcon, Yuma clapper rail, and Gila topminnow. The bald eagle is the only species known to breed within the affected site areas.

The peregrine falcon has been observed in the CAWCS area on the Salt River and upstream of Lake Pleasant on the Agua Fria River.

A population of Gila topminnows lives in Tule Creek upstream of the New Waddell site area.

There are 13 confirmed bald eagle breeding areas in the Southwestern United States, six of which are located along the Salt and Verde Rivers in the CAWCS area. The two most productive of these six areas are in the Confluence site area and the third most productive area (Bartlett) is located downstream of the Verde River Dams Modifications site area. Table IV-9 shows the productivity of these breeding areas in recent years.

Yuma clapper rails have been observed in the Confluence area and downstream of the Granite Reef Diversion Dam. Although observation data indicate that the species may breed in the area where observed, there has been no direct evidence to substantiate that breeding is in fact occurring.

Approximately 1,910 acres of cottonwood willow and mixed broadleaf communities, which are preferred habitat for the bald eagle, currently occur within the site areas. Also, 30 acres of cattail wetland which is preferred habitat for the endangered Yuma clapper rail occur in the Confluence site area.

Breeding areas and productivity for the bald eagle are expected to remain status quo or to improve slightly because of efforts of the Bald Eagle Recovery Team in conjunction with conservation

management by the Fish and Wildlife Service and the Forest Service (Tonto National Forest). By the year 2000, bald eagle preferred habitat is expected to increase to 2,180 acres within the site areas on the Tonto National Forest due to habitat rehabilitation by the Forest Service. Yuma clapper rail preferred habitat is expected to remain the same (30 acres at the Confluence site area).

TABLE IV-9
PRODUCTIVITY OF BALD EAGLE BREEDING AREAS

Breeding Area	Average Productivity (Number Fledges	Years Occupied[a]
Blue Point/Stewart Mountain breeding area (Confluence)	3.00	2
Fort McDowell breeding area (Confluence)	1.40	10
Bartlett breeding area (Confluence and Verde River Dams)	1.10	10
Redmond Flat (CAWCS study area but not in a site area)	0.75	8
Pinal Creek breeding area (Roosevelt)	0.80	5
Chalk Mountain breeding area (Cliff)	0.40	10

[a]Period of record for breeding area occupation: 1973-1982

Table IV-10 shows acreages of preferred habitat for these species in the future-without-the-project and impacts of Plan 8. Perennial stream is also an important habitat utilized by breeding bald eagles. Table IV-6 shows river mileage of perennial stream in the future-without-the-project.

TABLE IV-10
THREATENED AND ENDANGERED SPECIES PREFERRED HABITATS - IMPACTS OF PLAN 8

Acres of Habitat[a]	Cliff	Roose velt	Confluence/ Stewart Mountain	New Waddell	Total
Existing Condition	650	380	910	10	1,950
Future-Without (Plan 8) Condition	830	380	1,000[a]	10[b]	2,220
Impact	+180	0	+90	0	+270

[a] Includes 30 acres Yuma clapper rail preferred habitat
[b] Yuma clapper rail

b. Plans 1, 2, 3, 6, 7, and 9

Impacts of plans, as well as mitigation and residual impacts, of preferred habitat are summarized in Table IV-11. The impacts to perennial streams are summarized in Table IV-7. The impact assessment and effects evaluation focus on impacts to the endangered bald eagle. The proposed operation of Confluence Reservoir would eliminate 60 percent of the cottonwood-willow habitat and 17 miles of perennial stream which includes segments of river known to be foraging sites of the Fort McDowell and Blue Point/Stewart Mountain bald eagle breeding areas. The impact to preferred habitat and perennial streams at the Cliff site area will be the same as Plan 6 (discussed below). In all plans Roosevelt Lake will remain the same as its current pool size.

The changes in quantities of preferred habitat and miles of perennial stream vary among the action plans. Approximately 10 miles of river will be excavated for fill material downstream of Horseshoe Dam. The new reservoir will inundate 6 miles of perennial stream between Horseshoe Dam and the new Cliff Dam in all action plans. Approximately 350 acres of preferred habitat will be lost in this 6-mile reach. The plans also include breaching Horseshoe Dam which will cause the relocation of Horseshoe Reservoir at the new damsite. The lakebed of Horseshoe Reservoir will become exposed; the extent of exposure varying among the plans depending on the size of the typical-year pools. "New" river will develop in the exposed lakebed upstream of Cliff Reservoir and alluvial flats will provide sites for the growth of vegetation. The gain of river and riparian habitat will occur in the vicinity of several known nest sites of the Chalk Mountain breeding area. The gain in river mileage and riparian habitat upstream of Cliff Reservoir will be as follows: 7 miles of river and 660 acres of riparian habitat in Plans 3 and 6; 7 miles of river and 370 acres of riparian habitat in Plan 2; 3 miles of river and 130 acres of habitat in Plan 1; and 4 miles of river and 260 acres of habitat in Plan 7.

Consultation under Section 7 of the Endangered Species Act was undertaken only for Plan 6. The Biological Opinion stated that "the proposed action is likely to jeopardize the continued existence of the southwest eagle population. However, reasonable and prudent alternatives have been identified to alter the proposed plan to a degree that the action would no longer jeopardize the continued existence of this species." Commitments to modification of Plan 6 in accordance with the reasonable and purdent alternatives are contained in Section IV.C and Appendix F.

The existing conditions at Bartlett and Horseshoe Reservoirs will remain essentially unaltered in Plan 9. No major impact is anticipated for either the Chalk Mountain or Bartlett bald eagle breeding areas. Episodes of nest inundation which have disrupted breeding of the Chalk Mountain bald eagles are expected to continue. Opportunities for riparian woodland growth in the Horseshoe Reservoir Basin within the Chalk Mountain breeding area are precluded in Plan 9.

Table IV-11

THREATENED AND ENGANGERED PLANTS AND WILDLIFE--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

Plan/Site Area	Typical Year I (preferred habitat acres)	Typical Year M (preferred habitat acres)	Typical Year R (preferred habitat acres)	MSP I (acres)	200-Year Flood I (acres)
Plan 1					
Cliff	-350	110	-240	-340	-480
Roosevelt	-90	100	+10	-20	-170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-440	230	-210	-360	-650
Plan 2					
Cliff	-340	250	-90	-330	-330
Roosevelt	-90	100	+10	-20	-20
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-430	370	-60	-350	-350
Plan 3					
Cliff	-350	250	-100	-340	-480
Roosevelt	-90	100	+10	-20	-170
Confluence/Stewart Mountain	-590	20	-570	-590	-590
Waddell	0			0	0
Total[a]	-1,030	370	-660	-950	-1240
Plan 6					
Cliff	-350	250	-100	-340	-480
Roosevelt	-90	100	+10	-20	-170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-440	370	-70	-360	-650
Plan 7					
Cliff	-350	160	-190	-340	-480
Roosevelt	-90	100	+10	-20	-170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-440	280	-160	-360	-650
Plan 9					
Verde River Dams Modifications	-80	0	-80	-80	-80
Roosevelt	-90	100	+10	-20	-170
Confluence/Stewart Mountain	0	20	+20	0	0
Waddell	0			0	0
Total	-170	120	-50	-100	-250

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impact.

[a]Impacts in Plan 3 are for bald eagle preferred habitat (cottonwood-willow) and Yuma clapper rail preferred habitat (cattail marsh) combined. Impacts for all other plans are for cottonwood willow only. Reestablishment of 20 acres of cattail marsh below Granite Reef Dam would enhance Yuma clapper rail habitat in Plans 1, 2, 6, and 7, and would mitigate loss of marsh at the Confluence in Plan 3.

The Yuma clapper rail will be adversely affected by the complete loss of its known habitat in the Confluence area. The concomitant loss of breeding habitat for bald eagles and 100 percent loss of Yuma clapper rail habitat are considered an Adverse Flag effect for Plan 3.

Plans 6 and 7 will produce a large lake at the New Waddell site area. The lake will inundate a nest site tenatively considered a bald eagle nest. The Agua Fria River - Tule Creek confluence would also be inundated at peak storage; predatory and competitive lake fish would invade Gila topminnow habitat during periods when the creek is flowing into the lake. The potential threat to the endangered topminnow would increase in Plans 6 and 7, but the opportunity for invasion already exists (that is, the possibility of simultaneous flows in the Agua Fria River and Tule Creek). The impacts at the New Waddell site area are therefore somewhat conjectural.

(2) Mitigation

Conceptual mitigation strategies for impacts to endangered species are described in Table IV-1. The objectives of these mitigation measures are to minimize or eliminate impacts on productivity and to improve preferred habitat. Adverse impacts to the bald eagle could be alleviated in Plans 1, 2, 3, 6, 7, and 9. Plan 3 represents an unmitigatable loss of productivity in the two most productive breeding areas of the Southwest bald eagle population. Opportunities exist to enhance Yuma clapper rail habitat in all plans except Plan 3. The security of the topminnow habitat could be improved by placement of a drop-structure fish barrier on Tule Creek upstream of the IDF lake elevation. Opportunities to mitigate preferred habitat in the Horseshoe Reservoir Basin are precluded in Plan 9.

(3) Residual Impacts

Residual impacts are displayed in Table IV-11.

i. Special Use and Management Areas

(1) Direct and Indirect Impacts

(a) Plan 8

Special use range resources will include approximately 23,560 (25,240 for Plan 9) Animal Unit Months (AUM) in the site areas. The Animal Unit Month is a measure of the resource base available not only to livestock but to wildlife as well. Other special use resources for wildlife include: wildlife areas at Roosevelt Lake and Three Bar Wildlife Area; the Fred J. Weiler Greenbelt on the Gila drainage; limited-access areas near bald eagle breeding areas; six reservoirs on the Salt and Verde Rivers for continued use as State warmwater fisheries; and the Confluence area as an area of special interest for research and wildlife diversity. There is likely to be an increase in special use sites for cottonwood rehabilitation in the Tonto National Forest, plus development of the Lower Salt River Recreation Area plan in the Confluence site area.

Table IV-12 shows range and wildlife resources in the future-without-the-project in terms of AUMs, and impacts of Plan 8.

TABLE IV-12
SPECIAL USE AND MANAGEMENT AREAS - IMPACTS OF PLAN 8

AUMs	Cliff	Roosevelt	Confluence/ Stewart Mountain	New Waddell	Total
Existing Condition	6,103 (8,602)	9,639	11,155	3,633	30,530 (33,239)
Future-Without (Plan 8) Condition	3,798 (5,351)	6,647	9,486	3,629	23,560 (25,113)
Impact	-2,305 (-3,251)	-2,992	-1,669	-4	-6,970 (-7,995)

(b) Plans 1, 2, 3, 6, 7, and 9

Impacts of plans, as well as mitigation and residual impacts, are summarized in Table IV-13. The greatest quantitative loss of range resources and special use areas would occur under Plan 3 due to the inclusion of Confluence Reservoir. Under this plan the Blue Point cottonwood area and the site for the Forest Service Lower Salt River Recreation area would be inundated along with several habitat rehabilitation sites in the Confluence and Cliff site areas. Riparian communities in the Confluence vicinity which are good birding areas would be lost in Plan 3. Under Plans 1, 2, 6, and 7, only habitat rehabilitation sites in the Cliff site area would be inundated. This would not occur in Plan 9. Implementation of recreation plans at the Roosevelt Site in Plans 1, 3, 6, 7, and 9 would increase the number of people using areas adjacent to the waterfowl refuge maintained by the Arizona Game and Fish Department; however, recreation sites immediately adjacent to waterfowl areas are currently, and would continue to be, closed to access during the period of waterfowl occupation (November to February). Impacts resulting from increased human use result in qualitative losses to the waterfowl area.

Losses of range resource, expressed as AUM's, would be greatest under Plan 7; however, the net effect is insignificant compared to the total range resource in the site areas, since reductions in stocking rates will be implemented by management agencies in the future-without-the-project.

Table IV-13

SPECIAL USE AND MANAGEMENT AREAS--IMPACTS, MITIGATION, AND RESIDUAL IMPACTS BY SITE AREA AND POOL LEVEL

	Typical Year			MSP	200-Year Flood
	I (AUMs)	M	R	I (AUMs)	I (AUMs)
Plan 1					
Cliff	-202			-159	-389
Roosevelt	-121			-195	-615
Confluence/Stewart Mountain	-3			-3	-3
Waddell	0			0	0
Total	-326	TBD	-326	-357	-1007
Plan 2					
Cliff	+17			+25	+25
Roosevelt	-75			-149	-149
Confluence/Stewart Mountain	-1			-1	-1
Waddell	0			0	0
Total	-59	TBD	-59	-125	-125
Plan 3					
Cliff	-109			-159	-389
Roosevelt	-121			-195	-615
Confluence/Stewart Mountain	-979			-1099	-1099
Waddell	0			0	0
Total	-1209	TBD	-1209	-1453	-2103
Plan 6					
Cliff	-109			-159	-389
Roosevelt	-121			-195	-615
Confluence/Stewart Mountain	-3			-3	-3
Waddell	-806			-647	-647
Total	-1039	TBD	-1039	-1004	-1654
Plan 7					
Cliff	-192			-159	-389
Roosevelt	-271			-195	-615
Confluence/Stewart Mountain	-3			-3	-3
Waddell	-806			-647	-647
Total	-1272	TBD	-1272	-1004	-1654
Plan 9					
Verde River Dams Modifications	-5			-11	-11
Roosevelt	-121			-195	-615
Cliff	-3			-3	-3
Confluence/Stewart Mountain	-806			-647	-647
Waddell	-935	TBD	-935	-856	-1276

Notes

I = Unmitigated impact; M = Conceptual mitigation; R = Residual impact; [a]TBD = To be determined. Mitigation will involve range improvements and gain of new special use areas, to be negotiated with involved agencies; however, the quantitative improvement is not determined at this time.

(2) Mitigation

Conceptual mitigation strategies for management and special use areas are described in Table IV-1. The purpose of these mitigation measures is to replace wildlife habitat and/or range resources lost due to the project. Mitigated effects of Plan 3 are worse than for the other plans because the plan would cause inundation of special use sites at the Confluence and preclude setting aside of additional sites there as mitigation.

(3) Residual Impacts

Residual impacts are displayed in Table IV-13.

j. Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Construction impacts for a modified dam at Roosevelt or Stewart Mountain would be the same as the new dam option except construction activities for a modified dam would be shorter in duration and require less area. Operational impacts would be the same at Roosevelt or Stewart Mountain because lake elevations, size, and storage allocations would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact at either location for biological resources due to construction and operation. However, impacts would occur to endangered species and special use areas due to increased recreational use of the area. The nature and extent of the impacts will depend on management policies for recreational use.

k. Summary

The mitigated and unmitigated impacts and effects of Plans 1, 2, 3, 6, 7, and 9 are summarized in Tables IV-14, IV-15, IV-16, IV-17, IV-18 and IV-19. A range of impacts and effects is shown for the typical-year, MSP, and 200-year flood pool levels.

(1) Notes on Summary Tables

The net impact is the cumulative change between the future-without project and future-with project condition.

Effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk (*). Typical-year impacts reflect both quantitative and qualitative resource changes. Maximum conservation storage and flood events are assumed to be less frequent and shorter in duration than the typical-year condition; impacts are not as recurrent or qualitatively continuous. The effects are therefore described as conditional for the 200-year flood pool. Flood-related impacts involve changes in resource quality but not necessarily quantitative changes since natural recovery and succession are likely.

Table IV-14

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 1

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 510 ac - 1,220 ac - 2,210 ac	*SA SA Conditional SA	480ac	SA
2. Other Terrestrial Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 3,260 ac - 2,700 ac - 8,660 ac	*I I Conditional I	(2400ac)	I
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 3 mi/no change in flow - 6 mi -12 mi	*I SA Conditional SA	(17 mi)	I
4. Reservoir Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	+ 400 ac + 4,870 ac +12,410 ac	*I I Conditional I	Reduce drawdown rates	SB
5. Threatened/Endangered Species (bald eagle)	a. typical year b. MSP c. 200-Year Flood	- 440 ac/1 Breeding area - 360 ac/2 Breeding areas - 650 ac/2 Breeding areas	*SA AF Conditional AF	230ac	I
6. Management/Special Use Areas	a. typical year b. MSP c. 200-Year Flood	- 326 AUM - 357 AUM - 1,007 AUM	*I I Conditional I	TBD	I

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

Table IV-15

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 2

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year	- 40 ac	*SA	790ac	SA
	b. MSP	- 990 ac	SA		
	c. 200-Year Flood	- 990 ac	Conditional SA		
2. Other Terrestrial Biotic Communities	a. typical year	- 460 ac	*I	(2,610ac)	I
	b. MSP	- 100 ac	I		
	c. 200-Year Flood	- 100 ac	Conditional I		
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year	+ 1 mi/no change in flow	*I	(21 mi)	I
	b. MSP	- 2 mi	I		
	c. 200-Year Flood	- 2 mi	Conditional I		
4. Reservoir Aquatic Biotic Communities	a. typical year	- 360 ac	*I	Reduce drawdown rates	SB
	b. MSP	+ 2,450 ac	I		
	c. 200-Year Flood	+ 2,450 ac	Conditional I		
5. Threatened/Endangered Species (bald eagle)	a. typical year	- 430 ac	*I	370ac	I
	b. MSP	- 350 ac/2 Breeding areas	AF		
	c. 200-Year Flood	- 350 ac/2 Breeding areas	Conditional AF		
6. Management/Special Use Areas	a. typical year	- 59 AUM	*I	TBD	I
	b. MSP	- 125 AUM	I		
	c. 200-Year Flood	- 125 AUM	Conditional I		

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

Table IV-16

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 3

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 2,290 ac - 3,950 ac - 4,940 ac	*AF AF Conditional AF	1,060 ac	AF
2. Other Terrestrial Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 6,000 ac - 6,390 ac - 12,350 ac	*I I Conditional I	(3,350ac)	I
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	-16 mi/no change in flow -24 mi -30 mi	*AF AF Conditional AF	(39 mi)	AF
4. Reservoir Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	+ 3,080 ac/+1 Minimum pool +13,720 ac +21,260 ac	*SA SA Conditional SA	Reduce drawdown rates	SB
5. Threatened/Endangered Species (bald eagle and Yuma clapper rail)	a. typical year b. MSP c. 200-Year Flood	- 1,030 ac/2 Breeding areas - 950 ac/4 Breeding areas - 1,240 ac/4 Breeding areas	*AF AF Conditional AF	370 ac	AF
6. Management/Special Use Areas	a. typical year b. MSP c. 200-Year Flood	- 1,209 AUM - 1,453 AUM - 2,103 AUM	*I I Conditional I	TBD	I

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

Table IV-17

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 6 (AGENCY PROPOSED ACTION)

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 110 ac - 1,670 ac - 2,660 ac	*SA SA Conditional SA	1,060 ac	I
2. Other Terrestrial Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 11,060 ac - 9,160 ac - 15,120 ac	*SA SA Conditional I	(3,230ac)	I
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	+ 1 mi/no change in flow - 6 mi -12 mi	*I SA Conditional SA	(21 mi)	I
4. Reservoir Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	+ 1,900 ac/+1 Minimum pool +11,260 ac +18,800 ac	*SA SA Conditional SA	Reduce drawdown rates	SB
5. Threatened/Endangered Species (bald eagle) and Yuma clapper rail	a. typical year b. MSP c. 200-Year Flood	- 440 ac - 360 ac/2 Breeding areas - 650 ac/2 Breeding areas	*I AF Conditional AF	370 ac	I
6. Management/Special Use Areas	a. typical year b. MSP c. 200-Year Flood	- 1,039 AUM - 1,004 AUM - 1,654 AUM	*I I Conditional I	TBD	I

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

Table IV-18

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 7

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 120 ac - 1,670 ac - 2,660 ac	*SA SA Conditional SA	640 ac	SA
2. Other Terrestrial Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 13,540 ac - 9,160 ac - 15,120 ac	*SA SA Conditional I	(750ac)	I
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	- 2 mi/200 cfs minimum flow - 6 mi -12 mi	*SB I Conditional SA	(18 mi)	SB
4. Reservoir Aquatic Biotic Communities	a. typical year b. MSP c. 200-Year Flood	+ 3,690 ac/+2 Minimum pools +11,260 ac +18,800 ac	*SA SA Conditional SA	Reduce drawdown rates	BF
5. Threatened/Endangered Species (bald eagle)	a. typical year b. MSP c. 200-Year Flood	- 440 ac/1 Breeding area - 360 ac/2 Breeding areas - 650 ac/2 Breeding areas	*SA AF Conditional AF	280 ac	I
6. Management/Special Use Areas	a. typical year b. MSP c. 200-Year Flood	- 1,272 AUM - 1,004 AUM - 1,654 AUM	*I I Conditional I	TBD	I

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

Table IV-19

BIOLOGICAL RESOURCES NET IMPACT/EFFECT FOR PLAN 9

Factor	Scenario	Cumulative Net Impact	Unmitigated Effect	Mitigation	Mitigated Effect
1. Riparian/Wetland Biotic Communities	a. typical year	- 0 ac	I	120 ac	I
	b. MSP	- 890 ac	SA		
	c. 200-Year Flood	- 1,620 ac	Conditional SA		
2. Other Terrestrial Biotic Communities	a. typical year	- 9,830 ac	*I	(3,230ac)	I
	b. MSP	- 7,950 ac	I		
	c. 200-Year Flood	- 7,950 ac	Conditional I		
3. Perennial Stream/ Riverine Aquatic Biotic Communities	a. typical year	no change in flow	*I	(21 mi)	I
	b. MSP	-1 mi	I		
	c. 200-Year Flood	-5 mi	Conditional SA		
4. Reservoir Aquatic Biotic Communities	a. typical year	+ 1,770 ac/+1 Minimum pool	*SA	Reduce drawdown rates	SB
	b. MSP	+ 8,740 ac	SA		
	c. 200-Year Flood	+12,900 ac	Conditional SA		
5. Threatened/Endangered Species (bald eagle) and Yuma clapper rail	a. typical year	- 170 ac	*I	120 ac	I
	b. MSP	- 100 ac/1 Breeding area	SA		
	c. 200-Year Flood	- 250 ac/1 Breeding area	Conditional AF		
6. Management/Special Use Areas	a. typical year	- 935 AUM	*I	TBD	I
	b. MSP	- 856 AUM	I		
	c. 200-Year Flood	- 1,276 AUM	Conditional I		

* The effects are displayed as adverse flag (AF), significant adverse (SA), insignificant (I), significant beneficial (SB), or beneficial flag (BF). The effect that best represents the impact significance is shown with an asterisk.

For riparian/wetland biotic communities, cumulative net impact is for total riparian; unmitigated and mitigated effects were evaluated for high quality riparian. Mitigation would establish high quality habitat (cottonwood-willow, mesquite and cattail) on the acreages shown, but would not fully compensate project-related losses of such habitat.

2. Water Quality

a. Methodology

A water quality methodology was developed to assess the impacts and effects of each of the candidate plans. This methodology was formulated with the guidance of persons representing agencies concerned with the quality of water in central Arizona. The methodology appears in the Stage III Methodology for Environmental Quality Assessment, Section 3.2.

The methodology identifies changes in water quality brought about by the reservoir mixing of Colorado River and local surface water sources. The analysis presented in the water quality constituents section below uses only water quality data from samples taken by the U.S. Geological Survey and uses weighted averages to estimate "after-mix" constituent levels. A weighted average does not take into account the effects of the reservoir itself or the chemical interactions between various constituents.

The methodology also identifies potential eutrophication problems as significant impacts. Eutrophication potentials were computed for the Confluence and New Waddell Reservoirs where mixing of Colorado River and local surface waters would occur. The computations used the Canfield and Bachman equations described in the USBR Technical Memorandum titled Guidelines for Studies of Potential Eutrophication, 1981.

After the impacts to water quality constituents and eutrophication were assessed, the effect of the impacts was determined. The same group of advisors who provided consultation during the methodology formulation assisted in determining the process for assigning effects levels. The effects evaluation for the water quality constituents analysis examined the amount(s) of water affected by the impact, the magnitude of the impact, whether any applicable water quality criteria were exceeded, and the designated use(s) of the affected water.

b. Types of Impacts to Water Quality

(1) Operational Impacts

The water quality analysis has identified three types of significant operational impacts to water quality in the study area: 1) salt loading impacts, 2) impacts to water quality constituents, and 3) impacts to reservoir eutrophication potential.

(a) Salt Loading

Because of regulatory storage, additional CAP water could be developed and used in the study area. The development of this additional water (the regulatory storage yield) would not increase the salt concentration in the CAP water but would increase the total volume of salts imported (salt loading) to central Arizona. Without regulatory storage, the CAP would import an average of about 1,020,000 tons of salts each year. The salt loading impacts of the plans range from Plan 8, which would not change the salt loading, to Plan 3, which would increase the imported salts by about 16 percent each year.

While the imported salts to the basin will increase, such importation will work to reduce the total application of salts to the land. This is because the increment of additional water will replace ground water, which on the average is of poorer quality than the imported CAP water. Because the ground water quality varies throughout the area, this effect is dependent on the specific relationships of the quality of the ground water and the applied surface water at each point in the service area.

The major salt loading impacts of the CAP occur with the baseline CAP (no regulatory storage). The small increase in imported salts resulting from Plans 1, 2, 3, 6, 7, and 9 is considered insignificant in comparison to the salts imported by the entire CAP system and is therefore not considered in detail in this EIS. For further information see Water Allocations and Water Service Contracting Environmental Impact Statement, USBR 1982.

(b) Water Quality Constituents

Because of regulatory storage, CAP water could be mixed with or substituted for local water sources. The mixing could occur in a reservoir (New Waddell or Confluence) or in the delivery system (CAP water in a local delivery system). As a consequence of mixing, changes would occur in concentrations of various constituents in the local waters and in the CAP water. This is important because much of the natural surface water in the study area is diverted for uses which require good-quality water. It is important to note that if the constituent level of one source of water is increased by mixing, the constituent level of the other source of water will be decreased by mixing.

The current users of natural local waters affected by the plans would experience some water quality impacts. The Salt River Project (SRP) currently diverts Salt and Verde River water at Granite Reef Diversion Dam, and Maricopa County Municipal Water Conservation District #1 (MCMWCD) diverts waters of the Agua Fria River from Lake Pleasant. These waters are delivered to SRP users and MCMWCD user via open canals which are subject to the effects of aeration, temperature changes, detention time, and algal growth before delivery. Other quality effects on this water are the addition of pumped groundwater and chemical or physical effects of any treatment applied by the districts. Some of the CAWCS alternatives involve mixing of water from various sources or upstream exchanges which introduce

Colorado River water into existing delivery systems. For both the future-without and the future with regulatory storage, CAP water will be introduced or exchanged into these district delivery systems. Because the water delivered to the SRP and MCMWCD users undergoes a substantial change during transport, water quality differences with or without regulatory storage may not be detectable by the SRP or MCMWCD users.

For plans which include regulatory storage mixing of Colorado River and local surface water (Plans 3, 6, 7, 9), and have any potential for eutrophication, facilities to ensure that water delivered from the reservoir is adequately aerated during discharge will be provided. Aeration of water released from the reservoir would precipitate any dissolved heavy metals that might occur if eutrophication is present, before the water is delivered to users. The source of these heavy metals, with respect to reservoir operations, would likely be from bottom sediments which may redissolve in an oxygen deficient environment, if and when the reservoir becomes anaerobic.

(c) Eutrophication Potential

Regulatory storage mixing could produce changes in nutrient concentrations and ratios, leading to potential problems of eutrophication in the storage reservoirs or subsequently in the canal delivery system.

(2) Construction Impacts

There could be water quality impacts to existing surface water sources during the construction period of dams included in alternative plans. Except during severe floods, flows in the rivers would be diverted around the construction sites and otherwise controlled by the upstream dams. Potential water quality impacts, in the form of increased turbidity and sedimentation from clearing in the reservoir basin and from borrow areas, would be minimized wherever possible by holding the water in temporary sedimentation basins before release from the reservoir area. Water quality would also be adversely affected by point sources of wastewater, such as aggregate processing, concrete batching, and foundation draining. These small amounts of water would be contained on-site and allowed to evaporate, diposed of off-site, or treated to meet applicable criteria and released to the river channel. Sanitary wastes would have no impacts on water quality, since they would be removed to approved sites for disposal.

All plans (except Plan 8) would have potential for the same types of construction impacts. However, no construction impacts have been identified that could not be mitigated on site.

b. Water Quality Constituents

(1) Direct and Indirect Impacts

Direct impacts to water quality constituents would be the changes in constituent levels which result from the mixing or exchange of CAP and local surface waters. The indirect impacts would be experienced by the subsequent users of the affected CAP or local water.

Impacts to water quality constituents are compared with the future-without conditions in the following sections. Table IV-20 shows state and Federal regulated water contituents.

(a) Plan 8

In the future-without, Colorado River water would be imported to central Arizona by the CAP, but would not be stored in a reservoir. Distribution would occur through conveyance systems connected to the CAP aqueduct. M&I users of Colorado River water near Las Vegas report high levels of trihlomethane (THM) after chlorine disinfection, so normal disinfection of Colorado River water by CAP recipients could also produce high levels of THM.

In Plan 8 there would be no reservoir mixing of Colorado River and local waters prior to delivery. Water quality constituents of surface waters (SRP and MCMWCD#1) would not be affected by this plan. Concentrations of constituents in these waters are presented in the water quality section of Chapter III.

(b) Plan 1

Water quality constituent impacts of this plan would be caused by the direct substitution of Colorado River water for SRP water during the winter months and the introduction of SRP water into the CAP aqueduct during the summer months. It is estimated that only about 70,000 af of water, or 8 percent of the average annual SRP surface water supply, would be exchanged. The impacts to average CAP and SRP water beyond the exchange point and during the exchange period are shown on Table IV-21. During normal operation of the SRP system the Verde River supplies most of the SRP surface water during the proposed exchange period. CAP and Verde River water quality data is shown on Table IV-22 with the information in the last three columns showing the change that would occur during the exchange period.

The impacts of Plan 1 on water quality constituents are considered to be Insignificant because of the small amount of water affected and the fact that adequate notice for the exchange period would enable water users to plan for the different quality of the Colorado River water.

Table IV-20

STATE AND FEDERAL REGULATED WATER CONSTITUENTS
Units: mg/l Unless Noted Otherwise

	Arizona State Maximum Allowable Limits for Untreated Surface Water Protected Uses[a]					Federal and State Drinking Water Regulations for Treated Domestic Water[b]	
Constituents	Domestic Water (DWS)	Recreation Full Body (FBC)	Aquatic and Wildlife (A&W)	Agricultural Irrigation (AgI)	Livestock Watering (AgL)	Primary Maximum Contaminant Level (MCL)	Secondary Maximum Contaminant Level (SMCL)
Ammonia as NH_3	--	--	0.020	--	--	--	--
Arsenic, Diss	0.050	0.050	0.050	--	--	--	--
Arsenic, Total	--	--	--	2.000	0.200	0.050	--
Barium, Diss	1.000	1.000	--	--	--	--	--
Barium, Total	--	--	--	--	--	1.000	--
Boron, Total	--	--	--	1.000	--	--	--
Cadmium, Diss	--	--	0.010	--	--	--	--
Cadmium, Total	0.010	0.010	--	0.050	0.050	0.010	--
Chloride, Total	--	--	--	--	--	--	250.[d]
Chromium, Hexa	0.050	0.050	0.050	--	--	--	--
Chromium, Total	--	--	--	1.000	1.000	0.05	--
Copper, Diss	1.000	--	0.050	--	--	--	--
Copper, Total	--	--	--	5.000	0.500	--	1.[d]
Cyanides	0.200	0.200	0.020	--	0.200	--	--
Oxygen, Diss	--	GT 6.0	GT 6.0	--	--	--	--
Fluoride	--	--	--	--	--	1.4[c]	--
Iron, Total	--	--	--	--	--	--	0.3[d]
Lead, Diss	0.050	0.050	0.050	--	--	--	--
Lead, Total	--	--	--	10.000	0.100	0.05	--
Manganese	--	--	--	10.000	--	--	0.05[d]
Mercury, Total	0.002	0.002	0.002	--	0.010	0.002	--
Nitrate as N	--	--	--	--	--	10.	--
pH (pH Units)	--	6.5-9.0	6.5-9.0	4.5-9.0	6.5-9.0	--	6.5-8.5[d]
Phenolics	0.005	0.005	0.005	--	0.005	--	--
Selenium, Diss	0.010	0.010	--	--	--	--	--
Selenium, Total	--	--	0.050	0.020	0.050	0.01	--
Silver, Diss	0.050	0.050	0.050	--	--	--	--
Silver, Total	--	--	--	--	--	0.05	--
Sulfate	--	--	--	--	--	--	250.[d]
Sulfides	--	--	0.100	--	--	--	--
TDS	--	--	--	--	--	--	500.[d]
Turbidity (NTU)[e]	--	25.	25.	--	--	LT 5.[f]	--
Zinc, Diss	5.000	--	0.500	--	--	--	--
Zinc, Total	--	--	--	10.00	25.00	--	5.[d]

[a]ADHS, Rules and Regulations Title 9, Chapter 21, 1982. The above table does not list allowable limits for temperature alteration, coliform bacteria, organic compounds and radiochemicals. The partial body contact (PBC) protected use is not shown since there are no limits for the constituents listed, except pH.

[b]Code of Federal Regulation 40 CFR 141 and 143, 1980. ADHS, Rules and Regulations Title 9, Chapter 8, 1982. The above table does not list the MCL's for coliform bacteria, organic compounds and radiochemicals. Also not listed are SMCL's for color, corrosity, foaming agents and odor.

[c]Fluoride MCL ranges from 1.4 mg/l to 2.4 mg/l, depending on annual average of maximum daily local air temperatures which is assumed proportional to water intake. Average maximum daily air temperatures for Phoenix (85.1°F) and Tucson (81.5°F) have a MCL of 1.4 mg/l. USNOAA 1980.

[d]Federal SMCL's, the State of Arizona does not yet have any SMCL's (1982).

[e]Nephelometric turbidity units (NTU) are considered comparable to previously reported Formazin (FTU) and Jackson (JTU) turbidity units. Turbidity allowable limits apply to warm water lakes. Allowable limits for streams and cold water fisheries are not listed.

[f]The MCL is 1 NTU. However, 5 or less NTU's may be allowed if it does not cause interference with disinfection, maintenance or microbiological determinations.

Abbreviations: -- = No numeric standard established, GT = greater than, LT = les than, Diss = Dissolved Fraction, Total = Total Recoverable.

TABLE IV-21

WATER QUALITY IMPACTS
PLAN 1

(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a]						Future With Conditions					
		CAP Water[b]			SRP Water[c]			CAP Water[d]			SRP Water[e]		
		Minimum	Average	Maximum	Minimum[f]	Average[g]	Maximum[f]	New Ave.	Change[h]	% Change[h]	New Ave.	Change[h]	% Change[h]
	Alkalinity as $CaCO_3$	98.0	128.	150.	15.0	154.	350.	131.	+ 3.0	+ 2	128.	- 26.0	- 17
D	Arsenic	0.00400	0.00400	0.00400	0.00200	0.00761	0.0180	0.00443	+ 0.00043	+ 11	0.00400	- 0.00361	- 47
T	Arsenic	BDL	0.00284	0.00500	0.00100	0.00792	0.0210	0.00345	+ 0.00061	+ 21	0.00284	- 0.00508	- 64
D	Barium[i]	BDL	BDL	BDL	BDL	0.0676	0.200	--	--	--	BDL	--	--
T	Barium[h]	BDL	0.135	0.500	BDL	0.100	0.200	0.131	- 0.004	- 3	0.135	+ 0.035	+ 35
	Bicarbonate	120.	156.	177.	18.0	193.	427.	160.	+ 4.00	+ 3	156.	- 37.0	- 19
T	Boron	0.0500	0.196	0.360	0.140	0.187	0.230	0.195	- 0.001	- <1	0.196	+ 0.009	+ 5
D	Cadmium	BDL	0.000286	0.00100	BDL	0.00113	0.0140	0.000387	+ 0.000101	+ 35	0.000286	- 0.000844	- 75
T	Cadmium	BDL	0.00462	0.0130	BDL	0.00648	0.0100	0.00484	+ 0.00022	+ 5	0.00462	- 0.00186	- 29
	Calcium	73.0	85.6	100.	19.0	47.0	420.	80.9	- 4.70	- 5	85.6	+ 38.6	+ 82
T	Carbon (organic)	1.90	4.55	14.0	1.80	4.54	18.0	4.55	0	0	4.55	+ 0.01	+< 1
	Carbonate	BDL	0.0288	4.00	BDL	0.879	35.0	0.131	+ 0.102	+ 354	0.0288	- 0.85	- 97
	Chloride	75.0	94.5	140.	2.00	141.	610.	100.	+ 5.5	+ 6	94.5	- 46.5	- 33
	Chromium (Hexa)	0.00100	0.00100	0.00100	--	--	--	--	--	--	0.00100	--	--
T	Chromium	BDL	0.00357	0.0200	BDL	0.00268	0.0100	0.00346	- 0.00011	- 3	0.00357	+ 0.00089	+ 33
D	Copper[i]	BDL	BDL	BDL	BDL	0.00261	0.00700	--	--	--	BDL	--	--
T	Copper	BDL	0.00793	0.0290	BDL	0.00877	0.0200	0.00803	+ 0.00037	+ 5	0.00793	- 0.00084	- 10
T	Cyanide	BDL	0.000862	0.0200	--	--	--	--	--	--	0.000862	--	--
	Oxygen (Dissolved)	5.10	8.53	11.7	1.60	8.76	17.8	8.56	+ 0.03	+ <1	8.53	- 0.23	- 3
	Fecal Coliforms (cols/100 ml)	0.990	4.78	41.9	1.00	16.1	470.	6.14	+ 1.36	+ 28	4.78	- 11.3	- 70
D	Fluoride (84.7°F)	0.200	0.378	0.500	BDL	0.363	1.10	0.376	- 0.002	- <1	0.378	+ 0.015	+ 4
	Hardness (Total, as $CaCO_3$)	290.	339.	380.	79.0	194.	413.	322.	-17.0	- 5	339.	+145.	+ 75
	Hardness (noncarbonate)	170.	211.	243.	BDL	36.3	182.	190.	-21.0	- 10	211.	+175.	+482
T	Iron	0.0300	0.159	0.550	BDL	0.189	3.50	0.163	+ 0.004	+ 3	0.159	- 0.03	- 16
D	Lead	BDL	0.00144	0.00400	BDL	0.00507	0.0600	0.00188	+ 0.00044	+ 31	0.00144	- 0.00363	- 72
T	Lead	BDL	0.0408	0.100	BDL	0.0731	0.100	0.0447	+ 0.0039	+ 10	0.0408	- 0.0323	- 44
	Magnesium	26.0	30.9	40.0	5.50	18.9	55.0	29.5	- 1.40	- 5	30.9	+ 12.0	+ 63
T	Manganese	BDL	0.0208	0.0400	BDL	0.0743	0.380	0.0272	+ 0.0064	+ 31	0.0208	- 0.0535	- 72
T	Mercury	BDL	0.0000431	0.000600	BDL	0.000138	0.00260	0.0000545	+ 0.0000114	+ 26	0.0000431	- 0.0000949	- 69
T	Nitrate (as N)	0.170	0.170	0.170	BDL	0.0720	0.160	0.158	- 0.012	- 7	0.170	+ 0.098	+136
	pH (pH units)	7.10	7.95	8.80	4.50	7.86	9.10	7.94	- 0.01	- <1	7.95	+ 0.09	+ 1
T	Phosphorus (as P)	BDL	0.0258	0.100	BDL	0.216	8.30	0.0486	+ 0.0228	+ 88	0.0258	- 0.19	- 88
	Potassium	4.50	5.21	6.80	1.30	4.78	42.0	5.16	- 0.05	- <1	5.21	+ 0.43	+ 9
D	Selenium	0.00300	0.00300	0.00300	BDL	0.000430	0.00300	0.00269	- 0.000308	- 10	0.00300	+ 0.00257	+598
T	Selenium	BDL	0.00279	0.00500	BDL	0.000410	0.00200	0.00250	- 0.00029	- 10	0.00279	+ 0.00238	+580
	Specific Cond. (uß/cm)	950.	1120.	1720.	150.	869.	2340.	1090.	-30.0	- 3	1120.	+251.	+ 29
D	Silver[i]	BDL	BDL	BDL	BDL	BDL	BDL	--	--	--	BDL	--	--
T	Silver	BDL	0.00350	0.0100	BDL	0.000975	0.0100	0.00320	- 0.0003	- 9	0.00350	+ 0.00253	+259
	Sodium	90.0	107.	120.	4.20	105.	382.	107.	0	0	107.	+ 2.0	+ 2
	Sodium Adsorption Ratio (no units)	2.20	2.54	2.88	0.210	3.30	10.4	2.63	+ 0.09	+ 4	2.54	- 0.76	- 23
	Sulfate	240.	309.	380.	11.0	52.0	360.	278.	-31.0	- 10	309.	+257.	+494
	Dissolved solids (180°C)	602.	722.	848.	109.	497.	1300.	695.	-27.0	- 4	722.	+225.	+ 45
	Turbidity (JTU)	1.00	2.58	10.0	1.00	37.5	2800.	6.77	+ 4.19	+ 162	2.58	- 35.	- 93
D	Zinc	BDL	0.00889	0.0200	BDL	0.0121	0.120	0.00928	+ 0.00039	+ 4	0.00889	- 0.00321	- 27
T	Zinc	BDL	0.0239	0.310	0.0100	0.0342	0.200	0.0251	+ 0.0012	+ 5	0.0239	- 0.0103	- 30
	Phenolics	BDL	0.00127	0.00700	--	--	--	--	--	--	0.00127	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL = Below Detection Level

a Levels shown rounded to three significant figures.
b Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record October 1968 - June 1981.
c Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record December 1950 - September 1979.
d In CAP aqueduct after impacts of water exchange with SRP.
e At Granite Reef Diversion Dam. During exchange period, SRP water would be the same as CAP water.
f Minimum and maximum values are for the Salt or Verde Rivers and could be experienced only if one river was flowing.
g Weighted average based on STORET data and USGS flow records resulting in a 43 percent Verde River and 57 percent Salt River mix at the confluence of the two rivers.
h Changes are relative to future without average values.
i Constituents with "below detection level" future without average values could not be used to calculate future with values.

TABLE IV-22

WATER QUALITY IMPACTS
PLAN 1
(Special Case)
(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a]						Future With Conditions		
		CAP Water[b]			Verde River Water[c]			SRP Water[d]		
		Minimum	Average	Maximum	Minimum	Average	Maximum	New Ave.	Change[e]	% Change[e]
	Alkalinity as $CaCO_3$	98.0	128.	150.	28.0	185.	350.	128.	- 57.0	- 31
D	Arsenic	0.00400	0.00400	0.00400	0.00500	0.0121	0.0180	0.00400	- 0.0081	- 67
T	Arsenic	BDL	0.00284	0.00500	0.00700	0.0133	0.0210	0.00284	- 0.0105	- 79
D	Barium[f]	BDL	BDL	BDL	BDL	0.0550	0.100	BDL	--	--
T	Barium	BDL	0.135	0.500	BDL	0.100	0.200	0.135	+ 0.035	+ 35
	Bicarbonate	120.	156.	177.	34.0	236.	427.	156.	- 80.0	- 34
T	Boron	0.0500	0.196	0.360	0.190	0.190	0.190	0.196	+ 0.006	+ 3
D	Cadmium	BDL	0.000286	0.00100	BDL	0.00156	0.0140	0.000286	- 0.00127	- 81
T	Cadmium	BDL	0.00462	0.0130	BDL	0.00619	0.0100	0.00462	- 0.00157	- 25
	Calcium	73.0	85.6	100.	19.0	42.5	75.0	85.6	+ 43.1	+ 101
T	Carbon (Organic)	1.90	4.55	14.0	1.80	4.20	9.60	4.55	+ 0.35	+ 8
	Carbonate	BDL	0.0288	4.00	BDL	1.57	15.0	0.0288	- 1.54	- 98
	Chloride	75.0	94.5	140.0	2.00	18.8	130.	94.5	75.7	+ 403
	Chromium (Hexa)	0.00100	0.00100	0.00100	--	--	--	0.00100	--	--
T	Chromium	BDL	0.00357	0.0200	BDL	0.00375	0.0100	0.00357	- 0.00018	- 5
D	Copper[f]	BDL	BDL	BDL	BDL	0.00275	0.00700	BDL	--	--
T	Copper	BDL	0.00793	0.0290	0.00300	0.00888	0.0200	0.00793	- 0.00095	- 11
T	Cyanide	BDL	0.000862	0.0200	--	--	--	0.000862	--	--
	Oxygen (Dissolved)	5.10	8.53	11.7	8.60	11.6	17.8	8.53	- 3.07	- 26
	Fecal Coliforms (cols/100 ml)	0.990	4.78	41.9	1.00	8.35	99.0	4.78	- 3.57	- 43
D	Fluoride (84.7°F)	0.200	0.378	0.500	BDL	0.340	0.800	0.378	+ 0.038	+ 11
	Hardness (Total, as $CaCO_3$)	290.	339.	380.	79.0	212.	413.	339.	+127.	+ 60
	Hardness (noncarbonate)	170.	211.	243.	BDL	18.9	182.	211.	+192.	+1016
T	Iron	0.0300	0.159	0.550	BDL	0.192	3.50	0.159	- 0.033	- 17
D	Lead	BDL	0.00144	0.00400	BDL	0.00300	0.0120	0.00144	- 0.00156	- 52
T	Lead	BDL	0.0408	0.100	0.00400	0.0714	0.100	0.0408	- 0.0306	- 43
	Magnesium	26.0	30.9	40.0	6.40	25.7	55.0	30.9	+ 5.2	+ 20
T	Manganese	BDL	0.0208	0.0400	BDL	0.0900	0.380	0.0208	- 0.0692	- 77
T	Mercury[f]	BDL	0.0000431	0.000600	BDL	0.000263	0.00260	0.0000431	- 0.00022	- 84
T	Nitrate (as N)	0.170	0.170	0.170	0.0200	0.0967	0.140	0.170	+ 0.0733	+ 76
	pH (pH units)	7.10	7.95	8.80	6.80	8.01	8.80	7.95	- 0.06	- <1
T	Phosphorus (as P)	BDL	0.0258	0.100	BDL	0.206	0.400	0.0258	- 0.18	- 87
	Potassium	4.50	5.21	6.80	1.30	3.39	7.40	5.21	+ 1.82	+ 54
D	Selenium	0.00300	0.00300	0.00300	BDL	0.000750	0.00300	0.00300	+ 0.00225	+ 300
T	Selenium	BDL	0.00279	0.00500	BDL	0.000600	0.00100	0.00279	+ 0.00219	+ 365
	Specific Cond. (µ℧/cm)	950.	1120.	1720.	150.	510.	929.	1120.	+610.	+ 120
D	Silver[f]	BDL	BDL	BDL	BDL	BDL	BDL	BDL	--	--
T	Silver[f]	BDL	0.00350	0.0100	BDL	BDL	BDL	0.00350	--	--
	Sodium	90.0	107.	120.	4.20	30.4	290.	107.	+ 76.6	+ 252
	Sodium Adsorption Ratio (no units)	2.20	2.54	2.88	0.210	0.880	8.21	2.54	+ 1.66	+ 189
	Sulfate	240.	309.	380.	11.0	52.9	107.	309.	+256.	+ 484
	Dissolved solids (180°C)	602.	722.	848.	109.	314.	550.	722.	+408.	+ 130
	Turbidity (JTU)	1.00	2.58	10.0	1.00	83.3	2800.	2.58	- 80.7	- 97
D	Zinc	BDL	0.00889	0.0200	BDL	0.00700	0.0300	0.00889	+ 0.00189	+ 27
T	Zinc	BDL	0.0239	0.310	0.0100	0.0356	0.200	0.0239	- 0.0117	- 33
	Phenolics	BDL	0.00127	0.00700	--	--	--	0.00127	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL = Below Detection Level

a Levels shown rounded to three significant figures.
b Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record October 1968 - June 1981.
c Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record December 1950 - September 1979.
d At Granite Reef Diversion Dam. During the exchange period, SRP water would be the same as CAP water.
e Changes are relative to future without average values.
f Constituents with "below detection level" future without average values could not be used to calculate future with values.

(c) Plan 2

There would be no regulatory storage of Colorado River water associated with this plan. The resulting water quality impacts would be associated only with changes in detained flood waters and in flood flows. In general this plan would provide for flood flows over a longer period at smaller flow rates. There would be no impacts to water quality constituents associated with this plan.

(d) Plan 3

Water quality constituent impacts during the operation of this plan would primarily be caused by the mixing of Colorado River water with local surface water at the Confluence sites. The impacts to both the average CAP and SRP surface water supplies are shown in Table IV-23. A special impact assessment showing impacts to SRP water during the period when operations would deliver only Verde River water is shown in Table IV-24.

The impacts of Plan 3 on water quality constituents are considered to be Significant Adverse because of the large amount of SRP water affected and the large percentage of the SRP water which is normally treated for municipal and industrial use.

(e) Plans 6, 7, and 9

Water quality constituent impacts of these plans would be caused by the regulatory storage mixing of CAP Colorado River water with MCMWCD#1 Agua Fria River water at the New Waddell site and by the addition of SRP water to the CAP aqueduct near Granite Reef Diversion Dam. Plans 6, 7, and 9 would have the same impacts to water quality constituents since both plans use the same operation at the New Waddell and Granite Reef sites. SRP water quality would not be affected by either plan. The impacts of regulatory storage to both the average CAP and MCMWCD#1 surface water supplies are shown on Table IV-25. The additional impacts to average CAP water which result from adding SRP water near the Granite Reef site are shown on Table IV-26.

Table IV-25 shows that several MCMWCD#1 constituents undergo noticeable increases as a result of mixing with Colorado River water. The magnitude of these increases is determined by the relative volumes of water in the MCMWCD#1 and CAP pools during normal operations. During the period from 1928 to 1980, MCMWCD#1 delivered to its users about 66,000 af of water each year. However only 25,000 af, or about 41 percent, of this was surface water from Lake Pleasant (MCMWCD#1, Unpublished Data, 1981). This average annual surface water yield is relatively small when compared to the estimated 660,000 af of CAP water to be stored in New Waddell Reservoir; even though there are likely to be significant changes in constituents levels of MCMWCD#1 water, the amount of water affected each year is relatively small. Since the MCMWCD#1 water is not used as a source of domestic water, only the State of Arizona criteria for full body contact, aquatic and wildlife uses, agricultural irrigation, and livestock watering apply to the MCMWCD#1 water at the New Waddell site. None of these criteria will be exceeded as a result of

TABLE IV- 23

WATER QUALITY IMPACTS
PLAN 3
(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a]						Future With Conditions					
		CAP Water[b]			SRP Water[c]			CAP Water[d]			SRP Water[e]		
		Minimum	Average	Maximum	Minimum[f]	Average[g]	Maximum[f]	New Ave.	Change[h]	% Change[h]	New Ave.	Change[h]	% Change[h]
	Alkalinity as $CaCO_3$	98.0	128.	150.	15.0	154.	350.	133.	+ 5.0	+ 4	147.	- 7.0	- 5
D	Arsenic	0.00400	0.00400	0.00400	0.00200	0.00761	0.0180	0.00471	+ 0.00071	+ 18	0.00664	- 0.00097	- 13
T	Arsenic	BDL	0.00284	0.00500	0.00100	0.00792	0.0210	0.00384	+ 0.001	+ 35	0.00656	- 0.00136	- 17
D	Barium[i]	BDL	BDL	BDL	BDL	0.0676	0.200	--	--	--	--	--	--
T	Barium	BDL	0.135	0.500	BDL	0.100	0.200	0.128	- 0.007	- 5	0.109	+ 0.009	+ 9
	Bicarbonate	120.	156.	177.	18.0	193.	427.	163.	+ 7.0	+ 4	183.	- 10.0	- 5
T	Boron	0.0500	0.196	0.360	0.140	0.187	0.230	0.194	- 0.002	- 1	0.189	+ 0.002	+ 1
D	Cadmium	BDL	0.000286	0.00100	BDL	0.00113	0.0140	0.000451	+ 0.000165	+ 58	0.000904	- 0.000226	- 20
T	Cadmium	BDL	0.00462	0.0130	BDL	0.00648	0.0100	0.00498	+ 0.00036	+ 8	0.00598	- 0.0005	- 8
	Calcium	73.0	85.6	100.	19.0	47.0	420.	78.0	- 7.6	- 9	57.3	+ 10.3	+ 22
T	Carbon (Organic)	1.90	4.55	14.0	1.80	4.54	18.0	4.55	0	0	4.54	0	0
	Carbonate	BDL	0.0288	4.00	BDL	0.879	35.0	0.195	+ 0.166	+576	0.651	- 0.228	- 26
	Chloride	75.0	94.5	140.	2.00	141.	610.	104.	+ 9.5	+ 10	129.	- 12.0	- 9
	Chromium (Hexa)	0.00100	0.00100	0.00100	--	--	--	--	--	--	--	--	--
T	Chromium	BDL	0.00357	0.0200	BDL	0.00268	0.0100	0.00340	- 0.00017	- 5	0.00292	+ 0.00024	+ 9
D	Copper[i]	BDL	BDL	BDL	BDL	0.00261	0.00700	--	--	--	--	--	--
T	Copper	BDL	0.00793	0.0290	BDL	0.00877	0.0200	0.00809	+ 0.00097	+ 12	0.00854	- 0.00023	- 3
T	Cyanide	BDL	0.000862	0.0200	--	--	--	--	--	--	--	--	--
	Oxygen (Dissolved)	5.10	8.53	11.7	1.60	8.76	17.8	8.58	+ 0.05	+ <1	8.70	- 0.06	- <1
	Fecal Coliforms (cols/100 ml)	0.990	4.78	41.9	1.00	16.1	470.	7.00	+ 2.22	+ 46	13.1	- 3.0	- 19
D	Fluoride (84.7°F)	0.200	0.378	0.500	BDL	0.363	1.10	0.375	- 0.003	- <1	0.367	+ 0.004	+ 1
	Hardness (Total, as $CaCO_3$)	290.	339.	380.	79.0	194.	413.	311.	-28.0	- 8	233.	+ 39.0	+ 20
	Hardness (noncarbonate)	170.	211.	243.	BDL	36.3	182.	177.	-34.0	- 16	83.1	+ 46.8	+129
T	Iron	0.0300	0.159	0.550	BDL	0.189	3.50	0.165	+ 0.006	+ 4	0.181	- 0.008	- 4
D	Lead	BDL	0.00144	0.00400	BDL	0.00507	0.0600	0.00215	+ 0.00071	+ 49	0.00410	- 0.00097	- 19
T	Lead	BDL	0.0408	0.100	BDL	0.0731	0.100	0.0471	+ 0.0063	+ 15	0.0644	- 0.0087	-119
	Magnesium	26.0	30.9	40.0	5.50	18.9	55.0	28.5	- 2.4	- 8	22.1	+ 3.20	+ 17
T	Manganese	BDL	0.0208	0.0400	BDL	0.0743	0.380	0.0313	+ 0.0105	+ 50	0.0600	- 0.0143	- 19
T	Mercury	BDL	0.0000431	0.000600	BDL	0.000138	0.00260	0.0000617	+ 0.0000186	+ 43	0.000113	- 0.000025	-181
T	Nitrate (as N)	0.170	0.170	0.170	BDL	0.0720	0.160	0.151	- 0.019	- 11	0.0983	+ 0.0263	+ 37
	pH (pH units)	7.10	7.95	8.80	4.50	7.86	9.10	7.93	- 0.02	- <1	7.88	+ 0.02	+ <1
T	Phosphorus (as P)	BDL	0.0258	0.100	BDL	0.216	8.300	0.0631	+ 0.0373	+145	0.165	- 0.051	- 24
	Potassium	4.50	5.21	6.80	1.30	4.78	42.0	5.13	- 0.08	- 2	4.90	+ 0.12	+ 3
D	Selenium	0.00300	0.00300	0.00300	BDL	0.000430	0.00300	0.00250	- 0.0005	- 17	0.00112	+ 0.00069	+160
T	Selenium	BDL	0.00279	0.00500	BDL	0.000410	0.00200	0.00232	- 0.00047	- 17	0.00105	+ 0.00064	+156
	Specific Cond. (µs/cm)	950.	1120.	1720.	150.	869.	2340.	1070.	-50.0	- 4	936.	+ 67.0	+ 8
D	Silver[i]	BDL	BDL	BDL	BDL	BDL	BDL	--	--	--	--	--	--
T	Silver	BDL	0.00350	0.0100	BDL	0.000975	0.0100	0.00301	- 0.00049	- 14	0.00165	+ 0.000675	+ 69
	Sodium	90.0	107.	120.	4.20	105.	382.	107.	0	0	106.	+ 1.0	+ <1
	Sodium Adsorption Ratio (no units)	2.20	2.54	2.88	0.210	3.30	10.4	2.69	+ 0.15	+ 6	3.10	- 0.2	- 6
	Sulfate	240.	309.	380.	11.0	52.0	360.	259.	-50.0	- 16	121.	+ 69.0	+133
	Dissolved Solids (180°C)	602.	722.	848.	109.	497.	1300.	678.	-44.1	- 6	557.	+ 60.0	+ 12
	Turbidity (JTU)	1.00	2.58	10.0	1.00	37.5	2800.	9.42	+ 6.84	+265	28.18	- 9.40	- 25
D	Zinc	BDL	0.00889	0.0200	BDL	0.0121	0.120	0.00952	+ 0.00063	+ 7	0.0112	- 0.0009	- 7
T	Zinc	BDL	0.0239	0.310	0.0100	0.0342	0.200	0.0259	+ 0.002	+ 8	0.0314	- 0.0028	- 8
	Phenolics	BDL	0.00127	0.00700	--	--	--	--	--	--	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL = Below Detection Level

a Levels shown rounded to three significant figures.
b Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record October 1968 - June 1981.
c Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record December 1950 - September 1979.
d In CAP aqueduct after regulatory storage mixing. CAP deliveries before Granite Reef would not be affected by impacts at the Confluence Reservoir.
e At Granite Reef Diversion Dam.
f Minimum and maximum values are for the Salt or Verde Rivers and could be experienced only if one river was flowing.
g Weighted average based on STORET data and USGS flow records resulting in a 43 percent Verde River and 57 percent Salt River mix at the confluence of the two rivers.
h Changes are relative to future without average values.
i Constituents with "below detection level" future without average values could not be used to calculate future with values.

TABLE IV-24

WATER QUALITY IMPACTS
PLAN 3
(Special Case)
(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a] CAP Water[b] Minimum	Average	Maximum	Verde River Water[c] Minimum	Average	Maximum	Future With Conditions SRP Water[d] New Ave.	Change[e]	% Change[e]
	Alkalinity as $CaCO_3$	98.0	128.	150.	28.0	185.	350.	160.	- 25.0	- 14
D	Arsenic	0.00400	0.00400	0.00400	0.00500	0.0121	0.0180	0.00855	- 0.00355	- 29
T	Arsenic	BDL	0.00284	0.00500	0.00700	0.0133	0.0210	0.00872	- 0.00458	- 34
D	Barium[f]	BDL	BDL	BDL	BDL	0.0550	0.100	--	--	--
T	Barium	BDL	0.135	0.500	BDL	0.100	0.200	0.115	+ 0.015	+ 15
	Bicarbonate	120.	156.	177.	34.0	236.	427.	201.	- 35.0	- 15
T	Boron	0.0500	0.196	0.360	0.190	0.190	0.190	0.193	+ 0.003	+ 2
D	Cadmium	BDL	0.000286	0.00100	BDL	0.00156	0.0140	0.00100	- 0.00056	- 36
T	Cadmium	BDL	0.00462	0.0130	BDL	0.00619	0.0100	0.00550	- 0.00069	- 11
	Calcium	73.0	85.6	100.	19.0	42.5	75.0	61.4	+ 18.9	+ 44
T	Carbon (Organic)	1.90	4.55	14.0	1.80	4.20	9.60	4.35	+ 0.15	+ 4
	Carbonate	BDL	0.0288	4.00	BDL	1.57	15.0	0.895	- 0.675	- 43
	Chloride	75.0	94.5	140.	2.00	18.8	130.	51.9	+ 33.1	+176
	Chromium (Hexa)	0.00100	0.00100	0.00100	--	--	--	--	--	--
T	Chromium	BDL	0.00357	0.0200	BDL	0.00375	0.0100	0.00367	- 0.00008	- 2
D	Copper[f]	BDL	BDL	BDL	BDL	0.00275	0.00700	--	--	--
T	Copper	BDL	0.00793	0.0290	0.00300	0.00888	0.0200	0.00846	- 0.00042	- 5
T	Cyanide	BDL	0.000862	0.0200	--	--	--	--	--	--
	Oxygen (Dissolved)	5.10	8.53	11.7	8.60	11.6	17.8	10.3	- 1.3	- 11
	Fecal Coliforms (cols/100 ml)	0.990	4.78	41.9	1.00	8.35	99.0	6.79	- 1.56	- 19
D	Fluoride (84.7°F)	0.200	0.378	0.500	BDL	0.340	0.800	0.357	+ 0.017	+ 5
	Hardness (Total, as $CaCO_3$)	290.	339.	380.	79.0	212.	413.	268.	+ 56	+ 26
	Hardness (noncarbonate)	170.	211.	243.	BDL	18.9	182.	103.	+ 84.1	+445
T	Iron	0.0300	0.159	0.550	BDL	0.192	3.50	0.178	- 0.014	- 7
D	Lead	BDL	0.00144	0.00400	BDL	0.00300	0.0120	0.00232	- 0.00068	- 23
T	Lead	BDL	0.0408	0.100	0.00400	0.0714	0.100	0.0580	- 0.0134	- 19
	Magnesium	26.0	30.9	40.0	6.40	25.7	55.0	27.9	+ 2.20	+ 9
T	Manganese	BDL	0.0208	0.0400	BDL	0.0900	0.380	0.0597	- 0.303	- 34
T	Mercury	BDL	0.0000431	0.000600	BDL	0.000263	0.00260	0.000167	- 0.000096	- 37
T	Nitrate (as N)	0.170	0.170	0.170	0.0200	0.0967	0.140	0.129	+ 0.323	+ 33
	pH (pH units)	7.10	7.95	8.80	6.80	8.01	8.80	7.98	- 0.03	- <1
T	Phosphorus (as P)	BDL	0.0258	0.100	BDL	0.206	0.400	0.127	- 0.079	- 38
	Potassium	4.50	5.21	6.80	1.30	3.39	7.40	4.19	+ 0.8	+ 24
D	Selenium	0.00300	0.00300	0.00300	BDL	0.000750	0.00300	0.00174	+ 0.00099	+132
T	Selenium	BDL	0.00279	0.00500	BDL	0.000600	0.00100	0.00156	+ 0.00096	+160
	Specific Cond. (µ℧/cm)	950.	1120.	1720.	150.	510.	929.	777.	+267.	+ 52
D	Silver[f]	BDL	BDL	BDL	BDL	BDL	BDL	--	--	--
T	Silver[f]	BDL	0.00350	0.0100	BDL	BDL	BDL	--	--	--
	Sodium	90.0	107.	120.	4.20	30.4	290.	64.0	+ 33.6	+111
	Sodium Adsorption Ratio (no units)	2.20	2.54	2.88	0.210	0.880	8.21	1.61	+ 0.73	+ 83
	Sulfate	240.	309.	380.	11.0	52.9	107.	165.	+112.	+212
	Dissolved solids (180°C)	602.	722.	848.	109.	314.	550.	493.	+179.	+ 57
	Turbidity (JTU)	1.00	2.58	10.0	1.00	83.3	2800.	47.9	- 35.4	- 42
D	Zinc	BDL	0.00889	0.0200	BDL	0.00700	0.0300	0.00783	+ 0.00083	+ 12
T	Zinc	BDL	0.0239	0.310	0.0100	0.0356	0.200	0.0305	- 0.0051	- 14
	Phenolics	BDL	0.00127	0.00700	--	--	--	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL - Below Detection Level

a Levels shown rounded to three significant figures.
b Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record October 1968 - June 1981.
c Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record December 1950 - September 1979.
d At Granite Reef Diversion Dam.
e Changes are relative to future without average values.
f Constituents with "below detection level" future without average values could not be used to calculate future with values.

TABLE IV-25

WATER QUALITY IMPACTS
PLANS 6, 7, AND 9 - IMPACTS FROM REGULATORY STORAGE AT WADDELL
(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a]						Future With Conditions					
		CAP Water[b]			MCMWCD#1 Water[c]			CAP Aqueduct Water[d]			MCMWCD#1 Water[e]		
		Minimum	Average	Maximum	Minimum	Average	Maximum	New Ave.	Change[f]	% Change[f]	New Ave.	Change[f]	% Change[f]
	Alkalinity as $CaCO_3$	98.0	128.	150.	140.	175.	190.	129.	+ 1.0	+ <1	130.	- 45.0	- 26
D	Arsenic[g]	0.00400	0.00400	0.00400	0.00900	0.0100	0.0110	0.00414	+ 0.00014	+ 4	0.00420	- 0.0058	- 58
T	Arsenic	BDL	0.00284	0.00500	0.00900	0.0133	0.0160	0.00309	+ 0.00025	+ 9	0.00320	- 0.0101	- 76
D	Barium[gh]	BDL	BDL	BDL	0.0650	0.0730	0.0810	--	--	--	--	--	--
T	Barium[h]	BDL	0.135	0.500	<0.100	<0.100	0.100	0.134	- 0.001	- <1	0.134	+ 0.034	+ 34
	Bicarbonate	120.	156.	177.	--	--	--	--	--	--	--	--	--
T	Boron	0.0500	0.196	0.360	0.0900	0.165	0.230	0.195	- 0.001	- <1	0.195	+ 0.03	+ 18
D	Cadmium[gh]	BDL	0.000286	0.00100	<0.00300	<0.00300	<0.00300	0.000351	+ 0.000065	+ 23	0.000378	- 0.00262	- 87
T	Cadmium[h]	BDL	0.00462	0.0130	<0.00100	<0.00150	0.00200	0.00455	- 0.00007	- 2	0.00451	+ 0.00301	+201
	Calcium	73.0	85.6	100.	39.0	50.8	58.0	84.8	- 0.8	- <1	84.4	+ 33.6	+ 66
T	Carbon (Organic)	1.90	4.55	14.0	2.50	4.10	5.20	4.54	- 0.01	- <1	4.53	+ 0.43	+ 10
	Carbonate	BDL	0.0288	4.00	--	--	--	--	--	--	--	--	--
	Chloride	75.0	94.5	140.	32.0	36.0	40.0	93.1	- 1.4	- 1	92.5	+ 56.5	+157
	Chromium (Hexa)	0.00100	0.00100	0.00100	--	--	--	--	--	--	--	--	--
T	Chromium	BDL	0.00357	0.0200	0.00300	0.00725	0.0190	0.00366	+ 0.00009	+ 3	0.00370	- 0.00355	- 49
D	Copper[gh]	BDL	BDL	BDL	0.00700	0.00750	0.00800	--	--	--	--	--	--
T	Copper	BDL	0.00793	0.0290	0.00700	0.0138	0.0290	0.00807	+ 0.00014	+ 2	0.00813	- 0.00567	- 41
T	Cyanide[h]	BDL	0.000862	0.0200	<0.0100	<0.0100	<0.0100	0.00108	+ 0.000218	+ 25	0.00117	- 0.00883	- 88
	Oxygen (Dissolved)	5.10	8.53	11.7	8.60	8.88	9.10	8.54	+ 0.01	+ <1	8.54	- 0.34	- 4
	Fecal Coliforms (cols/100 ml)	0.990	4.78	41.9	4.00	36.3	120.	5.54	+ 0.76	+ 16	5.85	- 30.4	- 88
D	Fluoride (84.7°F)	0.200	0.378	0.500	0.300	0.325	0.400	0.377	- 0.001	- <1	0.376	+ 0.051	+ 16
	Hardness (Total, as $CaCO_3$)	290.	339.	380.	160.	215.	240.	336.	- 3.0	- <1	335.	+120.	+ 56
	Hardness (noncarbonate)	170.	211.	243.	23.0	41.3	54.0	207.	- 4.0	- 2	205.	+164.	+397
T	Iron	0.0300	0.159	0.550	0.0600	2.04	6.40	0.204	+ 0.045	+ 28	0.223	- 1.82	- 89
D	Lead[g]	BDL	0.00144	0.00400	0.00200	0.00200	0.00200	0.00145	+ 0.00001	+ <1	0.00146	- 0.00054	- 27
T	Lead	BDL	0.0408	0.100	0.00100	0.00425	0.00800	0.0399	- 0.0009	- 2	0.0396	+ 0.0354	+832
	Magnesium	26.0	30.9	40.0	16.0	21.8	25.0	30.7	- 0.2	- <1	30.6	+ 8.8	+ 40
T	Manganese	BDL	0.0208	0.0400	0.0100	0.0850	0.270	0.0223	+ 0.0015	+ 7	0.0230	- 0.062	- 73
T	Mercury[gh]	BDL	0.0000431	0.000600	<0.000100	<0.000100	<0.000100	0.0000445	+ 0.0000014	+ 3	0.0000450	- 0.000055	- 55
T	Nitrate (as N)	0.170	0.170	0.170	3.20	3.85	4.50	0.258	+ 0.088	+ 52	0.295	- 3.56	- 92
	pH (pH units)	7.10	7.95	8.80	8.30	8.43	8.60	7.96	+ 0.01	+ <1	7.97	- 0.46	- 5
T	Phosphorus (as P)	BDL	0.0258	0.100	0.0900	0.150	0.180	0.0288	+ 0.003	+ 12	0.0300	- 0.12	- 80
	Potassium	4.50	5.21	6.80	1.60	1.98	2.30	5.13	- 0.08	- 2	5.10	+ 3.12	+158
D	Selenium[gh]	0.00300	0.00300	0.00300	<0.00100	<0.00100	<0.00100	0.00295	- 0.00005	- 2	0.00293	+ 0.00193	+193
T	Selenium[h]	BDL	0.00279	0.00500	<0.00100	<0.00100	0.00100	0.00275	- 0.00004	- 2	0.00273	+ 0.00173	+173
	Specific Cond. (µU/cm)	950.	1120.	1720.	420.	582.	676.	1110.	-10.0	- <1	1100.	+518.	+ 89
D	Silver[gh]	BDL	BDL	BDL	<0.00100	<0.00100	<0.00100	--	--	--	--	--	--
T	Silver[h]	BDL	0.00350	0.0100	<0.00100	<0.00100	<0.00100	0.00344	- 0.00006	- 2	0.00342	+ 0.00242	+242
	Sodium	90.0	107.	120.	25.0	37.8	45.0	105.	- 2.0	- 2	105.	+ 67.2	+178
	Sodium Adsorption Ratio (no units)	2.20	2.54	2.88	0.900	1.20	1.40	2.51	- 0.03	- 1	2.49	+ 1.29	+108
	Sulfate	240.	309.	380.	53.0	85.0	100.	304.	- 5.0	- 2	301.	+216.	+254
	Dissolved Solids (180°C)	602.	722.	848.	257.	358.	401.	713.	- 9.0	- 1	710.	+352.	+ 98
	Turbidity (JTU)[i]	1.00	2.58	10.0	0.600	31.6	110.	--	--	--	--	--	--
D	Zinc[gh]	BDL	0.00889	0.0200	<0.0120	<0.0120	<0.0120	0.00896	+ 0.00007	+ <1	0.00900	- 0.003	- 25
T	Zinc	BDL	0.0239	0.310	0.0200	0.0325	0.0600	0.0241	+ 0.0002	+ <1	0.0242	- 0.0083	- 26
	Phenolics	BDL	0.00127	0.00700	--	--	--	--	--	--	--	--	--

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL = Below Detection Level

a Levels shown rounded to three significant figures.
b Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record October 1968 - June 1981.
c U.S. Geological Survey from U.S. Bureau of Reclamation, 1982; period of record January-April 1982.
d In CAP aqueduct after regulatory storage mixing at Waddell site. CAP deliveries before the Waddell site would not be affected by impacts at the Waddell site.
e At Lower Lake Pleasant.
f Changes are relative to future without average values.
g MCMWCD#1 samples for these constituents taken from below Lake Pleasant.
h These constituents show "below detection level " or "less than" average values. The future with conditions assumed the less than values to be representative. As a result, the change and % change may show exaggerated or wrong direction changes. Constituents with below detection level future without average values could not be used to calculate future with values.
i MCMWCD#1 turbidity is in NTU.

TABLE IV-26

WATER QUALITY IMPACTS
PLANS 6, 7 AND 9
IMPACTS FROM ADDITION OF SRP WATER
(mg/l unless otherwise noted)

	Water Quality Constituent	Future Without Conditions[a]						Future With Conditions					
		CAP Aqueduct Water[ab]			SRP Water[ac]			CAP Water[d]			SRP Water		
		Minimum	Average	Maximum	Minimum[e]	Average[f]	Maximum[e]	New Ave.	Change[g]	% Change[g]	New Ave.	Change	% Change
	Alkalinity as $CaCO_3$	98.0	129.	190.	15.0	154.	350.	131.	+ 3.00	+ 2			
D	Arsenic	0.004	0.00414	0.0110	0.00200	0.00761	0.0180	0.00441	+ 0.00041	+ 10			
T	Arsenic	BDL	0.00309	0.0160	0.00100	0.00792	0.0210	0.00347	+ 0.00063	+ 22			
D	Barium	BDL	—	0.0810	BDL	0.0676	0.200	—	—	—			
T	Barium[h]	BDL	0.134	0.500	BDL	0.100	0.200	0.131	- 0.004	- 3			
	Bicarbonate	—	—	—	18.0	193.	427.	—	—	—			
T	Boron	0.0500	0.195	0.360	0.140	0.187	0.230	0.194	- 0.002	- 1			
D	Cadmium[h]	BDL	0.000351	<0.00300	BDL	0.00113	0.0140	0.000412	+ 0.000126	+ 44			
T	Cadmium[h]	BDL	0.00455	0.0130	BDL	0.00648	0.0100	0.00470	+ 0.00008	+ 2			
	Calcium	39.0	84.8	100.	19.0	47.0	420.	81.9	- 3.7	- 4			
T	Carbon (Organic)	1.90	4.54	14.0	1.80	4.54	18.0	4.54	- 0.01	- <1			
	Carbonate	BDL	—	—	BDL	0.879	35.0	—	—	—			
	Chloride	32.0	93.1	140.	2.00	141.	610.	96.8	+ 2.30	+ 2			
	Chromium (Hexa)	—	—	—	—	—	—	—	—	—			
T	Chromium	BDL	0.00366	0.0200	BDL	0.00268	0.0100	0.00358	+ 0.00001	+ <1			
D	Copper	BDL	—	0.00800	BDL	0.00261	0.00700	—	—	—			
T	Copper	BDL	0.00807	0.0290	BDL	0.00877	0.0200	0.00812	+ 0.00019	+ 2			
T	Cyanide	BDL	0.00108	0.0200	—	—	—	—	—	—			
	Oxygen (Dissolved)	5.10	8.54	11.7	1.60	8.76	17.8	8.56	+ 0.03	+ <1			
	Fecal Coliforms (cols/100 ml)	0.990	5.54	120.	1.00	16.1	470.	6.36	+ 1.58	+ 33			
D	Fluoride (84.7°F)	0.200	0.377	0.500	BDL	0.363	1.10	0.376	- 0.002	- <1			
	Hardness (Total, as $CaCO_3$)	160.	336.	380.	79.0	194.	413.	325.	-14.0	- 4			
	Hardness (noncarbonate)	23.0	207.	243.	BDL	36.3	182.	194.	-17.0	- 8			
T	Iron	0.0300	0.204	6.40	BDL	0.189	3.50	0.203	+ 0.044	+ 28			
D	Lead	BDL	0.00145	0.00200	BDL	0.00507	0.0600	0.00173	+ 0.00029	+ 20			
T	Lead	BDL	0.0399	0.100	BDL	0.0731	0.100	0.0425	+ 0.0017	+ 4			
	Magnesium	16.0	30.7	40.0	5.50	18.9	55.0	29.8	- 1.10	- 4			
T	Manganese	BDL	0.0223	0.0400	BDL	0.0743	0.380	0.0264	+ 0.0056	+ 27			
T	Mercury[h]	BDL	0.0000445	<0.0001	BDL	0.000138	0.00260	0.0000518	+ 0.0000087	+ 20			
T	Nitrate (as N)	0.170	0.258	4.50	BDL	0.0720	0.160	0.243	+ 0.073	+ 43			
	pH (pH units)	7.10	7.96	8.80	4.50	7.86	9.10	7.95	0	0			
T	Phosphorus (as P)	BDL	0.0288	0.180	BDL	0.216	8.30	0.0434	+ 0.0176	+ 68			
	Potassium	1.60	5.13	6.80	1.30	4.78	42.0	5.10	- 0.11	- 2			
D	Selenium[h]	<0.00100	0.00295	0.00300	BDL	0.000430	0.00300	0.00275	- 0.00025	- 8			
T	Selenium[h]	BDL	0.00275	0.00500	BDL	0.000410	0.00200	0.00257	- 0.00022	- 8			
	Specific Cond. (uU/cm)	420.	1110.	1720.	150.	869.	2340.	1090.	-30.0	- 3			
D	Silver[h]	BDL	—	<0.00100	BDL	BDL	BDL	—	—	—			
T	Silver[h]	BDL	0.00344	0.0100	BDL	0.000975	0.0100	0.00325	- 0.00025	- 7			
D	Sodium	25.0	105.	120.	4.20	105.	382.	105.	- 2.0	- 2			
	Sodium Adsorption Ratio (no units)	0.900	2.51	2.88	0.210	3.30	10.4	2.57	+ 0.03	+ 1			
	Sulfate	53.0	304.	380.	11.0	52.0	360.	284.	-25.0	- 8			
	Dissolved solids (180°C)	257.	710.	848.	109.	497.	1300.	693.	-29.0	- 4			
	Turbidity (JTU)	—	—	—	1.00	37.5	2800.	—	—	—			
D	Zinc[h]	BDL	0.00896	0.0200	BDL	0.0121	0.120	0.00920	+ 0.00031	+ 3			
T	Zinc	BDL	0.0241	0.310	0.0100	0.0342	0.200	0.0249	+ 0.001	+ 4			
	Phenolics	BDL	—	—	—	—	—	—	—	—			

There would be no reservoir mixing of CAP and SRP water with this plan. However, water from the Cliff, Horseshoe, Bartlett and Roosevelt sites would be naturally mixed at the confluence of the Verde and Salt Rivers and then pumped up into the CAP aqueduct. There would be no significant impacts to SRP water quality.

Note: D = Dissolved Fraction; T = Total Recoverable; -- = Data Not Available; BDL = Below Detection Level

a Levels shown rounded to three significant figures.
b In CAP aqueduct after regulatory mixing at Waddell site.
c Arizona Department of Health Services from U.S. EPA STORET, 1981; period of record December 1950 - September 1979.
d In CAP aqueduct after regulatory storage mixing at Waddell site and addition of SRP water at Granite Reef. CAP deliveries before Granite Reef would not be affected by impacts of adding SRP water to CAP water at Granite Reef.
e Minimum and maximum values are for the Salt or Verde Rivers and could be experienced if only one river was flowing.
f Weighted average based on STORET data and USGS flow records resulting in a 43 percent Verde River and 57 percent Salt River mix at the confluence of the two rivers.
g Changes are cumulative including impacts from MCMWCD#1 and SRP water and are relative to CAP future without average values given in previous table.
h These constituents show "below detection level" or "less than" average values, or were derived from "less than" average values. The "less than" average values were assumed to be representative. As a result, the change and percent change may show exaggerated or wrong direction changes. Constituents with "below detection level" future without average values could not be used to calculate future with values.

Plans 6,7, or 9. The impacts of Plans 6, 7, and 9 on water quality constituents are therefore considered Insignificant.

(2) Mitigation for Water Quality Constituent Impacts

Since there are no water quality constituents impacts associated with Plan 2 and the impacts of Plans 1, 6, 7, and 9 are considered Insignificant, no mitigation measures are proposed for these plans.

The impacts of Plan 3 are judged to be Significant Adverse, mainly because of the large quantity of water affected and the large percentage (30-35) which would be used for M&I. While it is possible to mitigate these impacts by modifying existing water treatment plants and providing different types and/or higher levels of water treatment, such measures are extremely costly. Therefore, because Plan 3 is not the proposed action, mitigation measures are not being proposed. Should the decision be made to implement Plan 3 in the future, appropriate measures will be developed to mitigate adverse water quality constituents impacts.

While specific mitigation measures are not proposed for any of the plans, Reclamation recognizes the need for further studies to develop more accurate data regarding water quality impacts of regulatory storage.

Each regulatory storage reservoir should include a reservoir water quality sampling network capable of monitoring CAP Colorado River and local source water inflows and reservoir outflows. This will provide data for downstream water users to utilize during planning for water treatment or irrigation operations. Monitoring both the inflow and outflow will help to establish how the reservoir affects water quality and may provide information on reservoir operations which minimize water quality impacts.

Reclamation, in conjunction with the U.S. Geological Survey, has initiated a water quality monitoring system to establish baseline data for the New Waddell site. Monthly sampling of the Agua Fria River inflow and releases from Lake Pleasant releases was started In January 1982. Continuation of this sampling program is recommended for the agency proposed action (Plan 6). Plans 6, 7, and 9 would affect only MCMWCD#1 agricultural water at the New Waddell Reservoir. The after-mix water released from New Waddell Reservoir is not expected to exceed criteria for agricultural water use and no mitigation would there be required.

More detailed studies should also be conducted to assess the combined (synergistic) effects of reservoir water quality impacts. It may also be necessary to establish a monthly sampling program to monitor the SRP water quality near the point where SRP water would be diverted into the CAP aqueduct. Depending on results of such studies, Plans 1 and 3, which would directly affect SRP water delivered to existing water treatment plants, could require additional or modified water treatment.

If the need is identified for further water treatment for impacts resulting from the implementation of a plan, appropriate mitigation measures would be formulated.

(3) Residual Impacts

Plans 1 and 3 may impact local municipal and industrial waters. For instance, the increased non-carbonate hardness in the SRP water released from Confluence Reservoir could increase soap usage for domestic water users. The normal leaching of agricultural fields may not be adequate to prevent salt build-up in the crop root zone brought about by the increased salt levels in water released from the regulatory storage reservoirs. Additional water may need to be applied to flush the salts away from the root zones in order to maintain historic crop yield levels. Any need for additional water treatment could become a residual impact.

c. Eutrophication Potential

(1) Direct and Indirect Impacts

Impacts would be experienced by reservoir water users if water in a reservoir is affected by eutrophication, as discussed below.

(a) Plan 8

With Plan 8, there would be no reservoir storage of Colorado River water. Risk of eutrophication was not determined for the existing reservoirs which would be in the future-without (Plan 8) scenerio.

(b) Plans 1 and 2

There would be no storage of Colorado River water in the reservoirs affected by Plans 1 and 2. Risk of eutrophication was determined only for reservoirs which would store Colorado River water.

(c) Plan 3

Conditions expected in the Confluence Reservoir indicate that there is high potential for eutrophic conditions to occur during part of each year. The reservoir would be drawn down significantly in the very hot months of July and August. The greatest amount of direct sunlight for photosynthesis would also be available in these months. During the summer months, flows from the Verde River are usually small or nonexistent. With little or no inflow from the Verde River, the Verde arm of the reservoir could tend toward a stagnant condition.

Given these physical parameters and the presence of abundant nutrients (phosphorus and nitrogen), it is likely that eutrophic conditions would occur.

One downstream impact of eutrophication in Confluence Reservoir concerns THM, which is a compound produced in water with

significant concentrations or organic material when the water undergoes normal disinfection with chlorine. THM is considered a health hazard if concentrations in drinking water are high enough. New standards proposed by the Arizona Department of Health Services call for a maximum contaminant level of 0.1 mg/l for THM. Organic material in Colorado River water is present in significant quantities, making it possible that THM would be produced when Colorado River water is treated with chlorine. This would occur in the future-without and-with the project, and is therefore not an impact by itself; however, mixing of SRP and CAP water in Confluence Reservoir and subsequent distribution to M&I water users could place higher levels of organics in all treatment plants that currently take SRP water. Some of these plants may not take CAP water in the future-without-the-project. Eutrophic conditions at Confluence Reservoir could intensify the problems associated with THM production by increasing the levels of organic materials in the water subsequently delivered to domestic plants for disinfection.

The effect of Plan 3 on eutrophication potential is considered Significant Adverse because normal operation would probably produce eutrophic conditions which could alter the recreational use of the reservoir; additionally, eutrophication may increase THM production at existing water treatment plants.

(d) Plans 6, 7, and 9

Plans 6, 7, and 9 are similar in reservoir operation and would have similar impacts on the eutrophication potential at the New Waddell site. Conditions expected to occur in New Waddell Reservoir indicate that there is low to moderate potential for eutrophic conditions to occur during a typical year. The reservoir would be lowest during the months of September to November, but even at its low point the reservoir would be approximately 120 feet deep. During the summer months, flows from the Agua Fria River are usually small or nonexistent. With little or no inflow from the river, the reservoir could tend toward a stagnant condition. Given these physical parameters, eutrophic conditions could occur. However, lack of phosphorus in the New Waddell Reservoir (Lake Pleasant) would tend to limit algal growth.

The effects of Plans 6, 7, and 9 on eutrophication potential are considered Insignificant because no adverse eutrophic conditions are expected in New Waddell Reservoir under normal operation.

(2) Mitigation

The high eutrophication potential predicted for Confluence Reservoir and the moderate to low potential predicted for New Waddell Reservoir are based on analytical models. Further studies would need to be conducted for the Confluence and New Waddell sites to better define the extent of algal growth and effect on water quality. Mitigation, if required, could consist of notifying CAP and local surface water M&I users of unusual increases in algal growth in the reservoirs in order for treatment plants to adjust for any potential increase in THM production. Aeration of M&I water

released from the reservoir could also be required for mitigation during periods of unusual reservoir eutrophic conditions. This would cause precipitation of heavy metals which dissolve in the reservoir water under anaerobic conditions resulting from eutrophication.

(3) Residual Impacts

The eutrophication problems associated with the Confluence (high potential) and New Waddell (low to moderate potential) Reservoirs may be difficult to mitigate and may therefore become residual impacts.

d. Impacts with Modified Roosevelt and Modified Stewart Mountains Dams in Plans

If Roosevelt Dam were to be modified instead of replaced, water quality impacts would be the same. The same types of construction impacts would be possible, but present plans provide for working in dry conditions away from the reservoir water surface. This might require some drawdown of the reservoir for the modified dam but the water quality should not be affected. If SRP loses water as a result of the drawdown, the water would be replaced with CAP water delivered to users in the SRP service area who are already receiving CAP water.

Modified Stewart Mountain Dam would be the same as the new dam as far as water quality is concerned. There would be no drawdown of the reservoir and the potential for short term-construction impacts would be the same for both alternatives.

3. Recreation

a. Methodology

Within the recreation impact category, project plans were assessed as they affect the factors of stream-oriented and reservoir-oriented recreation opportunities. Reservoir-oriented recreation includes activities and experiences associated with flat-water bodies, while stream-oriented recreation is comprised of those activities and experiences oriented around flowing water bodies.

Recreation impacts are measured within each of these factors by the net loss or gain of water-related facilities and resources, and by the potential for recreation plans associated with the new or enlarged reservoirs to meet the water-related recreation needs of the 5-county study region.

For stream-oriented recreation, impacts are measured in terms of the following: net loss or gain in stream miles or adjacent land resources; net loss or gain in developed stream-related facilities; percentage needs met for stream-oriented fishing, tubing, non-powerboating, swimming, camping, and picnicking.

For reservoir-oriented recreation, impacts are measured in terms of the following: net loss or gain in acres of surface water and adjacent land resources; net loss or gain in developed reservoir-related recreation facilities; percentage needs met for reservoir-oriented boat fishing, powerboating, non-powerboating, swimming, camping, waterskiing, and picnicking.

The net loss or gain of recreation resources and facilities is an indication of how the supply of water-related recreation opportunities will be affected by project plans. To obtain a measurement of regional recreation needs that could be met by CAWCS plans, a needs assessment based on a capacity standards approach was conducted. The impact assessment takes the following form for each water-related recreation activity:

1. Resources		3. Appropriate Populations		
+				
Facilities				
x		x		
2. Capacity Standard		4. Participation Rates		
Recreation Days Supplied	-	Recreation Days Demanded	=	Recreation Days Needed

This procedure was performed for existing conditions, future-without-project conditions, and future-with-project conditions. The impact of the plans was measured by substracting the future-without from the future-with measurement.

Effects criteria were developed in consultation with the recreation advisory committee. Effects of reservoir-oriented recreation impacts are primarily beneficial, while those for stream-oriented recreation are primarily adverse. A plan was judged to have a significant impact on stream-oriented or reservoir-oriented recreation if more than 10 percent of the maximum annual recreation days for the aggregated site areas was gained or lost. A significant gain of recreation days has a beneficial effect and a significant loss has an adverse effect. Effects criteria are described in Stage III Methodology for Environmental Quality Methodology, Section 5.0.

b. Types of Impacts to Recreation

CAWCS recreation impacts are caused by construction of dams and creation of new or enlarged reservoirs. The reservoirs would be developed for recreation and for other CAWCS planning objectives. Conceptual recreation plans for the reservoirs call for the development of facilities such as camping areas, picnicking sites, beaches, boat launches, docks, and parking areas. The recreation plans are described in detail in Recreation Planning Report - Stage III Summary (USBR, 1982). The plans have been developed for all reservoirs in the action plans except for Cliff and Roosevelt Dams in Plan 2, which is a SOD-only plan.

While reservoirs would provide additional flat-water resources and facilities, they may also cause the loss of stream-oriented resources and facilities. In particular, stretches of the Salt and Verde River that are used for tubing, fishing, and stream-side picnicking and camping would be flooded by reservoirs in some plans, and would be lost for the life of the project. Stream-oriented facilities would be replaced-in-kind, to the extent possible.

For stream-oriented recreation, the impact analysis was based on the typical-year high reservoir level for each reservoir; and for reservoir-oriented recreation, the impact analysis was based on the average reservoir level during the recreation season of a typical year. This analysis accounted for fluctuating reservoir levels that affect boating capacity and attractiveness of the reservoir for certain recreational activities.

No designated Wilderness Areas will be directly impacted by the proposed project actions. However, two areas that are under study for Wilderness or Roadless Area designation by the U.S. Forest Service could be impacted by the proposed actions. The Forest Service has recommended that the Mazatzal Contiguous Area be added to the Mazatzal Wilderness Area. The area recommended for addition could be impacted by high water levels at Cliff Reservoir, approximately 1/5th mile north of the Sheep Bridge crossing. An analysis of the potential impacts indicated that they would be minimal and insignificant because (1) the occurrence of the events necessary to "back water" into the area is extremely rare, (2) the water would only intrude into the area for a short time, and (3) no impacts, which would cause the area to be removed from consideration for Wilderness designation, were noted. No further detailed assessment was conducted. If this area is added to the Mazatzal Wilderness Area, appropriate actions to address the potential impacts and to mitigate these impacts will be undertaken between Reclamation and the Forest Service.

In the re-evaluation of the Arizona Roadless Area Review Evaluation (RARE II) process the Forest Service has identified an area of Lime Creek, west of the Cliff Reservoir site, as a potential RARE II site. Cliff Reservoir could inundate a small portion of Lime Creek. The potential impacts of this action were not judged to be significant because (1) only a minor portion of the area would be affected, (2) most of the area is above the 2000 foot contour, and (3) the occurrence/likelihood of the events necessary to intrude water into the area is very infrequent. In addition, the Forest Service in their initial evaluation of the area recommended against further study or inclusion of the area in any Wilderness/Roadless designations. It appears that this recommendation will most likely be carried forward in the re-evaluation process. Discussions with the Forest Service have identified that impacts on the Lime Creek area would be insignificant.

c. Stream-Oriented Recreation

(1) Direct and Indirect Impacts

(a) Plan 8

No changes in stream-oriented recreation resources are expected in the future without CAWCS action, but some additional facilities are likely to be built. In the Cliff, Roosevelt, and New Waddell site areas, no new facilities are planned, and the number of maximum annual recreation days for stream-oriented activities is projected to remain the same as in the existing condition. In the Confluence site area, Alternative D of the Lower Salt River Recreation Area plan would be implemented, leading to more intensive use of the Salt River from Stewart Mountain Dam to the confluence with the Verde River. There would be approximately 2,250,000 stream-oriented maximum annual recreation days in the Confluence site area in the year 2000, most of them associated with tubing.

The number of estimated maximum annual recreation days for stream-oriented activities would be 2,281,000 in the aggregated site areas and 8,236,000 in the five-county region in the year 2000.

(b) Plan 1

With implementation of Plan 1, a total of 3 miles of the Verde River in the Cliff site area would be lost. Stream fishing occurs along the entire length of stream miles lost. As a result of Plan 1, regional needs for stream fishing would be intensified because demand would remain the same as in the future-without, but there would be fewer resources for fishing. Approximately 1,450 maximum annual recreation days for stream fishing would be lost.

Recreation development proposed for Cliff and Roosevelt in Plan 1 includes one stream-oriented recreation site in each site area. At Cliff, proposed facilities include picnic tables and developed campsites. At Roosevelt, plans call for development of a parking area for access to the Salt River. The implementation of the recreation plan for Plan 1 would result in a net gain of 5,850 maximum annual recreation days for stream-oriented recreation. The overall effect of the plan, taking into account losses and gains, has been evaluated as Insignificant.

(c) Plan 2

With implementation of Plan 2, a net gain of 1 mile of stream would occur on the Verde River in the Cliff site area. The gain represents reclaimed river in the lakebed of Horseshoe Reservoir. Losses occur along the reach of the river from Horseshoe Dam to proposed Cliff Dam, but 1 more mile of river would be gained in the lakebed than would be lost in the reach between the two dams. Because of the gain, there would be 696 additional maximum annual recreation days for stream-oriented activities in the year 2000.

During the years when Roosevelt Lake is full, the lake would be drawn down in September, October, and November. This would result in increased flows of about 700 cfs on the Salt River downstream of Stewart Mountain Dam. The recreation impacts of the increased flow in the river cannot be quantitatively assessed, but little change is expected to occur in recreation activities because of the increased flow.

The effect of Plan 2 on stream-oriented recreation has been evaluated as Insignificant.

(d) Plan 3

With implementation of Plan 3, a total of 16 miles of stream would be lost; 17 stream miles would be lost because of Confluence Reservoir and 1 stream mile would be gained because of recovery of a segment of the Verde River in the lakebed of Horseshoe Reservoir. Fishing occurs along the total length of stream miles lost, and tubing takes place on 16.8 miles. From a recreation perspective, the loss of stream miles associated with Plan 3 would constitute a major impact on tubing, an activity that is highly valued in central Arizona.

In a typical year, the entire stretch of river used for tubing would be inundated completely by the Confluence Reservoir at the beginning of the recreation season. As drawdown occurs over the spring and summer each year, more of the river channel would be exposed, but it would not be suitable for tubing. Resources for tubing as it is experienced today and in the future without the project would not exist on the Salt River.

The loss of 16.8 miles of river suitable for tubing represents a loss of half the tubing miles on the Salt and Verde Rivers in the study area. Remaining tubing areas with Plan 3 are the segment of the Salt River from Confluence Dam to Granite Reef Dam (3.3 miles) and the segment of the Verde River below Bartlett Dam to the Confluence Reservoir (14.2 miles). Other stream-oriented activities such as fishing would be similarly impacted by the loss of stream resources in the Confluence site area.

Implementation of the conceptual recreation plan for Plan 3 would result in the development of one stream-oriented recreation site in the Confluence site area, one in the Cliff site area, and one in the Roosevelt site area. The sites would be developed for picnicking, camping, and river access.

Implementation of Plan 3 would result in the net loss of approximately 1,054,800 stream-oriented maximum annual recreation days. The effect of this loss is evaluated as an Adverse Flag.

(e) Plan 6

With implementation of Plan 6, a total of 1 mile of stream would be gained on the Verde Rive where the stream segment in the lakebed of Horseshoe Reservoir would be reclaimed. There are no streams of recreational value in the New Waddell site area.

Recreational development proposed in the Cliff and Roosevelt conceptual recreation plans include one stream-oriented recreation site in each site area. In the Cliff site area, proposed facilities include picnicking and camping areas; in the Roosevelt site area, plans call for the development of a parking area for access to the Salt River.

As a result of Plan 6, regional needs for stream fishing would be partially met and an additional 700 maximum annual recreation days would be developed. A total of approximately 7,990 stream-oriented maximum annual recreation days would be added. Although the direction of this impact is beneficial, the overall effect has been evaluated as Insignificant.

(f) Plan 7

Impacts to stream-oriented recreation are the same in Plan 7 as in Plan 6, except that with implementation of Plan 7 a net loss of 2 stream miles would occur. Conceptual recreation plans for the site areas in Plan 7 are the same as in Plan 6. A total of approximately 6,386 stream-oriented maximum annual recreation days would be gained with implementation of the plan. The effect of this gain has been evaluated an Insignificant.

(g) Plan 9

With the implementation of Plan 9, stream-oriented recreational use would be the same as in Plan 8. Therefore, there are no impacts to stream-oriented recreation.

(2) Mitigation

The loss of stream resources cannot be mitigated effectively. The loss of tubing resources on the Salt and Verde Rivers caused by Plan 3 cannot be avoided if the Confluence Dam is built, nor can the resources be replaced elsewhere. The option of off-site mitigation was explored in the CAWCS, but it was concluded that the creation of tubing elsewhere was not feasible.

Partial mitigation for tubing losses might be possible by making the Verde River upstream from Confluence Reservoir to Bartlett Dam more suitable for tubing. This would involve maintaining flows of 500 cfs along this stretch of the river during the summer and providing better access to the river. It is probably not feasible for SRP to operate the system in such a way as to make these flows available during the summer. However, if adequate flows could be maintained, then some reduction in impact could be expected. If any minimum flows are incorporated into the project as a result of wildlife mitigation, their impact on recreational use of the river will be substantial and beneficial.

(3) Residual Impacts

Because stream losses cannot be mitigated, the mitigated impact and effect are the same as the unmitigated impact and effect.

Unmitigated/mitigated effects evaluations for the plans are as follows: Plans 1, 2, 6, 7, and 9 - Insignificant; Plan 3- Adverse Flag.

d. Reservoir-Oriented Recreation

(1) Direct and Indirect Impacts

(a) Plan 8

No changes in reservoir resources are expected in the future without CAWCS action, but considerable change will occur in reservoir-oriented facilities in each of the site areas by the year 2000.

The Forest Service plans to develop a reservoir-oriented campsite on the western shoreline of Horseshoe Reservoir in the Cliff site area. The only access road to the reservoir would not be improved; thus, the type of boaters that visit the lake would not be expected to change from the existing condition. Almost 60,000 reservoir-oriented maximum annual recreation days for developed and water surface activities would exist in the Cliff site area in the year 2000.

Forest Service developments in the Roosevelt site area in the year 2000 include a campground with 100 developed campsites and boat launching facilities. Maximum annual recreation days for reservoir-oriented activities would increase to a total of almost 410,000 by the year 2000.

In the Confluence site area, there would be no development of reservoir-oriented recreation resources or facilities in the future-without CAWCS action.

In the New Waddell site area, additional picnic areas, campgrounds, and boat launches are proposed by the Maricopa County Parks and Recreation Department for the Upper and Lower Lakes. Maximum annual recreation days for reservoir-oriented activities would total approximately 250,000 in the year 2000.

The number of maximum annual recreation days for reservoir-oriented recreation would be approximately 822,000 in the aggregated site areas and 6,479,000 in the five-county region in the year 2000.

(b) Plan 1

Plan 1 would result in the net gain of 683 surface acres of water at Cliff Reservoir for recreation. With the construction of Cliff Dam, vehicular access to Cliff Reservoir would be improved over that to Horseshoe Reservoir. Because of better access, the composition of boating activities at Cliff would be likely to change from primarily fishing and non-powerboating to a mix of activities similar to those at Bartlett Lake, where waterskiing and powerboating dominate.

Conceptual recreation plans proposed for the reservoirs at Cliff and Roosevelt call for the development of three reservoir-oriented recreation sites at Cliff and nine at Roosevelt. With this development and the changes in boating mix at Cliff, regional boat fishing, powerboating, and non-powerboating needs would be intensified; waterskiing needs would be partially met. A total of approximately 670,520 maximum annual recreation days for reservoir-oriented activities would be developed with Plan 1. This gain has been evaluated as Significant Beneficial.

(c) Plan 2

With Plan 2, reservoir resources would decrease by approximately 850 surface acres. All of this decrease would be in the Cliff site area, where Cliff Reservoir would essentially replace Horseshoe Reservoir. With construction of Cliff Dam, vehicular access to the site area would be improved over the access to Horseshoe Reservoir. As described in Plan 1, because of improvements in access to the reservoir, the composition of boating activities at Cliff is likely to be different from the activities at Horseshoe Reservoir. Waterskiing and powerboating are expected to be the primary boating activities at Cliff Reservoir, while fishing and non-powerboating are the main activities at Horseshoe Reservoir.

With Plan 2, regional boat fishing, powerboating, and non-powerboating needs would be intensified; waterskiing needs would be partially met. A total of approximately 48,650 reservoir-oriented maximum annual recreation days would be lost with Plan 2, partially because of the loss of surface acres of water. In addition, Plan 2 does not provide for new recreation development at Cliff and Roosevelt because it is a SOD-only plan. The overall effect of the plan on reservoir-oriented recreation has been evaluated as Insignificant.

(d) Plan 3

Plan 3 would result in the net gain of approximately 5,240 surface acres of water for recreation, representing an increase of approximately 30 percent over future-without conditions for reservoir-oriented resources in the study area. An increase of 5,320 surface acres would occur in Confluence Reservoir and a decrease of 77 surface acres would occur with Cliff Reservoir. The size of Confluence Reservoir would fluctuate from approximately 8,000 acres to 3,000 acres in a typical year. The impact of this fluctuation would be greatest on the Verde River arm of the reservoir where the flat topography would make the drawdown more apparent.

With the implementation of the conceptual recreation plan for Plan 3, 7 reservoir-oriented sites would be developed at Confluence Reservoir, 9 would be developed at Roosevelt Lake, and 3 would be developed at Cliff Reservoir. Facilities for picnicking, swimming, boat launching, and camping are included in the development plans. At the Confluence Reservoir, no recreation sites are planned for the Verde arm, which extends into the Fort McDowell Indian Reservation, because of the unattractiveness of the shoreline that would result for reservoir fluctuation.

Implementation of Plan 3 would have an impact on the mix of boating activities in the Cliff site area, as described in Plan 1. With Plan 3 approximately 3,537,380 additional maximum annual recreation days for reservoir-oriented activities would be developed. Regional recreation needs for all reservoir-oriented activities except boat fishing would be partially met by implementation of Plan 3. The effect of the gains associated with Plan 3 has been evaluated as Significant Beneficial.

(e) Plan 6

Implementation of Plan 6 would result in the net gain of approximately 4,200 surface acres of water for recreation. At New Waddell, a net increase of approximately 4,300 surface acres would occur. This takes into account a gain of 4,266 surface acres on the Upper Lake and a loss of 33 surface acres on the Lower Lake. In the Cliff site area, a decrease of approximately 80 surface acres would occur and improved access to the new reservoir would change the mix of boating activities as described in Plan 1.

Recreation plans call for the development of 4 reservoir-oriented sites at New Waddell, 3 at Cliff, and 9 at Roosevelt. Facilities for camping, picnicking, and boat launching are included in the plans. With Plan 6, a total of an estimated 1,066,000 reservoir-oriented maximum annual recreation days would be gained. The effect of Plan 6 on reservoir-oriented recreation has been evaluated as Significant Beneficial.

(f) Plan 7

Implementation of Plan 7 would result in the net gain of approximately 5,100 surface acres of water for recreation. At New Waddell, a net increase of approximately 4,300 surface acres would occur, taking into account gains on the Upper Lake and losses on the Lower Lake. At Cliff, an increase of approximately 800 surface acres would occur. The same recreation plans apply to Plan 7 as to Plan 6. A net total of approximately 1,085,870 reservoir-oriented maximum annual recreation days would be gained with Plan 7. In addition, this plan provides for an assured water supply for the downstream Rio Salado Development District. Although the secondary development of recreation opportunities because of this supply of water has not been assessed in quantitative terms, it has been taken into consideration in the effects evaluation. The overall effect of Plan 7 has been evaluated as a Beneficial Flag.

(g) Plan 9

Implementation of Plan 9 would result in the net gain of approximately 4,200 surface acres of water for recreation at New Waddell. This takes into account a gain of 4,266 surface acres on the Upper Lake and a loss of 33 surface acres on the Lower Lake.

Recreation plans call for the development of 4 reservoir-oriented sites at New Waddell and 9 at Roosevelt. Facilities for camping, picnicking, and boat launching are included in the plans. With Plan

9, a total of an estimated 884,000 reservoir-oriented maximum annual recreation days would be gained. The effect of Plan 9 on reservoir-oriented recreation has been evaluated as Significant Beneficial.

(2) Mitigation

Because the effects of the plans are either insignificant or beneficial, no mitigation measures are required. However, with Plan 3 further analysis to provide for a more stable lake on the Verde River arm of Confluence Reservoir is recommended. The flat topography and the wide water fluctuation on this arm of the reservoir would result in the annual exposure of large expanses of unvegetated saturated soil, thereby diminishing the attractiveness of that portion of the reservoir for shoreline activities. Also, during the latter months of the recreation season (August through October), the Verde arm may experience an algal growth of sufficient magnitude that some types of boating may be restricted (see Water Quality, Section 2c). Fishing activities, on the other hand, may benefit from the early stages of algal growth, which would provide food for fish. Although algal growth could occur on the Salt River arm of the reservoir, the potential is less than on the Verde arm.

(3) Residual Impacts

The unmitigated and mitigated impact and effect are the same for the plans. Effects evaluations are as follows: Plan 1 - Significant Beneficial; Plan 2 - Insignificant; Plan 3- Significant Beneficial; Plan 6 - Significant Beneficial; Plan 7 - Beneficial Flag; and Plan 9 - Significant Beneficial.

e. Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Construction impacts for a modified dam at Roosevelt would be the same as the new dam option; existing recreational facilities affected by construction of either alternative would be relocated and/or replaced. Operational impacts would be the same because lake elevations, size, and storage allocations would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact at Roosevelt for recreation. No additional recreation facilities are proposed for Saguaro Lake with either a New or Modified Stewart Mountain Dam, and no change in existing recreation resources would occur under either option.

4. Cultural Resources

The cultural resources impacts and effects analysis was prepared in accordance with 36 CFR Part 800, "Advisory Council on Historic Preservation Procedures for the Protection of Historic and Cultural Properties", and with Sections 106 and 110(f) of the National Historic Preservation Act as amended, which requires that Federal agencies take into account the effects of their undertakings on properties included in or eligible for inclusion on the National Register of Historic Places.

a. Types of Impacts to Cultural Resources

Impacts to cultural resources will result from construction, inundation and reservoir operation activities. For purposes of analysis and discussion four general types of site impacts have been defined. These are derived from criteria of effect as defined in 36 CFR 800 but are not to be confused with an actual determination of effect.

destruction - the elimination of significant values which characterize a site. Site destruction may result from a number of direct and indirect actions such as project-specific construction, operation, and maintenance actions.

alteration - the physical destruction of a portion of the data values which characterize a site.

impairment of setting - would occur when the physical or environmental setting is modified to the extent that it creates an adverse visual impact to that site, or to the extent that such modification would detract from the site's interpretive development as a public educational or recreational resource.

enhancement - a site's qualities may be enhanced through various management procedures which might include restoration, reconstruction, long-term preservation, or public-use interpretation.

The first three categories of site impact would result in adverse effects; the fourth category would result in a beneficial effect. All of the above types of impacts may occur either as a direct or indirect consequence of a project action.

The effects of the above impacts on the significant data values of a site may be expressed as the relationship between potential impacts to a site and the quality of that site. Four criteria have been recognized in evaluating a site's value or quality:

- historical association with significant events or persons
- public interpretive distinctive characteristics that have educational potential
- research potential
- social, religious, or ethnic significance

Construction activities produce the most severe type of impact imposed on cultural resources. They involve all earth-moving activities related to the construction of haul roads, recreation sites, transmission lines, and dams. In the extreme, the result of such impacts is to irreversibly destroy structures and artifacts and their spatial relationships within a cultural deposit and to eliminate the potential for additional studies. Not all construction activities are equally destructive. Some activities, such as the paving of a parking lot, may even serve to cap archaeological deposits and preserve them for the future. The potential for such beneficial effects are limited, however, and opportunities of this nature will be pursued as construction plans are finalized. In general, construction

related activities are the source of the most severe types of impacts anticipated for cultural resources.

Flooding of a site can result in relatively light to moderately severe impacts. In general, inundation will alter some of the contents and the physical relationships within a site, but it will not usually result in the total destruction of a site. Processes associated with inundation which are responsible for the impacts to cultural deposits include mechanical disturbances, chemical deterioration, and biological decay (Garrison, 1977; Lenihan et. al., 1981). The severity of impacts varies with the frequency and duration of inundation.

Secondary impacts are defined as those which result from secondary use of a facility. These are predominantly recreational activities associated with the reservoirs. The creation of recreational facilities often encourages vandalism of sites by increasing the ease with which they may be reached. Other types of recreation impacts occur when sites are used as locations for campgrounds, parking areas, or picnicking areas. Vehicular and pedestrian traffic serves to displace the material and enhance erosion by decreasing vegetation cover. Unusual forms of artifacts are often picked up by collectors thereby biasing the overall assemblage of artifacts recoverable by the archaeologist. The impacts associated with secondary use of a dam are thus fairly substantial. These impacts will also occur in the upper reservoir zones that are infrequently inundated. Although the sites are not totally destroyed, they will, unless protected or specifically managed, be considerably degraded over a 50-to 100-year period with most of the damages occurring during the early life of the project.

The procedures for assessing impacts and evaluating effects within this conceptual framework have been presented in detail in the Stage III Methodology for Environmental Quality Assessment (CAWCS, 1981), and are summarized below.

b. Methodology

(1) Prehistoric Resources

The archaelogical survey at the Cliff site area covered most of the area included in and below the IDF area (2,143 foot elevation contour line), and most of the construction zones (principally the borrow and recreation areas, with relatively less emphasis on roads, transmission lines, etc.). To determine the number of sites in the secondary impact zone, information from sample surveys was used to calculate densities for each site type, feature, and acreage of remains. The densities were calculated to control for environmental variability. For instance, site density decreases with distance from the Verde River and this information was incorporated into the predictions.

At the Roosevelt site area, all areas located below the 2,200 foot contour line, which closely corresponds to the IDF area, have been surveyed by Arizona State University (1979 and 1981), the Arizona State Museum (1976), or the Tonto National Forest (1977). In addition, Arizona

State University sample surveyed about 440 acres of the secondary impact zone. This information was used in conjunction with site record data obtained from the Tonto National Forest to develop an estimate of site density in the secondary impact zone (the area above the 2,200 foot contour line).

The primary impact zone at the Confluence site area had previously been surveyed by the Arizona State Museum as part of the original Orme Alternatives Study (Canouts, 1976). These data were also used for the CAWCS impact analysis. Site data on the secondary impact zone were estimated by developing density estimates for different categories of archaeological sites. Two different sets of figures, which are related to variation in topography, were used in arriving at these projections. Areas in the secondary impact zone bordering the Verde and Salt Rivers had higher overall density figures than upland areas away from each of the two rivers. To obtain as accurate an estimate as possible, this variation was taken into account in the calculation of density for each site type and feature type.

The archaeological survey at Lake Pleasant covered all of the inundation pool and a large portion of the secondary impact and construction zones. As estimate of the total number of sites in the secondary impact zone was calculated by using the survey areas to develop a site density per acre (for each category of site). The density figure was then multiplied by the acreage of the impact area to arrive at the estimate for the total number of sites in the secondary impact zone.

The archaeological survey of the Bartlett Dam study area includes a 12 percent sample survey of the area around Lake Bartlett. The sample survey consisted of 22 quadrants, each measuring 40 acres in size, and was conducted by Arizona State University in 1979. A total of 5 sites were found in these quadrats, one of which was associated with a rock-lined ball court. An additional 9 field loci were recorded but not assigned site numbers. These loci represent various types of agricultural field systems (terraces, cleared areas, and three-walled field houses). Site densities have been estimated for the area in the immediate vicinity of Lake Bartlett, and added to those already recorded for the Cliff Project area.

(2) Historic Resources

The methodology for the study of historic cultural resources in relation to proposed CAWCS flood control and regulatory water storage actions involves: 1) the definition of historic sites within the CAWCS study area (data collection), and 2) an evaluation of historic site data in relation to proposed CAWCS actions in order to determine if these sites would be affected.

Information on historic sites was initially obtained through the review of archaeological site files and historical documentary sources pertaining to specific elements of the study area. The presumed location of each historically documented site was then field-checked in order to determine if the site was present. In addition, historic sites identified during the course of Arizona State University's archaeological field surveys at each site area were subsequently field-checked by Archaeological Research

Services (ARS). All field-verified sites were documented at a level necessary for evaluation in terms of National Register of Historic Places eligibility criteria. ARS also performed intensive surveys in several areas which appeared to have a particularly high concentration of historic sites; these areas are located at Roosevelt Dam, on the Tonto Creek and the Salt River above the dam, and to a lesser extent at the Stewart Mountain, New Waddell, and Cliff Dam sites.

Each historic site was subsequently assessed in order to determine if it would be subject to impacts as a result of potential CAWCS actions. Four categories of site impact were defined, as previously described (destruction, alteration, impairment of setting, and enhancement). Quantitative value was assigned to each of these categories as follows: destruction (-3), alteration (-2), impairment (-1), and enhancement (+1).

An effects evaluation was then performed based on the relationship between potential impacts to a site, and the quality of that site. Four criteria were considered in determining a site's quality for effects evaluation purposes: its research potential; its interpretive/educational potential; it historical association; and its social, religious, or ethnic significance. A numerical value was then assigned to each criterion (2, 1, 1, and 1 respectively) if it existed at a particular site. For each site these values were then totalled to produce a numerical value reflecting resource quality.

An effects value (or effects factor expressed numerically) was then computed for each historic site (and for all historic sites within each affected site area and plan) by multiplying the applicable impact and quality figures. With the exception of low quality resources which would only be impaired, all sites having a negative effects factor would be adversely affected by CAWCS actions. High quality resources which would either be destroyed or altered were flagged to indicate an adverse effect of a particularly high magnitude. Flagged sites would normally include those on the National Register, or those clearly eligible to the National Register, which would either be destroyed or substantially altered.

c. Direct and Indirect Impacts

(1) Prehistoric Cultural Resources

All sites within the construction zone will be destroyed. The impacts resulting from inundation have been divided into four categories of alteration which include 1) the typical-year high (TYH) pool, 2) the maximum storage pool (MSP), 3) the 200-year flood pool ,and 4) the Inflow Design Flood (IDF) area.

All plans are compared to each other as well as to the future-without condition. This comparison is based on four factors:

- the estimated number of prehistoric archaeological sites

- the estimated acreage of archaeological remains
- the quality of the resource base
- the severity of the impact

Table IV-27 shows the estimated number and types of prehistoric archaeological sites in the CAWCS affected site areas.

Table IV-28 presents the number of sites in each plan according to plan number, type of impact, and site type. Qualitative and quantitative analyses resulted in an Adverse Flag effect rating for all action plans, in the following ranking:

	Plan Number
BEST	2
	9
	1
	6/7
WORST	3

(a) Plan 8

In the future-without-the-project in the affected site areas there will be approximately 3,350 prehistoric archaeological sites covering 12,027 acres (see Table IV-26). The site areas are within a perimeter about 1 mile beyond the maximum water surface elevation of each reservoir.

Natural decay through forces such as erosion, animal burrowing, plant and root growth, and oxidation will affect archaeological sites. Sites currently located along the perimeter of Lake Roosevelt and Lake Pleasant will be affected by inundation and subsequent drying as a result of fluctuations in the water level. Cultural factors which will affect prehistoric resources include activities such as land development, vandalism, or vehicular disturbances as a result of increased use of the area, predominantly for recreational purposes. Most of the deterioration which is anticipated to occur will result from pot hunting and fluctuations in the water level. In some areas, recent State legislation should help to counteract the negative effects of some of these conditions.

(b) Plans 1 and 2

Plans 1 and 2 are similar in the total number of sites impacted, but Plan 2 is preferable to Plan 1. Plan 1 impacts 60 additional sites through construction, 18 additional sites in the TYH pool, 19 additional sites in the MSP, and 220 additional sites in the 200-year floodpool. Under Plan 2, these sites would be impacted in the IDF and secondary impact zone where the impacts are less severe.

Each of these site areas also contain numerous large and special sites with features such as ball courts, trash mounds, and

Table IV-27

TOTAL NUMBER OF ARCHAEOLOGICAL SITES IN AFFECTED SITE AREAS[a]

	Cliff	Roosevelt	New Waddell	Bartlett	Total[b]
Artifact Scatters	476	458	67	530	1,256
1 room	347	493	26	498	1,022
2-5 rooms	461	293	12	530	858
6-20 rooms	133	175	5	151	332
21-100 rooms	9	45	0	9	57
101+ rooms	3	4	0	3	7
Petroglyph Only	3	1	10	3	36
Agricultural Sites	32	9	0	32	52
Total Number of Sites	1,464	1,478	120	1,756	3,620
Special Features					
Trash Mounds	87	216	5	96	952
Ball Courts	2	0	0	3	16
Water-Soil Control Features	1,273	780	67	1,300+	2,156+
Acreage of Archaeological Remains	1,489	2,783	102	1,752	12,380

[a]The number of sites and features are estimates based on various types of survey data. For more information, see Second Level Environmental Inventory.

[b]The Bartlett area also includes the Cliff area. So in order to not count the Cliff sites twice, the Cliff values have not been included in the totals.

Table IV-28

IMPACTS TO ARCHAEOLOGICAL RESOURCES, BY IMPACT TYPE AND SITE TYPE

		Largely Destroyed Over the Short Term			Altered Over the Long Term			
	PLAN	CONSTRUCTION	TYH	MSP	200-YEAR	IDF	SECONDARY IMPACT ZONE	TOTALS
ARTIFACT SCATTERS	1	36	19	10	60	72	737	934
	2	22	11	6	--	126	769	934
	3	54	52	17	60	87	865	1135
	6	47	28	16	60	75	775	1001
	7	47	28	16	60	75	775	1001
	9	18	14	4	36	37	946	1055
1 ROOM SITES	1	42	9	17	64	107	601	840
	2	21	3	11	--	137	668	840
	3	43	8	20	64	107	603	845
	6	49	8	21	64	108	616	866
	7	49	8	21	64	108	616	866
	9	15	2	7	31	52	1169	1276
2-5 ROOM SITES	1	29	9	5	49	52	610	754
	2	15	6	3	--	91	639	754
	3	32	10	7	49	54	625	777
	6	32	10	7	49	53	615	776
	7	32	10	7	49	53	615	776
	9	9	3	1	30	22	770	835
6-20 ROOM SITES	1	15	2	7	16	22	246	308
	2	9	2	4	--	27	246	308
	3	15	1	8	16	23	246	309
	6	20	1	8	16	22	246	313
	7	20	1	8	16	22	246	313
	9	7	0	3	10	14	297	331

Table IV-28 (continued)

IMPACTS TO ARCHAEOLOGICAL RESOURCES, BY IMPACT TYPE AND SITE TYPE

		Largely Destroyed Over the Short Term			Altered Over the Long Term			
	PLAN	CONSTRUCTION	TYH	MSP	200-YEAR	IDF	SECONDARY IMPACT ZONE	TOTALS
21-100 ROOM SITES	1	1	0	2	9	11	31	54
	2	1	0	2	--	14	37	54
	3	2	2	2	9	11	31	57
	6	1	0	2	9	11	31	54
	7	1	0	2	9	11	31	54
	9	1	0	2	6	5	40	54
101+ ROOM SITES	1	3	0	1	2	0	1	7
	2	1	0	0	--	5	1	7
	3	3	0	1	2	0	1	7
	6	3	0	1	2	0	1	7
	7	3	0	1	2	0	1	7
	9	1	0	0	2	0	4	7
SITES WITH PETROGLYPHS ONLY	1	1	1	1	1	0	0	4
	2	1	0	1	--	2	0	4
	3	2	9	2	1	1	11	26
	6	1	1	1	1	0	10	14
	7	1	1	1	1	0	10	14
	9	0	0	0	1	0	3	4
AGRICULTURAL SYSTEMS	1	5	0	3	19	14	0	41
	2	2	0	0	--	34	5	41
	3	5	1	3	19	15	10	52
	6	5	0	3	19	14	0	41
	7	5	0	3	19	14	0	41
	9	2	0	0	4	3	32	41

Table IV-28 (continued)

IMPACTS TO ARCHAEOLOGICAL RESOURCES, BY IMPACT TYPE AND SITE TYPE

		Largely Destroyed Over the Short Term			Altered Over the Long Term			
	PLAN	CONSTRUCTION	TYH	MSP	200-YEAR	IDF	SECONDARY IMPACT ZONE	TOTALS
TOTAL	1	132	40	46	220	278	2,226	2,942
	2	72	22	27	--	436	2,385	2,942
	3	156	82	60	220	298	2,392	3,208
	6	158	48	59	220	283	2,294	3,062
	7	158	48	59	220	283	2,294	3,062
	9	53	19	17	120	133	3,261	3,603
TRASH MOUNDS	1	26	12	9	71	37	148	303
	2	20	4	11	--	95	173	303
	3	77	149	11	71	128	502	938
	6	31	10	11	71	37	148	308
	7	31	10	11	71	37	148	308
	9	17	0	4	51	24	221	317
BALL COURTS	1	1	0	0	0	1	0	2
	2	1	0	0	--	0	1	2
	3	3	3	0	0	2	7	15
	6	1	0	0	0	1	0	2
	7	1	0	0	0	1	0	2
	9	0	0	0	0	1	2	3
WATER-SOIL CONTROL FEATURES	1	77	7	46	299	261	1,363	2,053
	2	36	5	0	--	502	1,510	2,053
	3	77	7	48	299	262	1,369	2,062
	6	90	12	49	299	261	1,409	2,120
	7	90	12	49	299	261	1,409	2,120
	9	27	7	1	61	65	2,086	2,247
ACREAGE OF ARCHAEOLOGICAL REMAINS	1	497	96	64	280	548	2,787	4,272
	2	173	79	50	--	869	3,101	4,272
	3	577	1,105	111	280	732	9,210	12,015
	6	532	82	87	280	554	2,839	4,374
	7	532	82	87	280	554	2,839	4,374
	9	297	8	38	127	341	3,877	4,688

platform mounds not common to the majority of locations in the region. In each of these site areas there is evidence for inter-regional interaction between the groups which occupied the areas prehistorically. This type of information is critical to an understanding of the prehistory of central Arizona. As such, to impact even one of these areas would cause the irreplaceable loss of information on intra- and inter-regional trade, interaction, and organization.

The effect of Plans 1 and 2 on prehistoric resources is considered an Adverse Flag.

(c) Plan 3

Plan 3 is considered to have the most severe impacts and effects on prehistoric resources because it would destroy the greatest number of sites with the highest acreage of archaeological remains. It combines Cliff, Roosevelt, and Confluence which all contain high quality, unique resources. In addition to the resources at Cliff and Roosevelt described in Plans 1 and 2, the high quality resources at the Confluence site would be negatively affected.

Research in the Confluence area indicates several differences between sites on the Salt River arm and sites on the Verde arm. Together, the Cliff, Roosevelt, and Confluence site areas represent a large social network which interacted on a regular basis. Because of this, Plan 3 would have an irreversible effect on a major data base which can provide valuable information on local and regional patterns of trade, interaction, social organization, and political organization in the central Arizona area.

Because of the severity of impacts of Plan 3 to prehistoric resources, this effect is considered an Adverse Flag.

(d) Plans 6 and 7

Plans 6 and 7 have identical impacts to prehistoric resources. These plans are preferable to Plan 3 because the impacts at New Waddell are much less severe than at the Confluence site. While the number of sites is relatively close, the acreage of archaeological remains is much higher at Confluence.

The effect of Plans 6 and 7 to prehistoric resources is considered an Adverse Flag.

(e) Plan 9

More sites are predicted to occur within the Plan 9 area than in any other plan. Nevertheless, Plan 9 is estimated to have a relatively low level of impact upon archaeological resources with only Plan 2 resulting in less adverse impacts. Because this plan involves no new reservoirs and increased size of three existing reservoirs, only 53 sites are estimated to be within construction zones where impacts would be severe.

Almost 95 percent of the Plan 9 sites lie in high flood pools or secondary impact zones where impacts will be infrequent and less damaging.

(2) Historic Cultural Resources

(a) Plan 8

None of the 192 inventoried historic sites within the CAWCS study area will be affected by the project under this alternative even though some of these sites may deteriorate, the sites will probably continue to be present in the future. Many of these sites will increase in significance due to their increased age and uniqueness. In addition, existing sites which were not considered during this study due to their relatively recent age will achieve significance in the future as they become older and more representative of the past.

(b) Plans 1 and 2

A total of 103 inventoried historic sites are present at the 3 affected site areas within both of these plans. Of this total, 89 sites possess scientific or historical values which would suggest that they are potentially eligible for inclusion on the National Register of Historic Places. Between 29 (typical-year reservoir) and 64 (maximum reservoir) sites would be impacted as a result on Plan 1; 27 and 59, respectively, would be destroyed; and 2 and 4 sites, respectively, would be altered. One site would be impaired. The effect of these impacts is expressed as an Adverse Flag with a comparative effect factor rating of between minus 173 and minus 370.

(c) Plan 3

A total of 177 inventoried historic sites are present at the four affected site areas within this plan. Of this total, 163 are potentially eligible for nomination to the National Register of Historic Places. Between 73 and 90 sites, respectively, would be impacted as a result of this plan; 72 and 85 of these respective totals would be destroyed; 1 and 4 sites would be altered, and one site would be impaired. Included is Fort McDowell, a particularly important site which would either be altered or partially destroyed. The effect of these impacts is expressed as an Adverse Flag with a comparative effect factor rating of between minus 434 and minus 798.

(d) Plans 6 and 7

A total of 118 inventoried historic sites are present at the 4 affected site areas included in these plans. Of this total 100 sites are potentially eligible for nomination to the National Register of Historic Places. Between 39 and 73 sites, respectively, would be impacted as a result of Plan 6; 39 of these respective totals would be destroyed. Between 3 and 6 would be altered; and 2 to 3 sites would be impaired. The effect of these impacts is expressed as an Adverse Flag with a comparative effect factor rating of between minus 225 and minus 422.

(e) Plan 9

A total of 121 inventoried historic sites are present at the four affected site areas within this plan. Of this total, 103 are potentially eligible for nomination to the National Register of Historic Places. Between 37 and 67 sites would be affected by this plan; 32 to 58 of these would be destroyed; 3 to 6 would be altered, and 2 to 3 would be impaired. The effect of these impacts is expressed as an Adverse Flag with a comporative effect factor rating of between minus 207 and minus 383.

Impacts and effects of each plan are presented below and are summarized in Table IV-29 for comparative purposes.

TABLE IV-29

HISTORIC SITE IMPACT/EFFECT BY PLAN

	Plan 8	Plan 1	Plan 2	Plan 3	Plans 6-7	Plan 9
Number of Sites	192	103	103	177	118	121
Number of "Significant" Sites	174[a]	89	89	163	100	103
Total Number of Sites Impacted (Range)[b]		29-64	29-64	73-90	39-73	37-67
-Destroyed (Range)		27-59	27-59	72-85	34-64	32-58
-Altered (Range		2-4	2-4	1-4	3-6	3-6
-Impaired (Range)		1	1	1	2-3	2-3
Effects Factor[c] (Range)		-173 to -370	-173 to -370	-434 to -798	-225 to -422	-207 to -383

[a]Sites will in general tend to deteriorate

[b]Range indicates the smallest number of sites affected to the largest number of sites affected, and reflect different reservoir pool levels.

[c]Comparative effect factor ratings are based on the severity of impact to the site and the value or importance of the site. The higher the rating the more severe are the impacts. This index is more fully explained in Stage III Methodology for Environmental Quality Assessment, Section 4.4.2.

d. Mitigation

The Advisory Council on Historic Preservation (Council) "Procedures for Protection of Historic and Cultural Properties" (36 CFR 800) require that Federal agencies make a determination of effect in consultation with the appropriate State Historic Preservation Officer (SHPO). The criteria of effect as defined in 36 CFR 800 are applied when it is determined that

cultural properties on or eligible for listing on the National Register of Historic Places may be affected by the agency's project. Reclamation has determined that CAP, as a whole, will adversely affect cultural resources, and in accordance with 36 CFR 800 has entered into a programmatic memorandum of agreement (PMOA) with the Council and the appropriate SHPOs. As stipulated in the PMOA, an historic preservation plan is being developed for the entire CAP and this plan will be used to guide development of a specific mitigation plan for CAWCS.

Mitigation of adverse impacts upon cultural resources is aimed at preserving the significant values of sites. This can be accomplished by avoiding sites and leaving them intact or by recovering the information they embody prior to their alteration or destruction. Because cultural resources are nonrenewable, the preferred general strategy is to protect sites in place. It may be feasible to avoid some sites where it would not involve a major modification of planned construction or operation activities. In addition, a substantial number of sites could be protected by development and implementation of a long-term management plan for sites in upper reservoir flood pools or secondary impact zones. Impacts to many sites, however, could not be avoided and mitigation would require data recovery studies. Data recovery efforts will therefore be guided by priorities based on relative site significance as well as magnitude and probability of impacts.

e. Residual Impacts

The data recovery approach to impact mitigation assumes that it is not necessary or possible to recover all information from each site; therefore, unrecovered information would remain at some sites and would be lost or destroyed as a result of project implementation. Even though the impact analysis presented above displays considerable variations among the plans, all are ranked as an Adverse Flag because of these residual impacts. Because of overriding public benefits to be realized through project implementation, the loss of cultural resource data or value losses may be deemed acceptable. Presumably, any unrecovered information would be of low research value.

f. Impacts with Modified Roosevelt and Modified Stewart Mountain in Plans

There is no difference in impacts to prehistoric cultural resources between New and Modified Stewart Mountain Dam since the water level would remain the same and borrow material would be obtained from outside of the site area. There would also be no difference between the New and Modified Roosevelt Dam because no sites are recorded in the vicinity of the new dam

site. The difference in maximum water level is also minimal, although in some rare instances sites located on the 2,136-foot contour could be inundated for a longer period of time.

The effects on historic sites are also similar whether new dams or modified dams are constructed. The difference between New and Modified Roosevelt is that with a new dam, the existing dam would have to be partially dismantled and breached. Any remnants would be inundated during normal operation; modification requires raising the existing dam, a change that would severely alter its physical structure. Either action would alter the original architectural integrity of the dam. Modification of the structure would not totally detract from the association of the dam with historic water development and would potentially allow for preservation of the downstream transformer building and parts of the power house which date from the period of original dam construction. New Stewart Mountain Dam would result in the destruction of the existing dam which is potentially eligible for inclusion on the National Register of Historic Places. Modified Stewart Mountain Dam would moderately alter the existing dam; the addition of a new spillway may not affect the potential of the dam to be placed on the National Register.

5. Social Resources

a. Types of Impacts to People

The social impacts analysis focuses on (1) impacts of relocation to individuals, families, and communities and (2) impacts of flood reduction on transportation, health, and safety.

Relocation would occur at the following dams and would involve the communities or entities indicated:

- Confluence Dam - Fort McDowell Indian Community (Plan 3)
- Roosevelt Dam - Rockhouse Farm, Roosevelt Lake Estates, North Bay Estates, and Roosevelt Gardens East (all action plans)
- Cliff Dam - KA Ranch (all action plans except Plan 9)

Flood reduction impacts would occur in the 200-year flood plain of the Salt and Gila Rivers through the Phoenix metropolitan area. Affected communities include the cities of Mesa, Tempe, and Phoenix; the town of Buckeye and surrounding areas; the Salt River and Gila River Indian Communities; and the area surrounding and including the Holly Acres subdivision.

b. Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Relocation and flood reduction impacts would be the same for New or Modified Roosevelt or Stewart Mountain because lake elevations, size, storage allocations, and flood control operations would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact between either option.

c. Methodology

Numerous factors were identified for both relocation and flood reduction impacts that were judged to best "capture" the social consequences of project actions. These factors were grouped into three categories: individual, interpersonal, and community factors. The selection of factors was based upon an extensive review of the research literature and on discussions with members of the affected populations. Both primary and secondary sources of data were incorporated into the assessment.

The literature review yielded a list of characteristics associated with success in adapting to relocation and with the ability to cope with disaster. The affected populations were compared with these lists of characteristics, and projections were made about the general level of expected impacts. The factors were measured for existing conditions, based on primary data that were collected using three techniques. First, case histories were conducted with members of the affected populations. These histories were recorded and transcribed; they contained information about the recent characteristics of the population and about the factors that would be traced across the project conditions. Second, interviews were conducted with key informants who were chosen for their specialized knowledge about some aspect of the impact assessment. Third, field observations were made and recorded by researchers who visited affected communities; they attended community functions and public meetings, and made notes on their observations.

Secondary data were used extensively in the assessment as well. Information relevant to the impact assessment that was collected in conjunction with several research projects was incorporated, as well as demographic information obtained from census data and local, state, and federal government agencies.

Data analysis consisted of making impact projections, rating the level of the impact, and assessing the probable effect of the impacts. Impacts were rated according to one of five levels. Changes were rated as follows, depending on the probability of occurrence, likely duration, number of people affected, reversibility of the impact, and the extent to which many areas of life were affected: 1) no change, 2) slight change, 3) moderate change, 4) substantial change, or 5) extreme change. For example, an extreme impact would have the following characteristics: it is very likely to occur, would last for a long time, would be difficult to reverse and would affect many areas of a person's life. In contrast, an impact described as slight may be irreversible, but may only affect a few people or alter some factor that is not highly valued.

The effect rating is contingent upon the value system of those experiencing the impact; the magnitude, duration, extent, and probability of impact; and the professional judgment of the analyst.

d. Relocation

The consequences of relocation vary, both on the individual and community level. Depending on the nature of the relocation and

on the characteristics of affected individuals and communities, the consequences of relocation could range from temporary stress to permanent lifestyle disruption. The impact of relocation depends on two general conditions: (1) how much change is generated by relocation, and (2) how that change is interpreted and tolerated by the people who are relocated.

Stress and its manifestations are the primary impacts of relocation to individuals, families, and communities.

Relocations would occur at the Fort McDowell Indian Community (Plan 3) and the Roosevelt Lake communities (Plans 1, 2, 3, 6, 7, and 9). While impacts at both areas are adverse, relocation of the Fort McDowell Community assumes an extraordinary adverse dimension because of characteristics of the community. By comparison, Roosevelt Lake impacts are less severe; however, they are still rated as Significant Adverse prior to mitigation.

(1) Fort McDowell Indian Community

Table IV-30 summarizes the impacts and effects of relocation for the Fort McDowell community, which are discussed below.

(a) Direct and Indirect Impacts of Plan 8 and Plans 1, 2, 6, 7, and 9

The existing conditions at Fort McDowell reflect changes in the community that are a result of long-proposed relocation. The future-without condition will be significantly altered. For example, health problems resulting from proposed relocation will be reduced and illness rates will return to normal.

The potential for economic self-sufficiency, community autonomy, and viability will be higher in the future-without condition than the present condition. The tribe's economy will no longer be stymied by the prospects of impending relocation, and the stature of community leaders and tribal government will be enhanced because they succeeded in preventing the community's relocation.

Identical conditions are predicted to occur with Plans 1, 2, 6, 7, and 9. It is probable that conditions would be even better with these plans than with Plan 8 because any future potential for a Confluence Dam would be eliminated by implementation of these plans.

(b) Direct and Indirect Impacts of Plan 3

The Confluence Dam and Reservoir would inundate a large portion of Fort McDowell Indian Community lands. Approximately 13,000 acres of the total 25,000 acres owned by the tribe would be acquired by the Bureau of Reclamation for the dam and reservoir. Some 290 members of the 374-member community would be relocated.

Table IV-30

FORT McDOWELL INDIAN COMMUNITY
IMPACTS AND EFFECTS OF RELOCATION

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 3	Plans 1, 2, 6, 7 and 9
Social Factors			
	No Relocations (374 people in affected community)	290 Relocations (77% of affected population)	No Relocations
Individual			
1. Changes in physical and mental health problems	1. Normal incidence of physical and mental health problems given age distribution of population	1. High incidence of physical and mental health problems which is expected to result in increased mortality rates	1. There are no impacts because no individuals are relocated
2. Changes in personal autonomy: (the degree to which individuals believe they have freedom and power to control their lives)	2. High levels of personal autonomy	2. Extreme decline in levels of personal autonomy	
3. Satisfaction with way of life	3. High satisfaction with way of life	3. Extreme decrease in satisfaction with way of life	
4. The potential for financial self-sufficiency	4. High potential for increased financial self-sufficiency	4. Substantial decrease in potential for sustained financial self-sufficiency	
Interpersonal			
1. The nature and extensiveness of family ties and informal support networks	1. High levels of extended family ties; highly integrated support systems within the family and tribe	1. Substantial decrease in extended family ties and family support networks	1. No Impact
2. Incidence of family problems such as divorce, child abuse and neglect, and alcohol and drug abuse	2. Normal incidence of family problems	2. Substantial increase in incidence of family problems such as divorce, child abuse and neglect, and drug abuse; moderate incidence of alcohol abuse	
Community			
1. Community Cohesiveness (the extent to which a community is unified with individuals mutually depending on each other for support)	1. High community cohesion; high levels of informal support networks	1. Extreme decrease in community cohesion. Substantial decline in number and efficacy of informal networks	1. No impact
2. Community Viability	2. High community viability (significant increase from present condition); strong community leadership; high potential for tribal autonomy	2. Extreme decrease in community viability; substantial decline in autonomy (ability to control the direction of the community) and in efficacy of tribal leadership; elimination of trend toward self-determination	

Table IV-30 (Continued)

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 3	Plans 1, 2, 6, 7 and 9
	No Relocations (374 people in affected community)	290 Relocations (77% of affected population)	No Relocations
Community (Con't)			
3. Economic self-sufficiency (the degree to which a community is/is not reliant on outside agencies for economic support); unemployment rate	3. High potential for increased tribal economic self-sufficiency; moderate level of unemployment	3. Substantial decrease in potential for tribal economic self-sufficiency (increased dependency on governmental services); substantial increase in unemployment	
4. Potential for sustaining the Yavapai culture	4. High potential for sustaining Yavapai culture	4. Extreme decrease in potential to sustain Yavapai culture	
Conceptual Mitigation			
	1. NA	1. Relocate the entire community together; do not relocate on an individual basis	1. NA
		2. Provide the tribe with additional land equal to or greater in size than that acquired, and of the highest quality available which is contigous to the reservation boundaries	
		3. Monetary compensation should cover all expenditures and new expenses incurred by the residents as a result of relocation and should be distributed according to the tribe's wishes	
		4. Provide special services to meet needs that are unique to this community	
		5. Initiate a plan that ensures the participation of the entire community in all decisions and plans related to the relocation	
		6. Provide an accurate, reliable system for disseminating information to residents so that they are constantly informed about the relocation proceedings; provide a means by which residents can participate in the relocation planning	

Table IV-30 (Continued)

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 3	Plans 1, 2, 6, 7 and 9
	No Relocations (374 people in affected community)	290 Relocations (77% of affected population)	No Relocations
Residual Impacts			
1. Residual impacts are those that cannot be eliminated by mitigation measures	1. NA	1. Mitigation could not eliminate any of the impacts of relocation among Fort McDowell residents. At best it could only slightly reduce a few of the impacts.	1. None
Unmitigated/Mitigated Effects			
	1. NA	AF/AF	No Effect

The consequence of this project action would be a marked increase in stress at both the individual and community level. The stress that would result from relocation of the Yavapai would be made manifest in three general ways: physiologically, psychologically, and socioculturally. Each of the following predicted impacts is a specific manifestation of one of these three forms of stress.

(i) Increase in Physical and Mental Health Problems: Following relocation, the Yavapai would experience increased physical and mental health problems that are expected to result in an increase in the community's mortality rates. Residents have experienced escalated stress levels resulting from threats of relocation, and medical utilization rates have significantly increased as the stress has escalated.

(ii) Extreme Decline in Levels of Autonomy: Relocation would result in an extreme decline in both personal and tribal autonomy. For many residents, their opposition to relocation has become the most critical issue in their lives. If, despite years of activity in which virtually every resident participated, they failed to prevent the construction of a Confluence Dam, residents inevitably would feel a sense of defeat. This defeat would be construed as evidence that they are powerless to protect their own interests and effect change.

(iii) Substantial Decrease in Potential for Sustained Economic Self-Sufficiency: Past experience with resettlement programs indicates that forced relocation for an Indian community does not improve the financial status of the residents. Almost invariably, monetary compensation, even including sums that appear quite generous, does not result in sustained financial security for relocatees and their descendants.

(iv) Decrease in Family Support Systems, Increase in Family Problems: The severe stress, demoralization, and sense of defeat experienced by the community would take its toll on family members causing disturbed family life, depression, anxiety, and a breakdown of family support systems. The hardships and pressures brought to bear on the family would result in disorganization within the family structure. The incidence of family problems such as alcohol and drug abuse, family violence, and child neglect is expected to increase.

(v) Extreme Decrease in Informal Support Networks and in Community Cohesiveness: Relocation disrupts social support networks. Normal behavior patterns are disrupted and people become isolated from each other as they attempt to cope with the shock of resettlement.

The disruption of support networks would substantially reduce the cohesiveness of the community. This cohesiveness is, in part, a consequence of residents' shared strong attachments to their land and their belief in their ability to control their lives and sustain the community. Relocation would disrupt their attachment to the land and cause residents to lose confidence in themselves and in their leaders. This would further reduce the cohesiveness of the community.

(vi) Extreme Decline in Satisfaction With Life: Residents of Fort McDowell are currently very satisfied with their lives except for stress caused by threat of relocation. The tribe is making significant progress toward their goal of self-determination. This would cease if residents were forced to relocate. Residents virtually all agree that the vast changes induced by their relocation would be highly undesirable and would alter those things which are presently most satisfying to them.

(vii) Extreme Decrease in Community Viability: Community viability is defined as the ability of a community to sustain itself. It is projected that compulsory relocation would result in an extreme decrease in the viability of the Fort McDowell community, for the following reasons:

Relocation would have deleterious consequences for the economy at Fort McDowell. Unemployment would increase and economic development activities would be abandoned because, following relocation, the Fort McDowell community would not have a reliable economic base.

One of the most commonly reported outcomes of compulsory relocation is the demise of the leadership or local government of the affected population. Besides losing confidence in their leadership, the residents would lose confidence in their system of government, for they would perceive it as inadequate to protect them and meet their most basic needs.

For Fort McDowell residents, the community is their tribe; it constitutes an integral part of their cultural identity. Relocation would disrupt their strong identification with their community because of the interrelatedness of their culture, community and land.

(viii) Extreme Decrease in Potential to Sustain Yavapai Culture: The prehistory and history of the Yavapai demonstrates that culturally and historically they are a people distinct from other groups in the Southwest.

Relocation would likely result in the destruction of the culture and society of the Yavapai. Even if the community would be relocated as a whole, it could take decades for new ties to form. In a cultural sense, fundamental patterns of social interaction, which are public displays of cultural behavior, can no longer be carried out after relocation. Although Yavapai people will survive as will some aspects of the culture, fundamental subsystems would be irreparably damaged, especially those that relate to the tribe as a cultural and legal entity, the community in its relationship to the land, and the people in their social relationships.

(c) Mitigation and Residual Impacts

The conceptual mitigation plan for Fort McDowell residents is outlined in Table IV-30. The impacts at Fort McDowell would be severe, irreversible, long lasting, and would affect every member of the tribe. While some mitigation may be possible, it would not significantly reduce the effects of relocation impacts.

One impact that could be partially mitigated is the breakdown of extended family and social networks. Enough land could be provided for the entire community to duplicate existing spatial housing patterns. Such an arrangement would have less of an impact than dispersing family and neighborhood networks, providing that residents were in good mental and physical health. Clearly, money would not mitigate any of the social impacts described here; money would, however, be paid to the tribe in compensation for land required by the project. Many members of the tribe have expressed concern for the consequences of an influx of large sums of money to people not experienced or trained to invest it.

Since mitigation does little to reduce the impacts of relocation on Fort McDowell residents, residual impacts remain virtually the same as unmitigated impacts. The mitigated effect remains the same, Adverse Flag.

(2) Roosevelt Lake Communities

The impacts and effects of relocation for Roosevelt Lake area residents are summarized in Table IV-31.

(a) Direct and Indirect Impacts of Plan 8

In the future-without condition for Roosevelt Lake communities, few changes in population numbers and characteristics are expected from the existing condition. This is because little private land remains available in the area, and residents do not want increased development. The proportion of full-time residents, however, will increase as individual lots are developed and housing structures are made more permanent.

(b) Direct and Indirect Impacts of Plans 1, 2, 3, 6, 7, and 9

With all action plans (Plans 1, 2, 3, 6, 7, and 9) Roosevelt Dam would be modified or a new dam built, creating a larger reservoir than currently exists. Land would be acquired by the Bureau of Reclamation for the larger reservoir, and homes and businesses within the take-line would be relocated.

As a result of differences among action plans, the number of people relocated at Roosevelt Lake would vary; however, the general impacts would be the same because of the similarity in the communities that would be affected. In the following sections, these general impacts are first described, and then the differences in the affected communities of Rockhouse Farm, Roosevelt Lake Estates, North Bay Estates, and Roosevelt Gardens East are discussed.

(i) General Impacts at Roosevelt Lake: Relocation would be stressful for Roosevelt Lake residents and would require considerable adjustment for them. Many residents are older and live on fixed incomes. Since private land is no longer available in the immediate vicinity,

Table IV-31

ROOSEVELT LAKE AREA
AGGREGATED IMPACTS AND EFFECTS OF RELOCATION

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 2	Plans 1, 3, 6, 7 and 9
Social Factors	No Relocations (596 people in affected communities)	247 Relocations (40% of affected population)	347 Relocations (58% of total population)
Individual			
1. Changes in physical and mental health problems	1. Normal incidence of physcial and mental health problems given age distribution of population	1. Slight increase in physical and mental health problems resulting from increased stress	1. Slight increase in physical and mental health problems resulting from increased stress
2. Changes in personal autonomy (the degree to which individuals believe they have freedom and power to control their lives)	2. High levels of personal autonomy	2. Substantial decrease in personal autonomy	2. Substantial decrease in personal autonomy
3. Satisfaction with way of life	3. High satisfaction with way of life	3. Substantial decrease in satisfaction with way of life	3. Substantial decrease in satisfaction with way of life
4. The potential for financial self-sufficiency	4. High potential for financial self-sufficiency	4. Moderate reduction in potential for self-sufficiency	4. Moderate reduction in potential for self-sufficiency
Interpersonal			
1. The nature and extensiveness of family ties and informal support networks	1. Low levels of informal support networks in all communities except Roosevelt Gardens; at Roosevelt Gardens moderately developed informal support networks. Family interaction primarily within nuclear family at all locations	1. Slight decrease in informal support networks among family and friends	1. Moderate decrease in informal support networks. Slight decrease in informal interactions between households
Community			
1. Community Cohesiveness (the extent to which a community is unified with individuals mutually depending on each other for support. A cohesive community is characterized by extensive informal support networks, frequent personal interaction, and by strong personal identification of residents with the community as a whole)	1. Low to moderate community cohesion in all communities except Roosevelt Gardens; high community cohesion at Roosevelt Gardens (formal social organization emerges on temporary basis to meet needs and respond to immediate problems). Low level community organization on day to day basis. (Emphasis on individuality more than community)	1. Slight decrease in community cohesion and social organization	1. Moderate decrease in community cohesion and slight decrease in social organization
2. Community Viability (the ability of a community to sustain itself)	2. Community development likely to remain at present low level which is adequate to sustain viability. Moderate potential for sustained community viability at area level	2. Moderate decrease in potential for sustained community viability	2. Substantial decrease in potential for sustained community viability

Table IV-31 (Continued)

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 2	Plans 1, 3, 6, 7 and 9
Conceptual Mitigation			
	1. NA	1. Relocate only those people who live within the area likely to be inundated more than once in 200 years, but not within the larger IDF area; provide low-cost flood insurance to people residing in the IDF area	1. Relocate only those 50 people who live within the confines of the 200-year flood pool, with no relocation of people in the IDF area 2. Provide low-cost flood insurance to people in the IDF area 3. Provide Forest Service land in the Roosevelt Lake area bordering Roosevelt Lake Estates for relocations, allowing enough space so neighbors may relocate near each other if they wish. 4. Provide monetary compensation for all relocation expenses incurred by residents 5. Provide special services to meet needs that are unique to these communities 6. Provide an accurate and reliable system for disseminating information to residents so that they are constantly informed about relocation proceedings; provide a means by which residents can participate in the relocation planning process

Table IV-31 (Continued)

Impacts and Effects	Plan 8 CAWCS No Action Future Without Project	Plan 2	Plans 1, 3, 6, 7 and 9
Residual Impacts			
1. Residual impacts are those that cannot be eliminated by mitigation measures	1. NA	1. None. If mitigation measures are implemented no people will be relocated	1. 50 individuals reside below elevation 2,173 feet at Roosevelt Lake Estates and would require relocation with mitigation. These individuals would experience slight levels of stress and inconvenience if relocated within the community and awarded equitable compensation
Unmitigated/Mitigated Effects			
	1. NA	SA/No Effect	SA/I

relocation could force many to leave the area. If residents could no longer maintain the same lifestyle elsewhere, the change in their lives would be both significant and disruptive.

Stress levels would be limited, to some extent, because there is not a high degree of consensus among residents regarding their expectations about relocation. None of the residents want to be relocated, but some feel they could adjust quite easily to relocation. Some residents believe that relocation would undermine their ability to live as they desire, while other think relocation would not change much in their lives.

If forced to move, residents would be very upset and disappointed; however, they would not construe their relocation as a personal defeat and would not be likely to internalize feelings of helplessness or failure which would reduce their ability to cope with the stress.

Since community cohesiveness, formal organization, and community viability are generally at low or moderate levels, relocation would not significantly reduce these factors even if it results in the dissolution of the community, as with Rockhouse Farm or North Bay Estates.

The aggregate impact to Roosevelt Lake residents is displayed in Table IV-31. The unmitigated effect has been evaluated as Significant Adverse. The severity of the impact stems from residents' strong desire to remain in the area, the problems associated with moving and re-establishing a home, financial considerations, and relocating large proportions of, or in some cases, entire communities. Differences among the effected communities are described below.

(ii) Rockhouse Farm: All of the 47 residents of Rockhouse Farm would be required to relocate with all action plans. The residents (except the owners of the mobile home park) rent their trailer lots; most rent their mobile homes or trailers as well. The degree of change caused by relocation of this community would not be great.

(iii) Roosevelt Lake Estates: Approximately 125 people would be relocated from Roosevelt Lake Estates with Plan 2; 175 people would be relocated with Plans 1, 3, 6, 7, and 9. A total of 359 people live in the Estates. The Estates residents own their own property. Since no private property remains available near the lake, those who are relocated would have to leave the area. This would disperse the community, disrupt interpersonal relationships, and substantially reduce individuals' feelings of satisfaction and autonomy.

(iv) North Bay Estates: All of the 60 residents of North Bay Estates would be relocated with all the action plans. About two-thirds of North Bay Estates residents live there only part-time. As a result, the community is not highly cohesive or well developed and community level impacts are minimal. However, individual level impacts would result in significant change for people who would be relocated.

(v) Roosevelt Gardens East: Fifteen people would be relocated as a result of Plan 2. Most of these are part-time residents, so impacts on all levels would not be great. Since private land near the lake is no longer available, residents would have to leave the area. With Plans 1, 3, 6, and 7, about one-third of the residents would have to relcoate, and impacts would be more adverse.

(vi) Impacts to Roosevelt Lake Area Business: The Lakeview Marina on the east side of the lake would be relocated with all action plans. The marina is the only boat launching ramp of its kind at Roosevelt lake and includes a small store equipped with supplies. The Rockhouse Farm store and trailer park, also on the east side of the lake, would require relocation with all action plans. One ranch, located on the west of the lake in Roosevelt Gardens East, would be relocated with all action plans. Other lands used by ranches for grazing cattle on both sides of the lake would be inundated with any increase in the lake's elevation.

Area businesses would experience a decrease in sales and profits if nearby communities are relocated. Recreational facilities would experience a temporary loss in income, with long-term prospects of profitability increasing because of greater recreational use of the lake. The Punkin Center School would have a decrease in enrollment if residents are relocated out of the area.

(c) Mitigation and Residual Impacts

The conceptual mitigation plan for Roosevelt Lake relocations focuses on not relocating people from ares where the probability of reservoir inundation is very low; in all plans, mitigation would consist of not relocating people from the IDF area. Other provisions of the conceptual mitigation plan are presented in Table IV-30.

With mitigation, the severity of the impacts would be greatly reduced in Plans 1, 3, 6, 7, and 9 resulting in an insignificant effect. The 90 families still requiring relcoation with mitigation (those who live at elevations below 2,173 feet) live near the northern boundary of Roosevelt Lake Estates, close to the lake. About half of these are part-time residents, many of whom are planning to retire in the community. Since it is possible to compensate for financial losses, to provide land in the area so that residents can retain the same lifestyle, and to provide moving services, the impacts of relocation for these 90 families can be significantly reduced. If these individuals can be relocated to higher Forest Service land adjacent to the community and compensated for all expenses incurred as a result of their move, all impacts would be virtually eliminated.

Mitigation for Plan 2 would eliminate all impacts because there would be no relocations.

(3) KA Ranch (Cliff Dam)

Relocation would occur at the Cliff site under all action plans except Plan 9. The impacts and effects of relocation at the KA Ranch within the Cliff site area are summarized in Table IV-32. The

Table IV-32

CLIFF SITE (KA RANCH)
IMPACTS AND EFFECTS OF RELOCATION

Impacts and Effects	Plan 8 and Plan 9 CAWCS No Action Future Without Project	Plans 1, 2, 3, 6, and 7
Social Factors		
	No Relocations (16 people reside at the ranch)	16 Relocations (100% of total population)
Individual		
1. Changes in physical and mental health problems	1. Normal incidence of physical and mental health problems	1. No change in incidence of physical and mental health problems
2. Changes in personal autonomy (the degree to which individuals believe they have freedom and power to control their lives)	2. High levels of personal autonomy	2. Slight decrease in personal autonomy
3. Satisfaction with way of life	3. High satisfaction with way of life	3. Slight decrease in satisfaction with way of life
4. The potential for financial self-sufficiency	4. High potential for financial self-sufficiency	4. Moderate reduction in potential for self-sufficiency
Interpersonal		
1. The nature and extensiveness of family ties and informal support networks	1. High levels of informal support networks among familial households	1. No impact
Conceptual Mitigation		
	1. NA	1. Monetary compensation should cover all expenditures and new expenses incurred by the residents as a result of relocation
		2. Attempt to replace patented land owned by residents with equivalent acreage in region with potential for adjacent grazing lease land and sufficient water rights to grow feed for cattle operation
		3. Provide an accurate, reliable system for disseminating information to relocatees so that they are constantly informed about the relocation proceedings

Table IV-32 Continued)

Impacts and Effects	Plan 8 and Plan 9 CAWCS No Action Future Without Project	Plans 1, 2, 3, 6, and 7
Residual Impacts		
1. Residual Impacts are those that cannot be eliminated by mitigation measures	1. NA	1. Mitigation procedures would lessen the stress and financial problems associated with relocation, althoug residents would experience minor stress and inconvenience while relocations take place.
Unmitigated/Mitigated Effects		
	1. NA	I/I

unmitigated impacts at the KA Ranch stem mostly from financial considerations and from the residents' desire to live in the area. Mitigation, based on monetary compensation and providing equivalent alternate land, could reduce the impacts. The impacts are described as slight because of the small number of people involved (16 people) and steps the family has taken to remain together in the area. The current owners of the ranch have recently pruchased another ranching operation in the area and plan to relocate together.

e. Flood Damage Reduction

This section described the social impacts and effects of flood damage reduction. Impacts and effects of alternative plans, including no action, are described in Tables IV-33, IV-34, and IV-35. Alternative plans are associated with three floodflow levels. Plan 8 (no action) does not provide flood control. Plan 2 provides control of the 200-year flood (275,000 cfs) to 157,000 cfs at Sky Harbor Airport. Plans 1, 3, 6, and 7 control the 200-year flood to between 70,000 and 92,000 cfs at the airport. Plan 9 controls the 200 year flood to 215,000 cfs.

(1) Types of Flood Damage Reduction Impacts

Each of the alternative flood control plans are analyzed according to two levels of measurement: individual and area. The individual level of analysis describes the direct effects of flooding while the area level described the indirect effects.

The direct impacts of flood control are the reduction or elimination of conditions experienced by individuals as a result of property inundation during and following a flood. These conditions include changes in physical and mental health, financial capacity, and life satisfication. Indirect impacts are the reduction or elimination of threats to area-wide public safety and welfare during and following a flood. These threats are contingent upon the degree of breakdown experienced by a particular area's physical infrastructure and public safety organizations. Area level impacts are assessed according to organizational characteristics peculiar to the CAWCS study area. These include disruptions in automobile, air, and rail transportation; public utilities; telecommunication; public safety response organizations; business operations; tourism; and communities inundated as they relate to public safety and welfare. One added impact of flood control is the additional land available for development as a result of reduced flood flows.

The degree of individual and area wide disruption in a flooding disaster varies; it depends largely upon the suddenness, duration and intensity of a particular flood event. Historic flooding events are used to characterize the type of impacts caused by floods in central Arizona.

(2) Direct and Indirect Impacts of Plan 8

Future social conditions without flood control are assumed to be conditions in the event of a 200-year flood by the year 2000. In the CAWCS study area, the 200-year flood is defined as a flow of 275,000 cfs as measured at Sky Harbor International Airport. Projection of the year 2000 population for the Salt-Gila flood inundation area 46,560. This number is slightly less than 2 percent of the projected Maricopa County population of

TABLE IV-33

FLOOD DAMAGE REDUCTION IMPACTS OF PLANS 1, 3, 6 and 7
CONTROL OF 200-YEAR FLOOD TO FLOW OF 70,000 TO 92,000 cfs

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Individual Level Factors			
(1) Physical and Mental Health	Potential for inundation area impacting of 46,560 individuals in year 2000. High probability for large number of flood-related deaths. Widespread potential for physical injury, illness, and severe stress for flood victims. High levels of disorganized (panic) activity.	Potential for inundation area impacting less than 100 individuals in year 2000. No flood-related deaths anticipated. Potential for physical injury and illness for less than 100 individuals. Low levels of disorganized (panic) activity.	Elimination of potential for inundation area impacte >46,460 individuals. Elimination of high probability of large number of flood-related deaths. Potential for physical injury and illness and severe stress eliminated for >46,460 individuals. Substantial reduction of potential for disorganized (panic) activity.
(2) Net Disaster Losses	Projected $87,292,000 in residential property damages in year 2000; majority of 46,560 individuals directly affected in low-to-moderate income brackets. Majority	Projected $602,000 in residential property damage in year 2000. Majority of <100 individuals affected low-to-moderate income sequential flooding disaster	Reduction of $86,690,000 in residential property damage by year 2000; majority of directly affected individuals in low-to-moderate income

TABLE IV-33 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Individual Level Factors (Continued)			
	of flood victims required to obtain loans or use personal savings to make repairs to property.	victims. Majority of <100 individuals inundated required to obtain loans or use personal savings to make repairs to property.	brackets. Extreme reduction of potential for loans and depletion of personal savings for property repairs by majority of >46,460 individuals.
(3) Lifestyle Disruption	Temporary lifestyle disruption for 46,560 individuals subject to inundation by floodwaters. Long and debilitating cleanup for many months; lost work and school time. Permanent changes in lifestyle for majority of 525 sequential disaster victims in Holly Acres subdivision.	Temporary lifestyle disruption for <100 individuals subject to inundation; permanent lifestyle disruption for majority of <100 sequential disaster victims in Holly Acres.	Extreme reduction of lifestyle disruption. Elimination of disruptions for >46,460 individuals. Elimination of lost work and school time for >46,460 individuals.

TABLE IV-33 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Area Level Factors			
(1) Transportation Disruptions			
- Automobile	Damages to roads and bridges projected to be $15,800,000 by year 2000. 0-1 river crossings operable. Transportation delay costs projected to be $39,694,000 by year 2000. High levels of stress experienced by area motorists due to traffic delays and hazardous driving conditions. Many unable to cross floodplain area.	15 bridge crossings remain operable. Closure of dip crossings. Damages to roads and bridges totalling <$5,000,000. No significant delays in transportation by the year 2000.	14-15 bridge crossings maintained. Substantial reduction of costs of damages to bridges and roads (>$10,800,000). Elimination of significant transportation disruptions.
- Air and Rail	Damages to airport facilities and railroad tracks and yard projected to be $7,021,000 by year 2000. Major delays in air service for 2 days beyond peak flow. Repairs would require 3 months to complete. >$500,000 in damages to airport channel clearing project.	No damage to air and rail transportation facilities. Minor damage may occur to airport channel clearing project.	Elimination of $7,021,00(in damage costs and reduction of damages to airport channel clearing project by year 2000.

TABLE IV-33 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Area Level Factors (Continued)			
(2) Public Utilities	Damages totalling $6,400,000 to electrical transmission towers and power lines: repairs would take 2 months to complete. No blackout expected. >$275,000 in damages to sewage and wastewater treatment plants. Damages to active landfills cannot be quantified at the present time.	Damages to electrical transmission towers and power lines would be well below $1 million. Insignificant damages to sewage and wastewater treatment plants. Damages to active landfills cannot be quantified at the present time.	Substantial reduction of damages to electrical transmission towers and power lines (>$5,400,000). Substantial reduction of damages to sewage and wastewater treatment plants and active landfills.
(3) Communication	Temporary delays in telephone service. Major delays in delivery schedules of newspapers, mail, and other subscription services.	Possibility of delays in telephone service for some. No delays in delivery schedules of newspapers, mail and other subscription services.	Elimination of disruption in delivery service of published material (mail, newspapers, etc.). Substantial reduction in disruption of phone service.
(4) Business Community	Damages totalling $68,713,000; combined both short and long term revenue losses costs could be in excess of $150 million	Damages totalling $6,194,000; Majority of damages occurring to sand and gravel operations.	Reduction of $62,519,000 in damages. Elimination of lost revenues due to transportation disruptions

TABLE IV-33 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Area Level Factors (Continued)			
(5) Tourism	Short- and long-term losses due to forced cancellations of trips and adverse publicity.	No significant disruption in tourist trade.	Substantial reduction of short- and long-term losses due to cancellations of trips and adverse publicity.
(6) Public Safety	Civil defense warning system fully activated. Emergency aid required from outside of metropolitan area. Emergency costs of $1,109,000. Lack of emergency personnel to carry out all door-to-door warnings.	Although no accurate estimate exists for emergency costs in a flood of this level, it is estimated that costs would be below $60,000.	Reduction of <$1,049,000 in emergency costs. Elimination of needed aid from outside of the Phoenix metropolitan area.
(7) Communities Subject to Inundation	Mesa, Tempe, Phoenix, SRPMIC, GRIC, Buckeye, Holly Acres. Breakdowns in established informal support networks and community cohesion for 7 communities.	Less than 100 individuals residing in the subdivision of Holly Acres could be inundated by floods below 100,000 cfs. Major breakdowns in informal support networks and community cohesion would not be anticipated.	Elimination of residential property damage and breakdowns in informal support networks and community cohesion for >46,460 individuals in 7 communities (Mesa, Tempe, Phoenix, SRPMIC, GRIC, Buckeye, Holly Acres).

TABLE IV-33 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level Between 70,000 and 92,000 cfs (Plans 1,3,6,7)	Impact
Area Level Factors (Continued)			
(8) Additional Land Use	No additional land available.	Approximately 3,563 additional acres available for higher urban uses. Valued at $107,311,000 by year 2000.	Additional 3,563 acres available for higher urban uses. Valued at $107,311,000 by year 2000.

TABLE IV-34

FLOOD DAMAGE REDUCTION IMPACTS OF PLAN 2
CONTROL OF 200-YEAR FLOOD TO FLOW OF 157,000 CFS

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Individual Level Factors			
(1) Physical and Mental Health	Potential for inundation for 46,560 individuals in year 2000. High probability for large numbers of flood-related deaths. Widespread potential for physical injuries and illness and severe stress for inundated flood victims. High levels of disorganized (panic) activity.	Potential for inundation for approximately 525 individuals by the year 2000. Low probability for large numbers of flood-related deaths. Potential for physical injury and illness and severe stress for 525 individuals. Low levels of disorganized (panic) activity.	Elimination of potential for inundation for approximately 46,035 individuals in year 2000. Moderate decrease in probability for large number of flood-related deaths. Elimination of potential for physical injury and illness and severe stress for 46,035 individuals. Substantia reduction in potential for disorganized (panic) activity.
(2) Net Disaster Losses	Projected $87,292,000 in residential property damage in year 2000; majority of 46,560 people directly affected are in low-to-moderate income brackets.	Projected $5,684,000 in residential property damage in year 2000. Majority of 525 individuals affected are low-to-moderate income sequential flooding disaster	Reductions of projected $81,608,000 in residential property damage by year 2000; majority of directly affect individuals are in low-to-

TABLE IV-34 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Individual Level Factors (Continued)			
	majority of inundated flood victims required to obtain loans or use personal savings to make repairs to property.	victims; majority of 525 inundated individuals required to obtain loans or use personal savings to make repairs to property.	moderate income brackets. Elimination of potential for loans and depletion of personal saving for property repairs for 46,035 individuals.
(3) Lifestyle Disruption	Temporary lifestyle disruption for 46,560 individuals subject to inundation by floodwaters. Long and debilitating cleanup for many months. Lost work and school time. Permanent changes in lifestyle for majority of 525 sequential disaster victims in Holly Acres.	Temporary lifestyle disruptions for 525 individuals inundated; permanent lifestyle disruption for many of 525 sequential disaster victims in Holly Acres. Lost work and school time for inundated individuals.	Substantial reduction of lifestyle disruption. Elimination of disruption for 46,035 individuals. Elimination of lost work and school time for 46,035 individuals.

TABLE IV-34 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Area Level Factors			
(1) Transportation Disruptions			
- Automobile	Damages to roads and bridges projected to be $15,800,000 by year 2000. 0-1 river crossings operable. Transportation delay costs projected to be $39,694,000 by year 2000. High levels of stress experienced by area motorists due to traffic delays and hazardous driving conditions. Many unable to cross floodplain area.	15 river crossings operable. Damages to roads and bridge crossings totalling >$5,000,000. Closure of all dip crossings. Transportation delay costs considered to be insignificant with new bridge crossings in place. Low levels of stress experienced by area motorists due to minor transportation delays (i.e. added driving distances to cross floodplain).	Substantial reduction of damages to bridges and roads as a result of flooding (<$10,800,000). Substantial reduction of transportation delay costs. Elimination of stress associated with long waits to cross floodplain area.
- Air and Rail	Damages to airport facilities and railroad tracks and yard projected to be $7,021,000 by year 2000. Major delays in air service for 2 days beyond peak flow. Repairs would require 3 months to complete. >$500,000 damage to airport channel clearing project.	No damage to air and rail transportation facilities in year 2000. No delays in service. Approximately $500,000 in damage to airport channel clearing project.	Elimination of $7,021,000 in damages to airport facilities and railroad tracks and yards by year 2000. Elimination of service disruptions.

TABLE IV-34 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Area Level Factors (Continued)			
(2) Public Utilities	Damages totalling $6,400,000 to electrical transmission towers and power lines; repairs would take 2 months to complete. No blackout expected. $275,000 in damages to sewage and wastewater treatment plants. Damages to active landfills cannot be quantified at the present time.	Damages totalling approximately $1,500,000 to electrical transmission towers and power lines. Approximately $80,000 in damages to sewage and wastewater treatment plants (majority at Buckeye Plant). Damages to active landfills cannot be quantified at the present time.	Substantial reduction of damages to electrical transmission towers and power lines ($4,900,000). Reduction of $195,000 in damages to sewage and wastewater treatment plants. Substantial reduction of damages to active landfills.
(3) Communication	Temporary delays in telephone service. Major delays in delivery schedules of newspaper, mail, and other subscription services.	No delays in delivery schedules of newspapers, mail, and other subscription services. Temporary delays in telephone service in some areas. Damage costs cannot be quantified at the present time.	Elimination of delays in scheduled deliveries of subscription services (i.e., newspapers, mail, etc.), due to reduction of transportation disruptions. Substantial reduction in number of telephone service disruptions.

TABLE IV-34 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Area Level Factors (Continued)			
(4) Business Community	Damages totalling $68,713,000; combined with both short and long term revenue losses costs could be in excess of $150 million.	Damages totalling $6,977,000. Majority of damages to sand and gravel operations.	Reduction of $61,736,000 in damages to business community. Substantial reduction of damages to sand and gravel operations.
(5) Tourism	Short- and long-term losses due to forced cancellations of trips and adverse publicity.	No significant disruption in tourist trade.	Substantial reduction of short- and long-term losses due to cancellations of trips and adverse publicity.
(6) Public Safety	Civil defense warning system fully activated. Emergency aid required from outside of metropolitan area. Emergency costs of $1,109,000. Lack of emergency personnel to carry out all door-to-door warnings.	Civil defense warning system fully activated. Emergency costs in excess of $505,000.[a] No aid required from outside of metropolitan area.	Reduction of approximately $604,000 in costs of emergency aid. Elimination of needed aid from outside of the Phoenix metropolitan area.

TABLE IV-34 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 157,000 cfs (Plan 2)	Impact
Area Level Factors (Continued)			
(7) Communities Inundated	Mesa, Tempe, Phoenix, SRPMIC, GRIC, Buckeye, Holly Acres. Breakdowns in established informal support networks and community cohesion for 7 communities.	Phoenix, Holly Acres. Breakdowns in established informal support networks and community cohesion for 2 communities (approximately) 525 individuals.	Elimination of residential property damage in 5 communities (Mesa, Temp Phoenix, SRPMIC, GRIC, Buckeye); elimination of damage for approximately 46,035 individuals. Damages continue to occur in Phoenix[b] and Holly Acres.
(8) Additional Land Use	No additional land available for development.	2,248 acres available for higher urban uses. Value for year 2000 is $66,026,000.	2,248 additional acres available for higher urban uses. Value for year 2000 is $66,026,000.

TABLE IV-35

FLOOD DAMAGE REDUCTION IMPACTS OF PLAN 9
CONTROL OF 200-YEAR FLOOD TO FLOW OF 215,000 CFS

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Individual Level Factors			
(1) Physical and Mental Health	Potential for inundation for 46,560 individuals in year 2000. High probability for large numbers of flood-related deaths. Widespread potential for physical injuries and illness and severe stress for inundated flood victims. High levels of disorganized (panic) activity.	Potential for inundation for >525 individuals by the year 2000. Low probability for large numbers of flood-related deaths. Potential for physical injury and severe stress among >525 individuals. Moderate levels of disorganized (panic) activity.	Elimination of potential for inundation for approximately 46,035 individuals in year 2000. Moderate decrease in probability for large number of flood-related deaths. Elimination of potential for physical injury and illness and severe stress for 46,035 individuals. Substantial reduction in potential for disorganized (panic) activity.
(2) Net Disaster Losses	Projected $87,292,000 in residential property damage in year 2000; majority of 46,560 people directly affected are in low-to-moderate income brackets.	Projected $18,954,000 in residential property damages by the year 2000. Majority of >525 individuals directly affected in low-to-moderate income brackets. Majority of >525 potential flood victims required to obtain loans or deplete personal savings to make repairs to property.	Reductions of projected $81,608,000 in residential property damage by year 2000; majority of directly affect individuals are in low-to-

TABLE IV-35 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Individual Level Factors (Continued)			
	majority of inundated flood victims required to obtain loans or use personal savings to make repairs to property.		moderate income brackets. Elimination of potential for loans and depletion of personal saving for property repairs for <46,035 individuals.
(3) Lifestyle Disruption	Temporary lifestyle disruption for 46,560 individuals subject to inundation by floodwaters. Long and debilitating cleanup for many months. Lost work and school time. Permanent changes in lifestyle for majority of 525 sequential disaster victims in Holly Acres.	Temporary lifestyle disruption for >525 individuals. Long and debilitating cleanup. Permanent changes in lifestyle for many of >525 individuals, some of whom are sequential disaster victims. Lost work and school time for >525 individuals.	Substantial reduction of lifestyle disruption. Elimination of disruption for <46,035 individuals. Elimination of lost work and school time for <46,035 individuals.

TABLE IV-35 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Area Level Factors			
(1) Transportation Disruptions			
- Automobile	Damages to roads and bridges projected to be $15,800,000 by year 2000. 0-1 river crossings operable. Transportation delay costs projected to be $39,694,000 by year 2000. High levels of stress experienced by area motorists due to traffic delays and hazardous driving conditions. Many unable to cross floodplain area.	Damages to roads and bridges projected to be $9,100,000 by year 2000. Three river crossings operable. Transportation delay costs projected to be $36,693,000 by year 2000. High levels of stress experienced by area motorists due to delays and hazardous driving conditions.	Substantial reduction of damages to bridges and roads as a result of flooding (<$6,700,000). Substantial reduction of transportation delay costs.
- Air and Rail	Damages to airport facilities and railroad tracks and yard projected to be $7,021,000 by year 2000. Major delays in air service for 2 days beyond peak flow. Repairs would require 3 months to complete. >$500,000 damage to airport channel clearing project.	No damages to air and rail transportation facilities projected for year 2000. No delays in service. >$500,000 damage to airport channel clearing project.	Elimination of $7,021,000 in damages to airport facilities and railroad tracks and yards by year 2000. Elimination of service disruptions.

TABLE IV-35 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Area Level Factors (Continued)			
(2) Public Utilities	Damages totalling $6,400,000 to electrical transmission towers and power lines; repairs would take 2 months to complete. No blackout expected. $275,000 in damages to sewage and wastewater treatment plants. Damages to active landfills cannot be quantified at the present time.	Damages totalling approximately $4,800,000 to electrical transmission towers and power lines; >$135,000 in damages to sewage and wastewater treatment plants. Damages to active landfills nonquantifiable at present time.	Reduction of damages to electrical transmission towers and power lines ($1,600,000). Reduction of <$140,000 in damages to sewage and wastewater treatment plants. Potential reduction of damages to active landfills.
(3) Communication	Temporary delays in telephone service. Major delays in delivery schedules of newspaper, mail, and other subscription services.	Major delays in delivery schedules of newspapers, mail, and other subscription services. Temporary delays in telephone service in some areas. Unable to quantify damages at present time.	Minimal reduction in delays in scheduled deliveries of newspapers, mail and other subscription services. Potential slight reduction in number of disruptions to telephone service.

TABLE IV-35 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Area Level Factors (Continued)			
(4) Business Community	Damages totalling $68,713,000; combined with both short and long term revenue losses costs could be in excess of $150 million.	Damages totalling $21,761,000. Majority of damages to sand and gravel operations. Lost revenues due to transportation disruptions.	Reduction of $46,952,000 in damages to business community.
(5) Tourism	Short- and long-term losses due to forced cancellations of trips and adverse publicity.	Short-term losses due to forced cancellations of trips and adverse publicity.	No impact.
(6) Public Safety	Civil defense warning system fully activated. Emergency aid required from outside of metropolitan area. Emergency costs of $1,109,000. Lack of emergency personnel to carry out all door-to-door warnings	Civil defense warning system fully activated. Emergency costs of approximately $809,000. No aid required from outside of metropolitan areas.	Reduction of approximately $300,000 in costs of emergency aid. Elimination of needed aid from outside of the Phoenix metropolitan area.

TABLE IV-35 (Continued)

Condition	200-Year Flood (275,000 cfs) (Plan 8)	Flood Level of 215,000 cfs (Plan 9)	Impact
Area Level Factors (Continued)			
(7) Communities Inundated	Mesa, Tempe, Phoenix, SRPMIC, GRIC, Buckeye, Holly Acres. Breakdowns in established informal support networks and community cohesion for 7 communities.	Phoenix, Holly Acres. Breakdowns in established informal support networks and community cohesion for 2 communities (>525 individuals).	Elimination of residential property damage in 5 communities (Mesa, Tempe Phoenix, SRPMIC, GRIC, Buckeye); elimination of damage for approximately <46,035 individuals. Damages continue to occur in Phoenix[b] and Holly Acres.

2,400,000 for the year 2000. Under Plan 8, these people in the following communities could be subjected to a flood of 275,000 cfs:

200-YEAR INUNDATION AREA POPULATION IN FUTURE-WITHOUT

Community	Population
Holly Acres Area	1,500
City of Mesa	16,000
City of Tempe	2,600
City of Phoenix	22,000
Salt River Pima-Maricopa Indian Community	360
Gila River Indian Community (Lehi)	300
Buckeye Area	3,800
Total projected 200-year inundation area population (year 2000)	46,560

(3) Direct and Indirect Impacts of Plans 1, 3, 6, 7

Future social conditions with Plans 1, 3, 6, and 7 assume a flood control plan that would reduce a 200-year flood (275,000 cfs) through the Phoenix metropolitan area to a flow of between 70,000 and 92,000 cfs. By controlling flows to between 70,000 cfs and 92,000 cfs, Plans 1, 3, 6 and 7 would eliminate the inundation and evacuation of Salt-Gila River ownstream community residents with the possible exception of a few individuals residing at Holly Acres. Additionally, New Waddell Dam would provide incidental flood control on the Agua Fria River although no dedicated flood control space would be provided. Benefits would include the elimination of flooding for 46,460 of the 46,560 residents projected to be living in the 200-year flood plain in the year 2000. Fourteen of the 29 automobile river crossings would remain open resulting in the elimination of major disruptions to transportation.

The effects of Plans 1, 3, 6 and 7 are considered a Beneficial Flag because they reduce or virtually eliminate all of the flooding problems affecting people living in the 200-year flood plain.

(4) Direct and Indirect Impacts of Plan 2

Future social conditions with Plan 2 assume a flood control plan that would reduce a 200-year flood through the Phoenix metropolitan area to a flow of 157,000 cfs at Sky Harbor Airport.

Individuals residing in the following communities would receive nearly total protection from inundation with flows controlled 157,000 cfs.

City of Mesa
City of Tempe
Salt River Pima-Maricopa Indian Community
Gila River Indian Community
Buckeye (including the towns of Arlington, Liberty and Palo Verde)

Individuals residing in the City of Phoenix and the Holly Acres area would sustain at least some damage as a result of a flood measured at 157,000 cfs at the airport:

Once construction of proposed new bridges is completed (see Plan 8), general transportation disruptions and the accompanying escalations in personal stress projected for area residents in the event of flooding are not expected to occur with flows of 200,000 cfs or under.

The effects of Plan 2 are considered Significant Beneficial because most of the problems resulting from flooding that affect 44,035 of the 44,560 people living in the 200-year flood plain would be reduced or eliminated. The impacts do not significantly alter the effects of flooding on the residents living in the Holly Acres area.

(5) Direct and Indirect Impacts of Plan 9

Future social conditions with Plan 9 assume a flood control plan that would reduce a 200-year flood through the Phoenix metropolitan area to a flow of 215,000 cfs at Sky Harbor Airport.

Individuals residing in the following communities would receive nearly total protection from inundation with flows controlled at 215,000 cfs.

City of Mesa
City of Tempe
Salt River Pima-Maricopa Indian Community
Gila River Indian Community
Buckeye (including the towns of Arlington, Liberty and Palo Verde)

Individuals residing in the City of Phoenix and the Holly Acres area would sustain damage as a result of a flood measured at 215,000 cfs at the airport. Only three river crossings would remain open resulting in significant delays in transportation and associated escalations.

The effects of Plan 9 are considered beneficial, because problems from flooding are reduced. However, somewhat significant damages still occur in Holly Acres, City of Phoenix, and because of transportation delays.

Impacts and effects of action plans are summarized in Tables IV-32, IV-33, IV-34, and IV-35.

6. Economics

a. Types of Economic Impacts

Impacts on national economic development are expressed as changes in average annual cost and benefits over the life of the project from

a national income viewpoint. The degree of beneficial effects from these impacts is determined by the amount of net benefits resulting from a plan.

The accounting framework used in the CAWCS studies is shown schematically in Figure IV-2. Costs include construction contracts, design, engineering, and administration of the plans. Energy is a significant component of the operation costs of all plans except 2 and 8 because much of the increased water supply developed by the plans must be pumped into Central Arizona from the Colorado River.

For the purpose of the analysis financing of the features was assumed to be from one source, the federal treasury. Under this assumption funds would be appropriated under two authorizing acts, the Reclamation Safety of Dams Act of 1978 and the Colorado River Basin Project Act. Currently, efforts are being made at the local level to develop other funding sources for the entire CAP, including the Regulatory Storage Division (see Appendix B). This effort could change the actual source of funding.

Benefits include the major categories of regulatory storage, flood control, and safety of dams corresponding to the major CAWCS project purposes. Recreation benefits are expressed as net loss or gain.

Regulatory storage benefits include water supply, hydropower, and power management benefits. Water supply benefits were calculated separately for irrigation water and municipal and industrial water. Power management benefits are distinguished from hydropower benefits. Power management refers to benefits derived from the ability to better manage CAP pumping loads provided by some of the regulatory storage structures. Hydropower benefits are benefits derived from the installation of a powerplant at a regulatory storage structure.

Flood control benefits include inundation reduction benefits, which result from prevention of physical damages to structures in the flood plain as well as savings in costs associated with floodfighting, closed businesses, transportation delays, and emergency operations. Location and intensification benefits of flood control result from improved land use in former flood prone areas.

For purposes of comparing and illustrating the effects of CAWCS plan features, SOD benefits were assumed to be equal to the least-cost SOD solution.

b. Methodology

Where possible, market values were used to estimate the benefits and costs of the resources provided by the project as well as of the resources used in construction and operation of the project. For example, construction costs were estimated using unit costs obtained from bids at current construction sites. However, all of the project outputs and many of the project inputs are extra-market goods. Several alternative methods exist for measuring the value of extra-market goods, and an attempt was made to select the most appropriate method for each type of project output. Despite

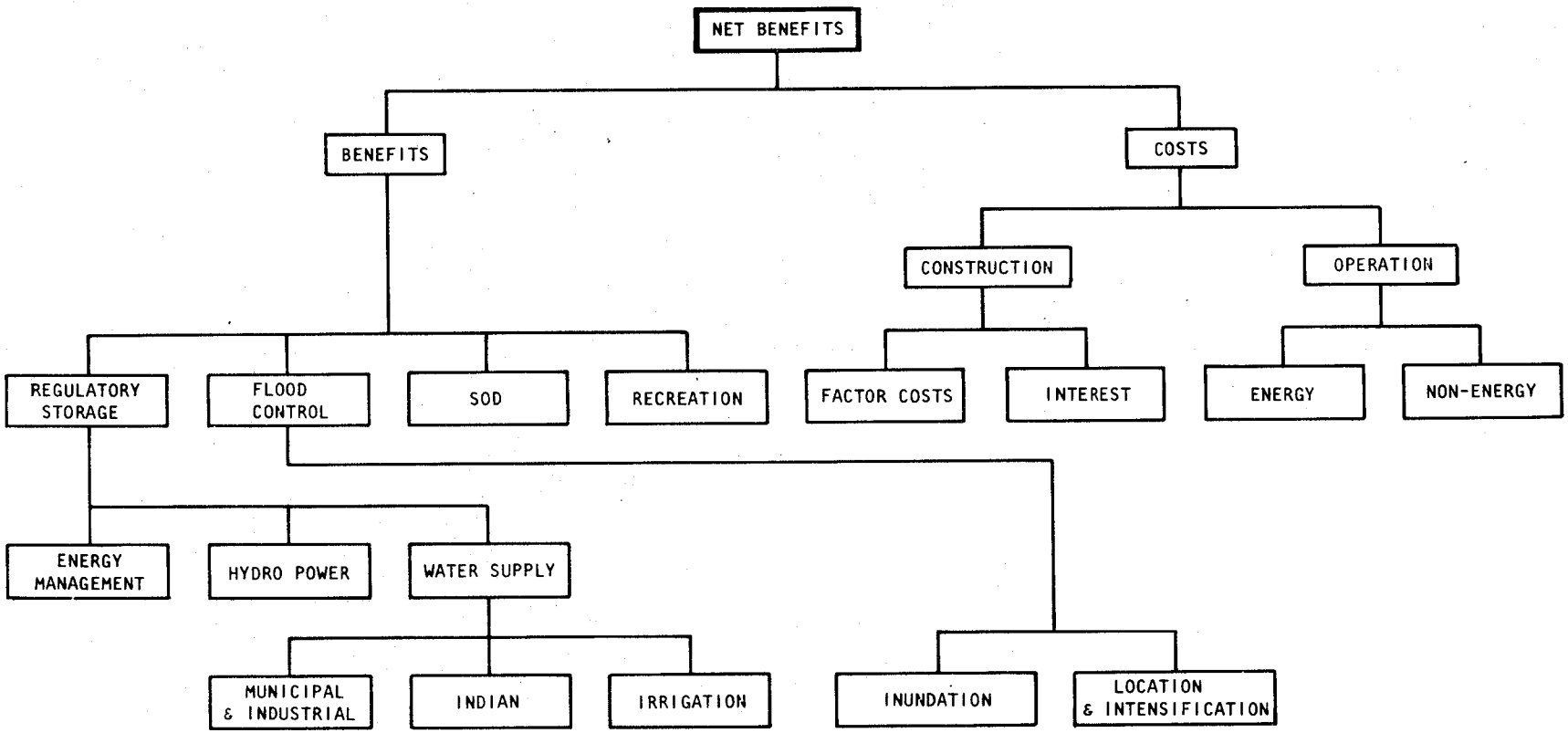


FIGURE IV-2
National Economic Development Impacts Accounting Frame Work

the diversity of detail, all approaches adhere to a consistent general model. The net benefits associated with any plan are the amount that a person would be willing to pay if that person could not externalize benefits or costs.

Figure IV-3 is adapted from the Smith-Krutella framework for classifying measurement benefits for extra-market goods. Within this general framework, the major project outputs of flood control, SOD, water supply, and power were measured using physical linkages. Behavioral linkages were used to measure recreation gains and losses.

c. Direct and Indirect Impacts

(1) Cost

The total construction cost of each plan and the total annual cost are shown on Table IV-36.

(2) Net Economic Benefits

The net economic benefits for each CAWCS plan are shown in Table IV-37. Net benefits are the dollar difference between annual costs and annual benefits. Details of the determination of the values are also discussed in Economics Supporting Document and Recreation Planning Report, (USBR, 1982). All values are based on the 1982 price level. All are annualized at 7-3/8 percent. Economic benefits by major category are shown in Table IV-37.

(3) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Table IV-36 shows differences in costs and benefits between new and modified dams.

7. Other Impacts of Plans

a. Air Quality

(1) Types of Impacts to Air Quality

The primary impact on air quality will be dust emissions, or TSP, from construction-related activities. The degree of impact is a direct function of distance from the construction site(s). Other miscellaneous air quality impacts are expected to have insignificant effects. The exception may be incineration impacts which may have Significant Adverse effects at times. The impacts of project actions on the ambient concentrations of air pollutants other than TSP (non-methane hydrocarbons, nitrogen dioxide, ozone and sulfur dioxide) were investigated during the study. Both short and long-term impacts for all factors except TSP were found to be negligible in all of the scenarios analyzed; therefore, this section describes only construction-related TSP impacts of plans.

TABLE IV-36

ECONOMIC COSTS AND BENEFITS OF PLANS

Plan Options	Total Construction Cost[a,b] ($)	Total Annual Cost[a,c] ($)	Total Annual Benefits[a] ($)	Net Economic Benefits[a] ($)
Plan 1				
Cliff + Modified Roosevelt + Modified Stewart Mountain	694,940,000	58,060,000	81,587,000	23,527,000
Cliff + New Roosevelt + New Stewart Mountain	874,230,000	71,300,000	81,587,000	10,287,000
Cliff + New Roosevelt + Modified Stewart Mountain	788,340,000	64,960,000	81,587,000	16,627,000
Cliff + Modified Roosevelt + New Stewart Mountain	780,830,000	64,400,000	81,587,000	17,187,000
Plan 2[d]				
Cliff + Modified Roosevelt + Modified Stewart Mountain	541,570,000	41,870,000	50,711,000	8,840,000
Cliff + Modified Roosevelt + New Stewart Mountain	627,460,000	48,210,000	50,711,000	2,501,000
Plan 3				
Confluence + Cliff + Modified Roosevelt + Modified Stewart Mountain	1,116,250,000	93,970,000	119,277,000	25,307,000
Confluence + Cliff + New Roosevelt + New Stewart Mountain	1,295,540,000	107,200,000	119,277,000	12,077,000
Confluence + Cliff + New Roosevelt + Modified Stewart Mountain	1,209,650,000	100,860,000	119,277,000	18,417,000
Confluence + Cliff + Modified Roosevelt + New Stewart Mountain	1,202,140,000	100,310,000	119,277,000	18,967,000
Plan 6				
New Waddell + Cliff + Modified Roosevelt + Modified Stewart Mountain	978,430,000	82,710,000	166,837,000	84,127,000
New Waddell + Cliff + New Roosevelt + New Stewart Mountain	1,157,720,000	95,940,000	166,837,000	70,896,000
New Waddell + Cliff + New Roosevelt + Modified Stewart Mountain	1,071,830,000	89,600,000	166,837,000	77,237,000
New Waddell + Cliff + Modified Roosevelt + New Stewart Mountain	1,064,320,000	89,050,000	166,837,000	77,787,000
Plan 7				
New Waddell + Cliff + Modified Roosevelt + Modified Stewart Mountain	978,430,000	82,710,000	160,707,000	77,997,000
New Waddell + Cliff + New Roosevelt + New Stewart Mountain	1,157,720,000	95,940,000	160,707,000	64,767,000
New Waddell + Cliff + New Roosevelt + Modified Stewart Mountain	1,071,830,000	89,600,000	160,707,000	71,107,000
New Waddell + Cliff + Modified Roosevelt + New Stewart Mountain	1,064,320,000	89,050,000	160,707,000	71,657,000
Plan 9				
New Waddell + Modified Roosevelt + Modified Stewart Mountain + Verde River Dams Modifications	931,790,000	76,030,000	143,089,000	67,059,000
New Waddell + New Roosevelt + New Stewart Mountain + Verde River Dams Modifications	1,111,080,000	89,260,000	143,089,000	53,829,000
New Waddell + New Roosevelt + Modified Stewart Mountain + Verde River Dams Modifications	1,025,190,000	82,920,000	143,089,000	60,169,000
New Waddell + Modified Roosevelt + New Stewart Mountain + Verde River Dams Modifications	1,017,680,000	82,360,000	143,089,000	60,729,000

[a]Costs and benefits are shown in January 1982 dollars. Annual equivalents are calculated at 7 3/8%. Cost of plans would be allocated among several funding sources; for this analysis two sources were assumed: Reclamation Safety of Dams Act and Colorado River Basin Project Act.
[b]Includes interest during construction (IDC).
[c]Includes operation, maintenance, and replacements costs (OM&R).
[d]Plan 2 (limited construction) includes only modifications to Roosevelt Dam which may be required for dam safety.
Source: Economics Supporting Document, USBR, 1982.

	TYPES OF LINKAGE BETWEEN OUTPUT CHANGE AND OBSERVED EFFECTS		TYPES OF ASSUMPTIONS REQUIRED	MEASUREMENT METHODS	BENEFIT CATEGORY
NO ROLE FOR BEHAVIORAL RESPONSES OF ECONOMIC AGENTS	PHYSICAL LINKAGES		RESPONSES ARE DETERMINED BY ENGINEERING OR TECHNOLOGICAL RELATIONSHIPS	DAMAGE FUNCTION	FLOOD CONTROL AGRICULTURAL WATER SUPPLY
				LEAST COST ALTERNATIVE	POWER SOD M&I WATER SUPPLY
BEHAVIORAL RESPONSES OF ECONOMIC AGENTS ARE ESSENTIAL	BEHAVIORAL LINKAGES	INDIRECT LINKS	RESTRICTIONS ON THE NATURE OF INDIVIDUAL PREFERENCES OR TECHNICALLY OBSERVED ASSOCIATIONS IN THE DELIVERY OF GOODS OR SERVICES	HEDONIC PROPERTY VALUE	
				TECHNICAL TRAVEL COST	FLAT WATER RECREATION FISH AND WILDLIFE
				HEDONIC TRAVEL COST	
		DIRECT LINKS	INSTITUTIONAL	CONTINGENT VALUATION	FLOWING WATER RECREATION
				CONTINGENT RANKING	

ADAPTED FROM SMITH-KRUTILLA FRAMEWORK FOR CLASSIFYING THE MEASUREMENT BASES AND METHODS OF ECONOMIC BENEFITS RESULTING FROM CHANGES IN OUTPUT OF EXTRAMARKET GOODS.

FIGURE IV-3

METHODOLOGY FOR ECONOMIC BENEFITS ANALYSIS

Table IV-37

ECONOMIC BENEFITS OF PLANS[a]

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
Regulatory Storage Benefits	0						
Power Management		0	0	18,640,000	72,640,000	72,640,000	72,640,000
Hydropower		0	0	3,910,000	7,820,000	7,820,000	7,820,000
Water Supply		9,410,000	1,310,000	15,130,000	12,900,000	6,770,000	10,738,000
Total Regulatory Storage Benefits		9,410,000	1,310,000	37,680,000	93,360,000	87,230,000	91,248,000
Flood Control Benefits	0						
Inundation Reduction		10,587,000	5,368,000	10,587,000	10,587,000	10,587,000	4,861,000
Location and Intensification		16,460,000	4,873,000	16,460,000	16,460,000	16,460,000	3,249,000
Total Flood Control Benefits		27,047,000	10,241,000	27,047,000	27,047,000	27,047,000	8,110,000
Safety of Dams Benefits	0	39,220,000	39,220,000	39,220,000	39,220,000	39,220,000	39,220,000
Recreation Benefits	0	5,910,000	0	15,330,000	7,210,000	7,210,000	4,511,000
Total Annual Benefit	0	81,587,000	50,771,000	119,277,000	166,837,000	160,707,000	143,089,000

[a]Shown in January 1982 dollars.

SOURCE: Economics Supporting Document, USBR, 1982. Plan 9 estimated on comparable basis.

It should be noted that all the impacts and effects described below are of short-to-moderate duration, lasting only as long as construction activities.

(2) Direct and Indirect Impacts

(a) Plan 8

The future-without conditions for ambient TSP at the affected site areas are shown in Table IV-38. The information presented for the period 1981 to 2000 is an estimate of the overall trend from the beginning of the period to the end.

TABLE IV-38
FUTURE-WITHOUT CONDITION
TOTAL SUSPENDED PARTICULATES[a]

Site Area	1981-2000 (est. ann. geometric mean concentrations in ug/m3)
Stewart Mountain	50 - 75
Cliff	35 - 60
New Roosevelt	35 - 60
Confluence	50 - 75
New Waddell	40 - 65
Downstream	
Country Club to 35th Avenue	100 - 140
91st Avenue to Gillespie Dam	60 - 75

[a]Federal and State annual geometric mean standard is 75 microgram per cubic meter (ug/m3).

Within the general Phoenix metropolitan area the Federal primary and State annual geometric mean TSP standard of 75 micrograms per cubic meter (ug/m^3) is often exceeded. With controls, the annual geometric mean is expected to decrease from 1981 through 1985 and then increase gradually through 2000. It is assumed that planned control measures will result in the regional attainment and maintenance of standards after 2000. TSP concentrations in the region outside the metropolitan area will likely remain near or below the Federal primary and State annual geometric mean standard during the entire period of 1981 through 2000.

(b) Plans 1 and 2

With regard to the Cliff site, any points of public access within 1/2 mile of construction sites may have increases in ambient TSP concentrations of approximately 55 ug/m^3. Beyond 1/2 mile the impact should be less than 55 ug/m^3.

Within approximately 1/4-mile of the construction areas at the New Roosevelt site, public access areas may have increases in ambient TSP concentrations of about 50 ug/m^3 due to construction activity. At distances greater than 1-1/2 miles the increases should be less than 35 ug/m^3.

Within about 1/2 mile of the Stewart Mountain construction site, areas of public access may have increases in ambient TSP concentrations of about 25 ug/m^3 or more due to construction activity. At distances greater than 1 mile, the increases should be less than 15 ug/m^3.

(c) Plan 3

Impacts related to TSP would be the same as for Plans 1 and 2 with the addition of impacts from Confluence Dam. At the Confluence site, public access areas within approximately 1-1/2 miles of construction areas may have increases in ambient TSP concentrations of 30 to 70 ug/m^3 due to construction activity. Beyond 1-1/2 miles the increases should be less than 30 ug/m^3.

(d) Plans 6, 7, and 9

Impacts related to TSP would be the same as for Plans 1 and 2 with the addition of impacts from New Waddell Dam construction. At the New Waddell site, public access areas within approximately 1/2-mile of construction areas may have increases in ambient TSP concentrations of 25 to 70 ug/m^3 due to construction activity. Beyond 1-1/2 miles the increases should be less than 25 ug/m^3.

(3) Mitigation

The effect of air quality impacts is considered Significant Adverse for all plans. Effects may be reduced to Insignificant if mitigation measures in the form of dust suppression are applied. Dust suppression may be accomplished through the use of any or all of the following: paving, chemical stabilization, watering, speed control; covering, vegetation, gravelling unsurfaced roads, and wind breaks.

(4) Residual Impacts

The only residual TSP impacts that are expected to result from plan implementation are those related to increased vehicular activity in excess of the existing condition. Such impacts would be secondary TSP impacts that cannot be quantified at this time.

(5) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Construction impacts for a modified dam at Roosevelt or Stewart Mountain would be the same; no long-term impacts have been identified for either option.

b. Aesthetics

(1) Types of Impacts to Visual Quality

Visual quality impacts include project-related changes in the natural character of the landscape, and changes in terms of viewer sensitivity and opportunity to enjoy the scenic qualities of the area.

Types of visual impacts to the natural environment that may occur with the construction or modification of a dam include the partial loss of a stream and high-quality riparian vegetation often associated with streams, the creation of a lake or the enlargement of an existing lake, and, in the case of new dam construction, the intrusion of a major structure into the natural landscape. As shown in Table IV-39, five measures were used to assess visual quality impacts on the natural environment: 1) acres of high-quality riparian vegetation lost or gained, 2) miles of flowing water lost, 3) acres of flat water gained, 4) acres of land exposed by reservoir drawdown, and 5) visual intrusion of major new structures.

Viewer sensitivity and opportunity to enjoy the scenic qualities of an area may be diminished or enhanced by project actions. To measure the scenic qualities of a site areas as they would be interpreted by viewers, Visual Interpretive Zones were developed and mapped. Visual Interpretive Zones classify the natural landscape into three zones: V1 (distinctive), V2 (average), and V3 (undistinguished). Adverse changes in the natural landscape may cause a shift from higher to lower quality Visual Interpretive Zones in an area. Likewise, beneficial alternation of the natural environment may cause a shift from lower to higher quality Visual Interpretive Zones.

(2) Direct and Indirect Impacts

(a) Plan 8

Within the aggregated site areas, over half of the visual resources are of average quality (V2), approximately 30 percent are of distinctive (V1) quality and less than 20 percent are of undistinguised (V3) quality. The visual quality of the natural landscape in the site areas is not anticipated to change significantly from the existing condition. Visual Interpretive Zones, as shown in Table IV-40, are expected to remain essentially unchanged in the future without the project.

Visual resources at the Cliff site area are primarily average (V2) and undistinguished (V3). This is due, in part, to the presence of Horseshoe Reservoir, which is often severely drawn down exposing unvegetated slopes. However, below Horseshoe Dam, along the Verde River, high-quality riparian vegetation is found.

Table IV-39

VISUAL QUALITY IMPACTS OF PLANS ON THE NATURAL ENVIRONMENT

	HIGH QUALITY RIPARIAN VEGETATION (acres)	FLOWING WATER (miles)	FLAT WATER (acres)	DRAWDOWN (acres)	MAJOR NEW STRUCTURES (number)
PLAN 1					
CLIFF	- 700	- 3.0	+ 683	+ 884	0
ROOSEVELT	- 230	0	0	0	0
PLAN 2					
CLIFF	- 690	+ 1.0	0	0	0
ROOSEVELT	- 210	0	0	0	0
PLAN 3					
CONFLUENCE	-2,400	-17.2	+5,320	+5,201	+1
CLIFF	- 700	+ 1	- 77	- 156	0
ROOSEVELT	- 230	0	0	0	0
PLAN 6					
CLIFF	- 700	+ 1	- 77	- 156	0
ROOSEVELT	- 230	0	0	0	0
NEW WADDELL	- 210	0	+4,299	+6,142	0
PLAN 7					
CLIFF	- 700	- 2.0	+ 796	- 24	0
ROOSEVELT	- 230	0	0	0	0
NEW WADDELL	- 210	0	+4,299	+6,142	0
PLAN 9					
VERDE RIVER DAMS	- 310	0	0	0	0
ROOSEVELT	- 230	0	0	0	0
NEW WADDELL	- 210	0	+4,299	+6,142	0

TABLE IV-40
ACREAGE OF VISUAL INTERPRETIVE ZONES IN FUTURE WITHOUT PROJECT

	VQZ1	VQZ2	VQZ3	TOTAL
Cliff	13,170	17,428	22,192	52,790
(Verde River Dams)	(14,905)	(36,913)	(24,052)	(75,090)
Roosevelt	23,973	50,396	6,601	80,970
Confluence	25,443	35,466	9,491	70,400
New Waddell	16,590	24,490	0	41,080
Aggregate	79,176	127,780	38,284	245,240

Visual resources at Roosevelt are primarily distinctive (VI) and average (V2). Although frequently drawn down leaving unvegetated slopes, Roosevelt Lake is the dominant visual resource in the site area. Flowing into Roosevelt Lake are Tonto Creek and the Salt River. Riparian vegetation along these two streams is composed of high-quality cottonwoods, willows and mesquite.

The Confluence site area is the only area where the natural environment has not been significantly altered by a dam. Abundant in riparian vegetation along their banks, the Salt and Verde Rivers meander for a total of 34 miles to their confluence. The site area is composed primarily of V1 (distinctive) and V2 (average) visual resources.

Upper and Lower Lake Pleasant dominate the natural landscape at the New Waddell site area. Although frequently drawn down exposing unvegetated slopes, Upper Lake Pleasant has many interesting coves and inlets along its shores. Very little high quality riparian vegetation and no perennial streams are found at New Waddell. The area is primarily composed of distinctive (V1) and average (V2) visual quality resources; no V3 (undistinguished) visual resources exist within the site area.

(b) Plan 1

Plan 1 would have an overall insignificant effect on visual resources in the site areas. Adverse changes in visual resources at individual site areas include the loss of high-quality riparian vegetation at Cliff and Roosevelt, and the loss of flowing water and an increase in drawdown at Cliff. Beneficial visual changes include an increase in flat water surface acres at Cliff. Some changes in Visual Interpretive Zones from higher quality visual resources to lower quality resources is projected at the Cliff site; no change in Visual Interpretative Zones is expected to occur at Roosevelt.

(c) Plan 2

With Plan 2 the net impact on visual quality resources is anticipated to be insignificant. At individual site areas, adverse visual changes include the loss of high quality riparian vegetation at both Cliff and Roosevelt. Beneficial changes include an increase in flowing water at Cliff. Because the overall effect of Plan 2 on visual resources is projected to be insignificant, changes in Visual Interpretive Zones would not occur at either Cliff or Roosevelt site areas.

(d) Plan 3

The implementation of Plan 3 would result in an overall significant adverse effect on visual quality resources in the study region, due primarily to the creation of a new reservoir with a large drawdown at the Confluence site. Although the increase in flat water associated with the new reservoir is a beneficial visual change, the accompanying dam structure, loss of flowing water and increase in drawdown has an overriding adverse impact on visual resources. Other adverse changes in visual resources associated with this plan include a loss of high-quality vegetation at Cliff, Roosevelt and Confluence, and a decrease in flat water at Cliff. Beneficial changes include a decrease in drawdown at the Cliff site. With the implementation of this plan, Visual Interpretative Zones at the Confluence site would shift from higher quality visual resources to those of lower quality. Visual Interpretative Zones at Cliff and Roosevelt would not change.

(e) Plan 6

With the implementation of Plan 6, the net impact on visual quality resources would be insignificant. At individual site areas adverse changes in visual resources include a loss of high quality riparian vegetation at Cliff, Roosevelt, and New Waddell, a decrease in flat water acres at Cliff; and an increase in drawdown at New Waddell. Beneficial changes include an increase in water surface acres at New Waddell; an increase in flowing water at Cliff, and a decrease in drawdown at Cliff. No changes in Visual Interpretative Zones is anticipated for any site area with the implementation of this plan.

(f) Plan 7

The implementation of Plan 7 would result in an insignificant effect on visual quality resources. At individual site areas, adverse changes on visual resources would include the loss of high quality riparian vegetation at Cliff, Roosevelt, and New Waddell; a loss of flowing water at Cliff and an increase in drawdown at New Waddell. Beneficial visual changes include an increase in flat water surface acres at Cliff and New Waddell and a decrease in drawdown at Cliff. No changes in Visual Interpretative Zones is anticipated with the implementation of Plan 7.

(g) Plan 9

With the implementation of Plan 9, the net impact on visual quality resources would be insignificant. At individual site areas adverse changes in visual resources include a loss of high quality riparian vegetation at Roosevelt, and New Waddell, and an increase in drawdown at New Waddell. Beneficial changes include an increase in water surface acres at New Waddell. No changes in Visual Interpretative Zones are anticipated for any site area with the implementation of this plan.

(3) Mitigation

The overall impact of Plan 3 on visual quality includes adverse impacts on flowing stream, loss of riparian vegetation, and drawdown, especially at the Confluence area. These impacts, to a large degree, cannot be mitigated. Tree planting is not effective when a constant water level cannot be maintained. No mitigation is required for Plans 1, 2, 6, 7 and 9.

(4) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Construction impacts for a modified dam at Roosevelt or Stewart Mountain would be the same as the new dam option except construction activities for a modified dam would be shorter in duration and require less area. Operational impacts would be the same at Roosevelt or Stewart Mountain because lake elevations, size, and changes in visual quality zones would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact at either location for visual quality.

c. Noise

(1) Types of Impacts to Noise

Noise impacts are described as construction or short-term impacts, and operational or long-term impacts. Impacts are measured by decibel (dB) changes in the ambient day-night sound level (L_{dn}) at each of the affected site areas. The EPA has suggested an annual L_{dn} of less than 55 dB as being requisite to protect public health and welfare. Recent EPA strategy calls for a short-term goal in which the L_{dn} should not exceed 65 dB in residential and recreational areas or other outdoor areas in which quiet is the basis of use.

Impact analysis has been restricted to noise-sensitive areas where potential impacts would occur. For example, only those areas where existing sound levels are below a L_{dn} of 65 dB and which would experience an increase in the ambient L_{dn} exceeding 10 dB due to project construction or operations have been assessed.

Construction activities at each of the dam sites will generally occur in open areas and away from noise-sensitive receptors (people or wildlife affected by noise), although some cases of noise impact may occur.

(2) Direct and Indirect Impacts

(a) Plan 8

Little or no change in the Cliff site ambient sound environment is expected by the year 2000. Day-night sound levels are expected to remain below 55dB.

At the Roosevelt site area, developed recreational facilities and new facilities will generally be anticipated to result in increases in the day-night sound level to between 55 and 65 dB. The L_{dn} would comply with the EPA's short-term goals for residential and noise-sensitive recreational areas.

At the Confluence site, continued growth in population in the communities of Fountain Hills, Fort McDowell, Rio Verde, and Goldfield Estates will cause an increase in the ambient sound levels to between 35 and 70 dB. Most noise-sensitive receptors will continue to experience L_{dn} below 65 dB; however, the number of residents experiencing sound levels between 55 and 65 dB will increase significantly.

Little or no change in the ambient sound quality environment at the New Waddell site is expected. The day-night sound levels are expected to remain below 55 dB.

(b) Plans 1 and 2

Construction activities at Cliff Dam are anticipated to result in insignificant noise impacts with the relocation of recreational facilities and residents near the existing Horseshoe Dam prior to construction. Upon completion of construction, no significant change from existing or future-without sound levels is anticipated. Day-night sound levels would remain below 55 dB.

Construction activities at Roosevelt Dam and borrow pits would occur and within less than 1/4-mile of the community of Roosevelt. The sound levels anticipated during construction at these two sites could be as high as 71 dB during peak periods of construction. Upon completion of construction, no significant change from future-without sound levels is anticipated.

Construction activities at the Stewart Mountain Dam are anticipated to result in insignificant noise impacts with the relocation of the nearest noise sensitive receptors prior to construction. Upon completion of construction, no significant change from existing or future-without sound levels is anticipated.

In summary, Plans 1 and 2 would result in localized temporary increases in noise levels at the Cliff and Roosevelt sites during construction. The effect of these impacts is considered Insignificant.

(c) Plan 3

In Plan 3 impacts at Cliff and Roosevelt are combined with impacts at the Confluence site.

Construction activities for the Confluence Dam would occur away from local receptors and would therefore result in insignificant noise impacts. Upon completion of construction no significant change from future-without conditions is anticipated.

The effect of these impacts is considered Insignificant.

(d) Plans 6,7, and 9

In Plans 6, 7, and 9 construction noise impacts in the area of the New Waddell Dam would be insignificant.

Upon completion of construction, no significant change from existing sound levels is anticipated due to the minimal development within the primary or secondary acoustical study areas. Day-night sound levels would remain below 55 dB.

The effect of these impacts is considered Insignificant.

(3) Mitigation

Because of the generally insignificant effect of noise associated with CAWCS plans, no mitigation is recommended.

(4) Residual Impacts

There are no residual impacts since no mitigation is proposed.

(5) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Construction impacts for a modified dam at Roosevelt or Stewart Mountain would be the same as the new dam option except construction activities for a modified dam would be shorter in duration and require less area. Operational impacts would be the same at Roosevelt or Stewart Mountain for a new structure or modified dam. Therefore, there is no significant difference in noise impact at either location.

d. Geology/Soils

(1) Types of Impacts to Geology/Soils

Impacts of CAWCS plans on geology and soils focus on mineral resources, primarily sand and gravel, and on prime farmland. Impacts to mineral resources were measured in terms of surface acres enhanced by reduced flood levels or lost as a result of acquisition and inundation. Impacts to prime farmland were measured by acres lost for construction and operation of a plan.

(2) Direct and Indirect Impacts

(a) Plan 8

With Plan 8, the future-without condition assumes that mining of sand and gravel in the Verde-Salt-Gila channel area will occur on approximately 570 surface acres on the Fort McDowell Indian Community and on portions of approximately 17,725 surface acres within the Salt-Gila River channel (primarily on the Salt River Indian Community, in the Salt River channel, and along the Gila River). In these areas, mining is expected to occur where suitable material is found, where mining is compatible with surrounding land use, and near areas where the greatest urban development is anticipated.

Mining of sand and gravel within the study area is anticipated to yield nearly 22 million short tons for the year 2000. Approximately 19 million short tons were extracted in 1980 (CAWCS, Regional Future Without the Project).

Prime farmland by the year 2000 is expected to include approximately 16,385 acres in affected areas: 15,065 acres in the downstream area, 130 acres in the Cliff site area, 1,120 acres in the Confluence site area, and 70 acres in the New Waddell site area.

Within the CAWCS study area, there are an estimated 620,000 acres of prime farmland (1980 value). By the year 2000 it is projected that there will be approximately 589,000 acres. In general, there will be an increase in prime farmland acreage on the Indian reservations and a decrease on non-Indian lands, primarily as a result of urban growth.

(b) Plans 1, 2, 3, 6, 7, and 9

Plans 1, 2, 3, 6, 7, and 9 have impacts on the sand and gravel deposits in the Verde-Salt-Gila Rivers area. Nearly all of the 18,295 surface acres of known and potential sand and gravel resource is currently subject to losses from major flooding. Plan 9 does not eliminate losses due to major flooding. The impacts and effects of alternative plans are summarized in Table IV-41.

Adverse impacts to prime farmland result from loss of acreage during construction and/or operation of a project. Downstream

Table IV-41

IMPACTS TO SAND AND GRAVEL
DEPOSITS ON VERDE, SALT, AND GILA RIVERS

Plan	Impact/Mitigation	Effect Unmitigated/Mitigated
1	3,120 surface acres enhanced by reduced flood levels; 15,175 surface acres unaffected by project. No mitigation necessary.	Significant Beneficial/ Significant Beneficial
2	1,350 surface acres enhanced by reduced flood levels; 16,945 surface acres unaffected by project. No mitigation necessary.	Significant Beneficial/ Significant Beneficial
3	3,120 surface acres enhanced by reduced flood levels; 190 surface acres acquired for project; 14,985 surface acres unaffected by project. Mitigation plan negates loss of 190 surface acres.	Significant Beneficial/ Significant Beneficial
6,7	3,120 surface acres enhanced by reduced flood levels; 15,175 surface acres unaffected by project. No mitigation necessary.	Significant Beneficial/ Significant Beneficial
9	0 acres enhanced by reduced flood levels. 18,295 acres unaffected by project. No mitigation necessary.	Insignificant/ Insignificant

impacts to prime farmland were not evaluated because of the uncertainty of land use changes as a result of increased flood control. The end result of this protection may be the conversion of agricultural lands to industrial, commercial, or recreational uses. Table IV-42 shows the impacts and effects of plans to prime farmland.

(3) Mitigation

In Plan 3, approximately 190 surface acres of known and potential sand and gravel deposits on the Fort McDowell Indian Community would be acquired for the project and inundated during operation. A mitigation policy which would allow mining operations to continue beyond the limits of the

Confluence maximum storage pool would reduce loss of on-site resources from 33 percent to 27 percent. Increasing sand and gravel production capabilities at the Fort McDowell Indian Community may require Federal assistance for equipment, market development, and other related items.

Historically there has not been a policy for mitigation of environmental losses of prime farmland. However, on-site losses could be minimized if additional acreage of prime farmland were brought into agricultural production as a replacement for the acreage lost. With Plans 1, 2, 6, and 7 on-site mitigation of prime farmland losses is not possible. With Plan 3, some prime farmland acreage loss could be prevented if a policy was established allowing acreage outside the Confluence maximum storage pool to remain under agricultural production.

(4) Residual Impacts

Unmitigatable losses of prime farmland occur at the Cliff site (130 acres) and at the Confluence site (350 acres). Loss at Cliff is a residual impact of all plans. Loss at Confluence site occurs in Plan 3.

(5) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Impacts would be the same for New or Modified Roosevelt or Stewart Mountain because lake elevations, size, storage allocations, and level of flood control would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact at either location for geology/soils.

e. Land Resources

(1) Types of Impacts to Land Resources

The land resource analysis focuses on two factors: impacts on adjacent land resources (land use compatibility), and impacts of potential secondary development opportunities and induced land use changes of regional significance (land use conversions). Complex site-specific landownership and institutional decisions and agreements will be required once the preferred plan has been selected and detailed engineering plans have been completed.

Table IV-42

IMPACTS TO PRIME FARMLAND

Plan	Impact/Mitigation	Effect Unmitigated/Mitigated
1,2	130 acres of prime farmland at Cliff site acquired for project. On site mitigation is not possible.	Significant Adverse/ Significant Adverse
3	850 acres of prime farmland acquired for project (130 acres at Cliff site, 720 acres at Confluence site). On site mitigation at Cliff site not possible. Mitigation at Confluence site could reduce loss of 720 acres to 350 acres; mitigation of total loss is not possible.	Significant Adverse/ Significant Adverse
6,7	130 acres of prime farmland at Cliff site acquired for project. On site mitigation is not possible. Prime farmland acreage within New Waddell site area boundary is not affected by the project.	Significant Adverse/ Significant Adverse
9	No prime farmland affected by project.	Insignificant/ Insignificant

(2) Direct and Indirect Impacts

(a) Plan 8

The CAWCS no-action alternative, Plan 8, will not provide any additional increment of flood protection to areas within the Agua Fria, Verde and Salt/Gila River floodplains, and thus will limit or prohibit the implementation of proposed plans such as the

Rio Salado Development District, Sky Harbor International Airport Expansion, and the Maricopa County Flood Control District channel maintenance program.

As the Phoenix metropolitan area expands, considerable development will likely occur on presently vacant lands and agricultural lands located outside of the 100-year flood plain. However, the land use patterns of the Gila River flood plain below the Salt/Gila confluence will most likely remain essentially as agricultural/conservation open space areas, with development opportunities generally prohibited by possible flood flows from the Salt and Gila Rivers and their uncontrolled tributaries.

The predominantly open space desert characteristics of the Cliff area are expected to be maintained in the future given present Forest Service land management plans and policies. Additionally, lands along the Verde River corridor immediately north of the existing Sheep Bridge near Hot Springs have been determined to meet criteria for possible Congressional designation as a wild and scenic river. Through the Tonto National Forest the Verde flood plain is likely to continue to remain as an open space area primarily used for recreational, conservation, and livestock grazing purposes (Forest Service, Tonto National Forest).

Roosevelt Lake is the largest water body in the CAWCS study area. The recreational facilities at Roosevelt Lake are expected to increasingly serve regional recreational demands.

Developments which are expected to occur in the Confluence area include the continued development of the Fountain Hills, Rio Verde, and Goldfield Estates urban areas; the construction of some additional Forest Service recreational facilities and upgrading of access routes near the Blue Point Bridge on the Lower Salt River; and, the development of approximately 5,000 acres of irrigated agricultural lands and the establishment of sand and gravel mining operations at five locations on the Fort McDowell Indian Community. The Salt River Indian Community also has conceptual plans for commercial recreation developments extending from the Confluence site to south of Granite Reef Diversion Dam. The presently unincorporated area immediately south of the Tonto National Forest between Granite Reef Diversion Dam and the Superstition Mountains is likely to be urbanized as part of the City of Mesa.

Several public- and private-sector plans have been proposed within the Lake Pleasant vicinity. Such plans include State acquisition of selected BLM lands with eventual disposition planned to private developers; City of Peoria annexation of State trust lands for future

development; and, the Cities of Phoenix and Glendale are considering alternative locations for a new water treatment plant to deliver CAP municipal and industrial water. Residential and electronic/engineering industrial development are also being considered in the Lake Pleasant vicinity.

(b) Plan 1

Land use compatability assessments for the alternative action plans are based on four major assumptions:

- Land areas encompassed within the surcharge space at the reservoirs will be managed as open space with natural habitat land cover;

- All construction-related sites will be completely reclaimed as stated in the plan descriptions;

- Present Congressional, Forest Service, Indian and local governmental land management and conservation policies will remain relatively unchanged for national forests, Indian reservations and regional parks through the next century; and

- Any future developments on adjacent private lands will be planned and implemented in accordance with contemporary zoning and environmental regulations so as to minimize the formation of any potential incompatible land use patterns.

The implementation of Plan 1 would likely result in only insignificant modifications to the existing land use compatibility of parcels located adjacent to the maximum storage pools. Almost all of the parcels adjacent to the proposed reservoirs are classified as mostly compatible open space desert rangelands within the Tonto National Forest. The effect of Plan 1 on land use compatability is considered Insignificant.

No significant use conversions are expected as a result of Cliff, Roosevelt and Stewart Mountain Dams because these are are almost exclusively public lands located within the Tonto National Forest.

Plan 1 would reduce flood flows in the Salt River significantly. The 100 year flood, for instance, would be reduced from 215,000 cfs to 55,000 cfs at Sky Harbor International Airport. This flood protection would eliminate the flooding of 6219 acres of land, then by creating many opportunities for land conversions and redevelopment of adjacent parcels along the Salt River corridor through the cities of Mesa, Tempe, and Phoenix. These changes in land use would be governed by local zoning ordinances, and would be influenced by an increase in the value of land.

For the past decade local governments have supported a plan for the development of the Salt River corridor known as "Rio Salado". The Rio Salado Development District (RSDD) was established by the State Legislature to formulate a master plan for the development of the area.

A draft of the master plan is currently being considered by the RSDD. It includes a continuous regional park, and intensive development of its banks for industry, housing, recreation, tourism, cultural and educational uses. One of several obstacles to implementation of the Rio Salado concept is that the area is prone to flooding. Other obstacles are that the RSDD lacks authority to levy taxes, lacks the power of current domain, lacks the authority to zone or regulate land use, and lacks the funds required for implementation.

The flood protection afforded by Plan 1 would remove one of the obstacles to Rio Salado implementation. If flood protection is not provided by the Federal Government, local government is expected to explore the feasibility of implementing its own plan. Although Rio Salado might be influenced by the implementation of this plan it cannot be established that Rio Salado will necessarily follow the implementation of Plan 1, or it will be precluded if flood control is not provided by the Federal Government.

At Sky Harbor International Airport the 1,100-foot reconstruction of the eastern part of the southern runway destroyed during the three recent floods was completed in November 1983. Plan 1 would provide adequate permanent flood protection required for the reconstructed runway (City of Phoenix).

Also at Sky Harbor, the concept of constructing a third 9,000-foot parallel runway requiring the relocation or channelization of a segment of the Salt River has been proposed.

None of the CAWCS alternative plans would create additional land development/land conversion opportunities in flood plain areas downstream of the Salt/Gila confluence nor would they provide an adequate level of permanent flood protection to preclude the need for Maricopa County Flood Control District to develop and maintain a cleared (from phreatophytic vegetation) and graded 1,000-foot-wide corridor within the floodway of the Salt and Gila Rivers from 91st Avenue to Gillespie Dam (Maricopa County Flood Control District, Fish and Wildlife Service).

The effects of land use conversion impacts have been assessed as Significant Beneficial for Plan 1.

(c) Plan 2

The land resources impacts of Plan 2 are the same as Plan 1, with the following exceptions for land conversions.

Plan 2 is a limited structural plan, and would provide flood control of the 100-year event to 157,000 cfs, rather than 55,000 cfs, at Sky Harbor Airport; thereby protecting approximately 2,248 acres of land located in the present flood plain. Implementation of Plan 2 would not enhance development opportunities in the vicinity of any of the proposed dam sites.

An Insignificant effects value has been assigned to identified land conversion impacts of Plan 2.

(d) Plan 3

Land resources impacts of Plan 3 are the same as Plan 1 with the addition of impacts at the Confluence site.

At the Confluence site some adjacent residential parcels would periodically overlook reservoir drawdown areas. Also, new recreational facilities could complement the planned Goldfield Estates Residential Community. Overall, the effect of land use compatability impacts of Plan 3 is considered Insignificant.

Under Plan 3, the Confluence Dam and Reservoir would necessitate the acquisition of approximately 9,460 acres of Fort McDowell and Salt River Indian reservation lands and would preclude the planned development of irrigated agricultural lands and planned sand and gravel mining operations on the Fort McDowell Indian Community.

On privately owned lands, the anticipated rate of urban development could be slightly accelerated. Also, some limited urban development could potentially occur on approximately 1,200 acres of adjacent State trust lands. In total, the effect of land use conversions in Plan 3 is considered Insignificant.

(e) Plan 6

The impacts of Plan 6 are the same as Plan 1, with the following additions.

Implementation of Plan 6 may permit or accelerate urbanization of the northern and western sectors of the greater Phoenix metropolitan area. This is because of a locational advantage offered by storage of CAP water intended for municipal and industrial purposes at the New Waddell site instead of storage at the Confluence site.

Implementation of the proposed larger New Waddell Dam and Lake Pleasant Reservoir under Plan 6 would necessitate the acquisition of approximately 1,350 acres of privately owned lands, 400 acres of BLM National Resource Lands, and 2,050 acres of Arizona State Land Department trust lands.

Also, under Plan 6 no land conversion opportunities are likely within the 35-mile segment of the Agua Fria River flood plain between the existing Waddell Dam and the Agua Fria/Gila River confluence because the New Waddell Dam would provide only incidental additional downstream flood protection.

Overall, the effect of Plan 6 for land use conversions is considered Significant Beneficial.

(f) Plan 7

Plan 7 is the same as Plan 6 except that it would provide approximately 30,000 af of water per year of water for the Rio Salado Development District. Because of this, the effect of Plan 7 for land use conversions is considered a Beneficial Flag.

(g) Plan 9

The land resources impacts of Plan 9 are the same as Plan 1, with the following exceptions for land conversions.

Plan 9 would provide flood control of the 100-year event to 170,000 cfs, rather than 55,000 cfs, at Sky Harbor Airport; thereby protecting approximately 2,000 acres of land located in the present flood plain. Implementation of Plan 9 would not enhance development opportunities in the vicinity of any of the proposed dam sites.

An insignificant effects value has been assigned to identified land conversion impacts of Plan 9.

(3) Mitigation

Because of the generally insignificant and/or beneficial effects of CAWCS plans, no mitigation is recommended.

(4) Residual Impacts

There are no residual impacts since no mitigation is proposed.

(5) Impacts with Modified Roosevelt and Modified Stewart Mountain Dams in Plans

Impacts would be the same at Roosevelt or Stewart Mountain because lake elevations, size, storage allocation, and land use and ownership would be identical for a new structure or modified dam. Therefore, there is no significant difference in impact at either location for land resources.

8. Summary of Impacts

The impacts of the alternative plans are summarized for significant resources (biological resources, water quality, recreation, cultural resources, social resources, and economics) in Table IV-43 (environmental impacts), Table IV-44 (social impacts), and Table IV-45 (economic impacts).

C. Mitigation Plan for the Proposed Action (Plan 6)

Reclamation is committed to either minimize or eliminate the adverse impacts caused by the proposed action. The mitigation plan specifies the measures adopted by Reclamation at this time. However, specific features may be adjusted to accommodate changes incurred during project implementation.

Table IV-43

SUMMARY OF ENVIRONMENTAL IMPACTS AND EFFECTS OF PLANS

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
BIOLOGICAL RESOURCES							
Threatened/Endangered Plants and Wildlife							
Loss of acres of preferred habitat in typical year (bald eagle in all plans and Yuma clapper rail in Plan 3)	+300 (2,260 acres in site areas)	-440	-430	-1,030	-440	-440	-170
Number of bald eagle breeding areas with disrupted productivity as a result of loss of stream miles (see Perennial Stream/Riverine Communities factor)	0 (5 breeding areas in site areas, of which 3 most productive are at Confluence; 6 breeding areas in CAWCS area; 13 breeding areas in southwestern U.S.)	1	0	2	3	1	0
Conceptual Mitigation		Establish 230 acres preferred habitat	None proposed	Establish 370 acres preferred habitat	Section 7 reasonable and prudent alternatives will be implemented	Establish 280 acres preferred habitat	None proposed
Typical Year Unmitigated/ Mitigated Effect		SA/I	I	AF/AF	SA/I	SA/I	I
Riparian/Wetland Biotic Communities							
Loss or gain of high quality habitat in typical year	-2,260 (9,970 acres in site areas)	-930	-900	-3,330	-1,140	-1,140	-740
Loss or gain of low-quality habitat in typical year	-90 (1,940 acres in site areas)	+420	+860	+1,040	+1,030	+1,020	+740
Total loss or gain of acres of habitat in typical year	-2,350 (11,910 acres in site areas)	-510	-40	-2,290	-110	-120	0
Conceptual Mitigation		Establish 480 acres of high quality habitat	Establish 790 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 1,060 acres of high quality habitat	Establish 120 acres of high quality habitat
Typical Year Unmitigated/ Mitigated Effect (on high quality habitat)		SA/SA	SA/SA	AF/AF	SA/I	SA/SA	I/I

Table IV-43 (Continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
BIOLOGICAL RESOURCES Cont'd							
Perennial Stream/ Riverine Communities							
Loss of miles of perennial stream in typical year	0 (70 miles in site areas; 137 miles in CAWCS area)	-3	+1	-16	+1	-2	0
Change in flow characteristics of Salt and Verde Rivers	No change (on average, 106 days/ year ≤ 50 cfs in Salt, 61 days/year ≤ 50 cfs in Verde)	No change	No change	No change	No change	Guaranteed minimum flows of 200 cfs in Salt and Verde	No change
Conceptual Mitigation		None proposed	None proposed	Stream losses not mitigatable	None proposed	None proposed	None Proposed
Typical Year Unmitigated/ Mitigated Effect		I	I	AF/AF	I	SB	I
Reservoir Aquatic Communities							
Gain or loss of surface acres of habitat in typical year	0 (13,640 acres in site areas; 30,000 acres in CAWCS area)	+400	-360	+3,080	+1,900	+3,690	+1,770
Gain of guaranteed minimum pool(s)	0 (no guaranteed minimum pools at SRP lakes or Lake Pleasant)	0	0	+1 minimum pool at Confluence	+1 minimum pool at New Waddell	+2 minimum pools at Cliff and New Waddell	0
Drawdown rates greater than 2 inches/day during spawning season	No change (drawdown rates 1.3 in/day at Roosevelt, 9.2 in/day at Horseshoe, 1.6 in/day at Lake Pleasant)	4.6 in/day at Cliff (decrease from current condition)	9.2 in/day at Cliff (no change from current condition)	4.0 in/day at Cliff and 2.6 in/day at Confluence (increase over current condition)	4.0 in/day at Cliff and 4.7 in/day at New Waddell (increase over current condition)	4.5 in/day at Cliff and 4.7 in/day at New Waddell (increase over current condition)	4.7 in/day at New Waddell
Conceptual Mitigation		None proposed	None proposed		Reduction in drawdown rates to 2 in/day during spawning season		
Typical Year Unmitigated/ Mitigated Effect		I	I	SA/SB	SA/SB	SA/BF	SA/SB

Table IV-43 (Continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
WATER QUALITY							
Constituents							
	CAP water in local systems at locations and times chosen by users. Local surface water sources maintain quality independent of CAP influence. CAP water known to have high levels of dissolved organics	Average of 70,000 af of SRP (Verde River) water exchanged w/CAP each year. Comparison of Water Sources[a] (mg/l) Ca 42.5 / 85.6 D Cd 0.00156 / <0.000286 T Cd 0.00619 / <0.00462 T Fe 0.192 / 0.159 Hard 212. / 339. Na 30.5 / 107. D Pb 0.00300 / 0.00144 T Pb 0.0714 / 0.0408 D Se 0.000750 / <0.00300 T Se 0.000600 / <0.00279 SO_4 52.9 / 309. TDS 314. / 722. After-exchange maximum concentrations reach new highs for numerous constituents. Degradation of some SRP water during period when only Verde River water is normally delivered. Possible short-term impacts to M&I and agricultural users. Short exchange period affects only 8% of SRP surface water.	No change from future-without condition.	Annual average of 845,000 af of SRP surface water mixed with 250,000 af of CAP water at Confluence site. 30-35% of SRP water treated for M&I use. Changes in Average Verde River Concentrations[a] (mg/l) Ca 42.5 to 61.4 (+44%) D Cd 0.00156 to 0.00100 (-36%) T Cd 0.00619 to 0.00550 (-11%) T Fe 0.192 to 0.178 (-7%) Hard 212. to 268. (+26%) Na 30.4 to 64.0 (+111%) D Pb 0.00300 to 0.00232 (-23%) T Pb 0.0714 to 0.0580 (-19%) D Se 0.000750 to 0.00174 (+132%) T Se 0.000600 to 0.00156 (+160%) SO_4 52.9 to 165. (+212%) TDS 314. to 493. (+57%) After-mix maximum SRP concentrations reach new highs for numerous constituents. All of SRP surface water degraded and possible increased M&I treatment costs with short-term maximum CAP concentrations. Possible changes in agricultural operation only during period when Verde River water is normally delivered. High dissolved organic levels in CAP water reach water treatment plants which otherwise would receive only SRP water.	Annual average of 25,000 af of MCMWCD#1 surface water mixed with 701,800 af of CAP water at Waddell site. None of the MCMWCD#1 water treated for M&I uses. Changes in Average MCMWCD#1 Concentrations[a] (mg/l) Ca 50.8 to 84.4 (+66%) D Cd <0.00300 to 0.000378 (-87%) T Cd <0.00150 to 0.00451 (+201%) T Fe 2.04 to 0.223 (-89%) Hard 215. to 335. (+56%) Na 37.8 to 105. (+178%) D Pb 0.00200 to 0.00146 (-27%) T Pb 0.00425 to 0.0396 (+832%) D Se <0.00100 to 0.00293 (+193%) T Se <0.00100 to 0.00273 (+173%) SO_4 85.0 to 301. (+254%) TDS 358. to 710. (+98%) After-mix maximum MCMWCD#1 concentrations reach new highs for numerous constituents with no significant effect on agricultural users.		
Conceptual Mitigation		None proposed	Not applicable	None proposed	None proposed	None proposed	
Typical Year Unmitigated Effect		I	No effect	SA	I	I	

Table IV-43 (Continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
WATER QUALITY Cont'd							
Eutrophication							
Potential for eutrophic conditions to occur in reservoirs which store CAP Colorado River water in CAWCS study area[b].	No Colorado River water storage reservoir in study area.	Same as Future Without Condition		Confluence Reservoir has high potential for eutrophication with high probability for blue-green algal dominance. Probable aesthetic impacts on Verde arm in most years. Eutrophication provides potential for increased levels of dissolved organics in Confluence Reservoir water.	New Waddell Reservoir has low to moderate potential for eutrophication with no projected problems		
Conceptual Mitigation		------- Not applicable --------		Downstream impacts mitigatable with different disinfection process for SRP M&I water.	None proposed		
Typical Year Unmitigated/ Mitigated Effect		--------- No Effect ----------		SA/I	I	I	
Salt Loading							
Increased amount of dissolved salts imported in Colorado River water.	Baseline CAP imports average of 1,020,000 tons of dissolved salts each year.	10.6% increase in average annual imported salt volume.	1.6% increase in average annual imported salt volume.	16.2% increase in average annual imported salt volume.	13.3% increase in average annual imported salt volume.	11.3% increase in average annual imported salt volume	
Conceptual Mitigation		None proposed	None proposed	None proposed	None proposed	None proposed	
Typical Year Unmitigated/ Effect		I	I	I	I	I	

[a]Prefix D means dissolved fraction while T means total recoverable. All values shown rounded to three significant figures. Constituents shown on this table were selected to show some significant impacts; a more complete list of constituents and their impacts is included in Chapter IVB2.

[b]Eutrophication potentials were computed using the Canfield and Bachman equations described in the USBR Technical Memorandum titled "Guidelines for Studies of Potential Eutrophication" Denver, Co., 1981. Risk of eutrophication under normal operating conditions is based on phosphorus concentration which is assumed uniform over the studied area.

Table IV-43 (Continued)

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
CULTURAL RESOURCES							
Prehistoric Cultural Resources							
Number of sites destroyed by construction activities/total number of sites potentially affected in dam site areas[c]	0 sites in site areas)	132/2,942	72/2,942	156/3,208	158/3,062		53/3603
Acres of archaeological deposits affected	0 acres of deposits in site areas)	4,272	4,272	12,015	4,374		4688
Effects Factor (for total sites affected)[d]		-5,760	-4,747	-14,665	-5,887		-5456
Conceptual Mitigation		Avoiding resource; partial data recovery (e.g., mapping sites, collection of surface artifacts, use of remote sensing techniques, test excavations, partial site excavations); site protection (e.g., fencing around site, policing, site monitoring, enforcement of laws against vandalism). Complete mitigation of impacts not possible.					
Unmitigated/ Mitigated Effect		AF/AF	AF/AF	AF/AF	AF/AF		AF/AF
Historic Cultural Resources							
Number of sites destroyed by construction and related activities/ total number of sites potentially affected in dam site areas[c]	0 (192 sites in site areas)	29/64	29/64	73/90	39/73		36/67
Effects Factor (Range)[d]		-73 to -320	-173 to -370	-438 to -798	-225 to -422		-207 to -383
Conceptual Mitigation		Avoiding resource; partial data recovery; site protection; site documentation (e.g., recording surface architecture or structural features); additional historical research.					
		Roosevelt Dam and Verde River Sheep Bridge impacts only partially mitigable		Fort McDowell, Roosevelt Dam, and Verde River Sheep Bridge impacts only partially mitigable	Roosevelt Dam and Verde River sheep Bridge impacts only partially mitigable		Roosevelt Dam impacts only partially mitigable
Unmitigated/ Mitigated Effect		AF/AF	AF/AF	AF/AF	AF/AF		AF/AF

[c]Affected areas include all reservoir pool zones plus a secondary impact zone that extends approximately 1 mile beyond the maximum water surface elevation.

[d]This factor incorporates both the quality of the resource and the severity of the impacts. See Stage III Methodology for Environmental Quality Assessment (Dames & Moore, 1981) for details.

Table IV-43

Factors/Measures	Plan 8 CAWCS No Action (Future Without Project)	Plan 1	Plan 2	Plan 3	Plan 6	Plan 7	Plan 9
RECREATION							
Stream-Oriented Recreation							
Net loss or gain of miles of perennial stream/loss of tubing miles in typical year	0/0 (70 stream miles in site areas; 986 miles in 5-county region)	-3/0	+1/0	-16/17	+1/0	-2/0	0/0
Net loss or gain in maximum annual recreation days for stream-oriented activities in typical year	0/0 (2,280,000 stream-oriented recreation days in site areas; 8,236,000 in 5-county region)	+5,850	+696	-1,504,802	+7,992	+6,386	0
Conceptual Mitigation		None proposed	None proposed	Loss of stream miles not mitigatable	None proposed	None proposed	None proposed
Typical Year Unmitigated/ Mitigated Effect		I	I	AF/AF	I	I	I
Reservoir-Oriented Recreation							
Net loss or gain in usable surface acres in typical year	0 (16,600 acres in site areas; 35,000 in 5-county region)	+683	-853	+5,243	+4,222	+5,095	+4,233
Net loss or gain in maximum annual recreation days for reservoir-oriented activities in typical year	0 (822,000 reservoir-oriented recreation days in site areas; 6,479,000 for 5-county region)	+670,520	-48,647	+3,537,383	+1,066,005	+1,085,873	+884,000
Conceptual Mitigation		---------- None proposed for this factor ----------					
Typical Year Unmitigated Effect		SB	I	SB	SB	BF	SB

Table IV-44

SUMMARY OF SOCIAL IMPACTS AND EFFECTS OF PLANS

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 8 CAWCS No Action (Future Without the Project)	For 374 Fort McDowell Indian Community residents: Normal incidence of physical and mental health problems. High satisfaction with way of life. High levels of personal automony. High potential for increased financial self-sufficiency. High levels of extended family ties. Normal incidence of family problems. High community cohesion and viability. High potential for increased tribal economic self-sufficiency. Moderate levels of unemployment. High potential for sustaining Yavapai culture.	For 596 Roosevelt Lake area residents: Normal incidence of physical and mental health problems. High levels of personal automony. High satisfaction with way of life. High potential for financial self-sufficiency. Low levels of informal support networks in all communities except Roosevelt Gardens. Low to moderate community cohesion in all communities except Roosevelt Gardens. Community development likely to remain at present low level.	For 46,560 people living in the flood prone areas by the year 2000 (conditions occur with a 200-year flood of 275,000 cfs) COMMUNITIES AFFECTED: Mesa, Tempe, Phoenix, Salt River Pima Maricopa Indian Community (SRPMIC), Gila River Indian Community (GRIC), Buckeye, Holly Acres: Potential for inundation for 46,560 individuals. High probability for large numbers of flood-related deaths. Projected $87,292,000 in residential property damage. Temporary lifestyle disruption for 46,560 individuals subjected to inundation by floodwaters. Permanent changes in lifestyle for majority of 525 sequential disaster victims in Holly Acres. Damages to roads and bridges projected to be $15,800,000. Transportation delay costs projected to be $39,694,000. Air and rail facility damages projected to be $7,021,000. Damages of $6,400,000 to power facilities. >$275,000 in damages to treatment plants. Temporary delays in telephone service. Business losses of $68,713,000; combined with both short- and long-term revenue losses, costs could be in excess of $150 million. Short- and long-term losses to tourism. Civil defense warning system fully activated. Emergency costs of $1,109,000. No additional land available for development.

Table IV-44 (Continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 1	Same as Future-Without conditions.	IMPACTS For 347 Roosevelt Lake area residents: Slight increase in incidence of physical and mental health problems. Substantial decrease in personal automony. Substantial decrease in satisfaction with way of life. Moderately reduced financial capacity. Moderate decrease in informal support networks. Moderate decrease in community cohesion. Substantial decrease in community viability. MITIGATION: Relocate only those people who live within the 200-year flood pool, with no relocation of people in the IDF area. Provide Forest Service land in the Roosevelt Lake area for relocations, allowing enough space so neighbors may relocate near each other if they wish. Provide monetary compensation for all relocation expenses incurred by residents. Provide special services to meet needs that are unique to these communities. Provide an accurate and reliable system for disseminating information to residents so that they are constantly informed about relocation proceedings; provide a means by which residents can participate in the relocation planning process. UNMITIGATED/MITIGATED EFFECT: SA/I	IMPACTS For 46,560 people living in the flood prone areas by the year 2000 (conditions occur with reduction of a 200-year flood to 70-92,000 cfs at airport): Potential for inundation for less than 100 individuals in Holly Acres area. Projected $602,000 in residential property damage. Temporary lifestyle disruption for <100 individuals; permanent lifestyle disruption for majority of sequential disaster victims in Holly Acres. 15 bridge crossings remain operable. Damages to roads and bridges totalling <$5,000,000. No significant delays in transportation. Damages to electrical transmission towers and power lines would be well below $1 million. Possibility of delays in telephone service for some. No delays in delivery schedules of newspapers, mail, etc. Business losses totaling $6,194,000; majority of damages occurring to sand and gravel operations. No significant disruption to tourist trade. Emergency costs would be below $60,000. Approximately 3,563 additional acres valued at $107,311,000 available for higher urban uses. MITIGATION: Not required UNMITIGATED EFFECT: BF

Table IV-44 (Continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 2	Same as Future-Without conditions.	IMPACTS For 247 Roosevelt Lake area residents: Slight increase in incidence of physical and mental health problems. Substantial decrease in personal automony. Moderate decrease in satisfaction with way of life. Moderately reduced financial capacity. Moderate decrease in informal support networks. Moderate decrease in community cohesion and slight decrease in social organization. Substantial decrease in potential for sustained community viability. MITIGATION: Relocate only those people who live within the 200-year flood pool, with no relocation of people in the IDF area. UNMITIGATED/MITIGATED EFFECT: SA/No effect	IMPACTS For 46,560 people living in the flood-prone areas by the year 2000 (conditions occur with a reduction of 200-year flood to 157,000 cfs at airport): Potential for inundation of approximately 525 individuals. Low probability of flood-related deaths. Projected $5,684,000 in residential property damage. Temporary lifestyle disruption for 525 individuals inundated; permanent lifestyle disruption for many sequential disaster victims in Holly Acres. 15 bridge crossings remain operable. Closure of all dip crossings. Damages to roads and bridge crossings totalling >$5,000,000. No significant delays in transportation. Damages totaling $1,500,000 to electrical transmission towers and power lines. Approximately $80,000 in damages to sewage and wastewater treatment plants. Temporary delays in telephone service in some areas. No delays in delivery schedules of newspapers, mail, etc. Business losses totalling $6,977,000; majority of damages to sand and gravel operations. No significant disruption in tourist trade. Civil defense warning system fully activated. Emergency costs in excess of $505,000. 2,248 acres valued at $66,026,000 available for higher urban uses. MITIGATION: Not required. UNMITIGATED EFFECT: SB

Table IV-44 (Continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 3	IMPACTS: For 290 Fort McDowell Indian Community residents: High incidence of physical and mental health problems which is expected to result in increased illness and mortality. Extreme decline in levels of personal autonomy. Extreme decrease in satisfaction with way of life. Substantial decrease in potential for sustained financial self-sufficiency. Substantial decrease in extended family ties. Substantial increase in incidences of family problems. Extreme decrease in community cohesion and viability. Substantial decrease in potential for tribal economic self-sufficiency; substantial increase in unemployment. Extreme decrease in potential to sustain Yavapai culture. MITIGATION: Relocate the entire community together. Provide land of the highest available quality contiguous to the reservation. Monetary compensation should cover all expenditures. Provide for participation of the entire community in all decisions and plans. Provide a system for disseminating information to residents. UNMITIGATED/MITIGATED EFFECT: AF/AF	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.
Plan 6 (Agency Proposed Action)	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.
Plan 7	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	Impacts and effects same as Plan 1.

Table IV-44 (Continued)

	Relocation of Indian People	Relocation of Non-Indian People	Flood Damage Reduction
Plan 9	Same as Future-Without conditions.	Impacts and effects same as Plan 1.	IMPACTS For 46,560 people living in the flood-prone areas by the year 2000 (conditions occur with a reduction of 200-year flood to 215,000 cfs at airport): Potential for inundation of >525 individuals. Low probability of flood-related deaths. Projected $18,954,000 in residential property damage. Temporary lifestyle disruption for >525 individuals inundated; permanent lifestyle disruption for many sequential disaster victims in Holly Acres. 3 bridge crossings remain operable. Closure of all dip crossings. Damage to roads and bridge crossings totalling $9,100,000. Significant delay in transportation. Damages totalling $4,800,000 to electrical transmission towers and power lines. Greater than $135,000 in damages to sewage and wastewater treatment plants. Temporary delays in telephone service in some areas. Delays in delivery schedules of newspapers, mail, etc. Business losses totalling $21,761,000; majority of damages to sand and gravel operations. Short-term disruption in tourist trade. Civil defense warning system fully activated. Emergency costs in excess of $809,000 MITIGATION: Not required. UNMITIGATED EFFECT: B

TABLE IV-45

SUMMARY OF ECONOMIC COSTS AND BENEFITS OF PLANS

ECONOMICS	Plan	Total Construction Cost ($ Range)[a]	Total Annual Cost ($ Range)[a]	Total Annual Benefits ($)	Net Economic Benefits ($ Range)[a]
Plan 8	(No CAWCS Action)	0	0	0	0
Plan 1		694,940,000 to 874,230,000	58,060,000 to 71,300,000	89,040,000	30,980,000 to 17,740,000
Plan 2[b]		541,570,000 to 627,460,000	41,870,000 to 48,210,000	53,310,000	11,440,000 to 5,100,000
Plan 3		1,116,250,000 to 1,295,540,000	93,970,000 to 107,200,000	125,970,000	32,000,000 to 18,770,000
Plan 6	(Agency Proposed Action)	978,430,000 to 1,157,720,000	82,710,000 to 95,940,000	174,290,000	91,580,000 to 78,350,000
Plan 7		same as Plan 6	same as Plan 6	168,160,000	85,450,000 to 72,220,000
Plan 9		931,790,000 to 1,111,080,000	76,030,000 to 89,260,000	143,089,000	53,829,000 to 60,169,000

[a]Costs range from Modified Roosevelt/Modified Stewart Mountain options to New Roosevelt/New Stewart Mountain options. Net economic benefits correspond to these options. Costs of plans would be allocated among several funding sources; for this analysis 2 sources were assumed: Reclamation Safety of Dams Act and Colorado River Basin Project Act.

[b]New Roosevelt is not included in Plan 2.

The mitigation plan is displayed for only the proposed action because that is the action Reclamation expects to implement. If another action is recommended for implementation, then very similar mitigation measures would be applied to mitigate the impacts of that action, although the actual quantity and quality would most likely be different.

The following subsections describe the mitigation plan for Plan 6. For each major resource category, commitments for mitigation are established, various means for accomplishing the commitments are described, and additional opportunities are discussed.

1. Biological Resources

Based on Habitat Evaluation Procedures utilized in developing this mitigation plan, mitigation measures and project modifications are described which will fully alleviate impacts to Riparian/Wetland Communities, Reservoir Aquatic Communities, Perennial Streams, and Special Use Areas and avoid jeopardizing endangered species. Other Terrestrial Communities have mitigation measures presented which are also reasonable and feasible but provide less than full compensation for losses due to cost and operational constraints. Reservoir Aquatic Communities will benefit from the Plan 6 action due to increases in habitat and prey availability. However, the largemouth bass and allied species, which are the mainstay of the sport fishery at New Waddell, will be adversely affected by the action. This will directly affect the economic value of this resource.

Throughout the development of this mitigation plan Reclamation has coordinated with the Fish and Wildlife Service and the Arizona Game and Fish Department in accordance with the Fish and Wildlife Coordination Act and the Endangered Species Act. Recommendations made by these agencies have been considered in the selection of mitigation measures that will be implemented.

Additional opportunities have been identified for impact reduction and/or enhancement of habitat values. These measures could be considered if 1) the proposed measures are not effective in meeting the objective of no net loss of habitat value, or 2) enhancement of habitat value is determined to be appropriate and the required sponsorship of the measure is available. Implementation of these opportunities will be dependent on discussions with wildlife and land management agencies as well as an analysis of the cost and effectiveness of the measures.

The primary impacts described in Chapter IV are based on the effects of impounding water. The amount of water impounded and the operation of the reservoir were determined by forecasting the availability of water based on historical records. The mitigation of the effects of the reservoirs is therefore dependent on the accuracy of these forecasts. The best information available has been used to determine the compensation for the adverse effects of the project on fish and wildlife resources. If new data become available the effects and mitigation measures will be reassessed while attempting to maintain the level of compensation committed to herein.

The principal method for determining mitigation needs was the Habitat Evaluation Procedure developed by the Fish and Wildlife Service. This methodology quantifies changes in wildlife habitat quality and quantity over time. The measure used to quantify change is a Habitat Unit (HU). Habitat unit values have been derived for each habitat type impacted in the Plan 6 area. Habitat Unit Values for each resource category with and without mitigation are presented in Table IV-46.

a. Riparian/Wetland Communities

(1) Commitment

Reclamation is committed to implementing a plan that will result in no net loss of habitat values to the Riparian/Wetland Communities upstream of Bartlett and Stewart Mountain Dams and at Lake Pleasant. Reclamation is also committed to revegetating 250 acres of cottonwood-willow and 690 acres of mesquite at the Cliff site.

(2) Means of Accomplishing Commitment

(a) The methods for meeting this commitment will include revegetating cottonwood/willow and mesquite habitat types in suitable areas within the exposed bed of Horseshoe Reservoir above elevation 1940. Based on current information sufficient area will be exposed to recover all of the habitat value lost to construction and operation of Plan 6, including losses at Roosevelt and New Waddell Dams (Table IV-46). Additionally, only partial conservation pool clearing will occur in existing stands of the riparian/wetland community at New Waddell and Cliff Damsites, thereby reducing impacts. No clearing will occur at Roosevelt Dam under current plans.

(b) The mixed scrub at all sites and cattail habitat at Cliff Dam will recover without revegetation through natural succession as they do now when reservoirs are drawn down for extended periods of time. To ensure full development of the habitat values, livestock grazing and ORV use would need to be eliminated in this riparian area and fencing may be required if adequate protection is not provided through other means such as fencing the IDF areas. (See discussion on other Terrestrial Communities). The Tonto National Forest has further recommended that this area be set aside as a wildlife and waterfowl area and managed in cooperation with other wildlife and land management agencies. This recommendation will be implemented through a management agreement among these agencies. As these measures will be within the Tonto National Forest, this agency will be requested to manage the area.

(c) The draining of Horseshoe Reservoir and the breaching of Horseshoe Dam will be scheduled to coincide with the seeding and germination period of cottonwood and willow species in March and April. By draining the lake during this period, the increased production of cottonwood and willow trees would offset mixed scrub establishment, as mixed scrub species tend to germinate in early to mid summer. This measure will be reflected in the construction schedule for Cliff Dam. The implementation of this measure would reduce the initial cost of revegetation by eliminating the need to root plow, burn, or spray unwanted vegetation such as salt cedar and reduce the amount of plant materials required to accomplish the objective.

Table IV-46. Acreage and habitat units for the future without and the future with the project and; mitigated acreages, habitat units and costs for each mitigation measure in each community type affected in the Plan 6.

	RIPARIAN/WETLAND COMMUNITIES								
	Cliff		Roosevelt		Waddell		Totals		
	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Cost
FUTURE WITHOUT PROJECT AREA	+1270	+5797	+2140	+11017	+480	+1992	+3890	+18806	N/A
PROJECT IMPACTS									
Construction impact	-480	-2037	-130	-647	-40	-173	-650	-2857	N/A
Conservation pool clearing	-353	-2553	0	0	0	0	-353	-2553	N/A
Conservation pool flooding	-117	-846	-240	-1609	-440	-1819	-797	-4274	N/A
Construction reclamation	+120	+830	+110	+500	+20	+99	+250	+1429	N/A
Succession[4]	+690	+3168	+180	+401	+80	+275	+950	+3844	N/A
FUTURE WITH PROJECT[1] REMAINING AREA	+1130	+4377	+2060	+9662	+100	+374	+3290	+14413	N/A
TOTAL IMPACT[2]	-140	-1420	-80	-1355	-380	-1618	-600	-4393	N/A
MITIGATION									
Revegetation	+840	+6383	0	0	0	0	+840	+6383	$840,000
Succession[4]	-300	-1405	0	+3868	0	+72	-300	+2535	N/A
FUTURE WITH PROJECT[3] AREA MANAGED	+1670	+9355	+2060	+13530	+100	+446	+3830	+23331	
Change due to Project	+400	+3558	-80	+2513	-380	-1546	-60	+4525	N/A
TOTAL COST	$840,000		-0-		-0-				$840,000

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1. The remaining area equals future without project after accounting for project impacts.
2. Total impacts = future without project + future with project remaining area.
3. Future with project area managed = future with project remaining area with mitigated habitat values.
4. Succession represents an ecological change from one vegetation cover type to another.

Table IV-46 continued

	OTHER TERRESTRIAL COMMUNITIES								
	Cliff		Roosevelt		Waddell		Totals		
	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Cost
FUTURE WITHOUT PROJECT AREA	+9120	+53542	+7830	+34963	+8660	+30603	+25610	+119108	N/A
PROJECT IMPACTS									
Construction impact	-910	-5342	-880	-3929	-1670	-5901	-3460	-15172	N/A
Conservation pool clearing	-808	-4743	0	0	-1425	-5036	-2233	-9779	N/A
Conservation pool flooding	-862	-5061	-3440	-15361	-4945	-17475	-9247	-37897	N/A
Construction reclamation	+400	+2348	+400	+1768	+1580	+5583	+2380	+9699	N/A
Succession[4]	+820	+4814	+2090	+9332	0	0	+2910	+14146	N/A
FUTURE WITH PROJECT[1] REMAINING AREA	+7760	+45558	+6000	+26773	+2200	+7774	+15960	+80105	N/A
TOTAL IMPACT[2]	-1360	-7984	-1830	-8190	-6460	-22829	-9650	-39003	N/A
MITIGATION									
Wildlife water facilities	(13)	+2789	(10)	+2094	(4)	+645	(27)	+5528	$675,000
IDF Fencing	(50 mi)	+7608	(55 mi)	+13022	(35 mi)	+3491	(140)	+24121	$1,190,000
FUTURE WITH PROJECT[3] AREA MANAGEMED	+7760	+55955	+6000	+41889	+2200	+11910	+15960	+109754	
Change due to Project	-1360	+2413	-1830	+6926	-6460	-17693	-9650	-8354	N/A
TOTAL COST	$770,000		$740,000		$405,000				$1,865,000

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1. The remaining area equals future without project after accounting for project impacts.
2. Total impacts = future without project + future with project remaining area.
3. Future with project area managed = future with project remaining area with mitigated habitat values.
4. Succession represents an ecological change from one vegetation cover type to another.

Table IV-46 continued

	PERRENIAL STREAM COMMUNITIES								
	Cliff		Roosevelt		Waddell		Totals		
	Miles	Habitat Value	Miles	Habitat Value	Miles	Habitat Value	Miles	Habitat Value	COSTS
FUTURE WITHOUT PROJECT AREA	+20	+45558	+15	N/A	0	N/A	+35	+45558	N/A
PROJECT IMPACTS									
Construction impact	-4	-9113	0	N/A	0	N/A	-4	-9113	N/A
Conservation pool flooding	-6	-13668	0	N/A	0	N/A	-6	-13668	N/A
Construction reclamation	+4	+6962	0	N/A	0	N/A	+4	+6926	N/A
FUTURE WITH PROJECT[1] REMAINING AREA	+14	+29739	+15	N/A	0	N/A	+29	+29739	N/A
TOTAL IMPACT[2]	-6	-15819	0	N/A	0	N/A	-6	-15819	N/A
MITIGATION									
Reclamation of stream miles	+7	+22240	0	N/A	0	N/A	+7	+22240	$610,000
Fish barriers	(+1)	N/A	(0)	N/A	(+1)	N/A	(+2)	N/A	$60,000
FUTURE WITH PROJECT[3] AREA MANAGED	+21	+51979	+15	0	0	0	+36	+51979	N/A
Change due to Project	+1	+6421	0	0	0	0	+2	+6421	N/A
TOTAL COST	$619,000		-0-		$51,000				$670,000

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1. The remaining area equals future without project after accounting for project impacts.
2. Total impacts = future without project + future with project remaining area.
3. Future with project area managed = future with project remaining area with mitigated habitat values.

Table IV-46 continued

	RESERVOIR AQUATIC COMMUNITIES								
	Cliff		Roosevelt		Waddell		Totals		
	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Costs
FUTURE WITHOUT PROJECT AREA	+610	+1061	+11930	+29036	+830	+1950	+13370	+32047	N/A
PROJECT IMPACTS									
Construction impact	0	N/A	0	N/A	-80	-188	-80	-188	N/A
Conservation pool flooding	+130	+226	0	N/A	+1850	+3246	+1980	+3472	N/A
Construction reclamation	0	N/A	0	N/A	+40	+78	+40	+78	N/A
FUTURE WITH PROJECT[1] REMAINING AREA	+740	+1287	+11930	+29036	+2600	+5086	+15270	+35409	N/A
TOTAL IMPACT[2]	+130	+226	0	N/A	+1890	+3324	+2020	+3550	N/A
MITIGATION									
Drawn down rates (in/day)	(-.72)	+459	N/C	N/C	(-1.49)	+601	N/A	+1060	-0-
Minimum pool	(+1030)	N/A	N/C	N/A	(+1540)	N/A	(+2570)	N/A	N/A
Safety Clearing	-1161	+20	0	+459	-1425	+117	+2586	+479	-0-
FUTURE WITH PROJECT[3] AREA MANAGED	+740	+1766	+11930	+29495	+2600	+5804	+15270	+37065	N/A
Change due to Project	+130	+705	0	+459	+1770	+3854	+1900	+5018	N/A
TOTAL COST	-0-		-0-		-0-				-0-

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1. The remaining area equals future without project after accounting for project impacts.
2. Total impacts = future without project + future with project remaining area.
3. Future with project area managed = future with project remaining area with mitigated habitat values.

Table IV-46 continued

	SPECIAL USE AREAS								
	Cliff		Roosevelt		Waddell		Totals		
	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Acres	Habitat Value	Costs
FUTURE WITHOUT PROJECT AREA	0	N/A	+2000	N/A	0	N/A	+2000	N/A	N/A
PROJECT IMPACTS									
Recreation impacts	0	N/A	-100	N/A	0	N/A	-100	N/A	N/A
FUTURE WITH PROJECT[1] REMAINING AREA	0	N/A	+1900	N/A	0	N/A	+1900	N/A	N/A
TOTAL IMPACT[2]	0	N/A	-100	N/A	0	N/A	-100	N/A	N/A
MITIGATION									
Provide winter waterfowl food areas	+1720	N/A	+100	N/A	0	N/A	+1820	N/A	$20,000
FUTURE WITH PROJECT[3] AREA MANAGED	+1720	N/A	+2000	N/A	0	N/A	+3720	N/A	N/A
Change due to Project	+1720	N/A	0	N/A	0	N/A	+1720	N/A	N/A
TOTAL COST	$10,000		$10,000		-0-				$20,000

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1. The remaining area equals future without project after accounting for project impacts.
2. Total impacts = future without project + future with project remaining area.
3. Future with project area managed = future with project remaining area with mitigated habitat values.

(d) All riparian habitat in the construction areas not required for construction purposes will be protected from damage. All lands containing riparian habitat which is removed due to construction outside the impoundment area will be contoured and revegetated to preconstruction conditions.

(3) Additional Opportunities

(a) Support could be provided to land management programs that promote riparian/wetland habitat rehabilitation in suitable drainages at all project sites. An example of such a program is the Forest Service's riparian habitat rehabilitation program in the Tonto National Forest, with rehabilitation sites in the areas near the proposed Cliff Dam on the Verde River and the Salt River.

(b) Privately-owned parcels of land bordering the Salt and Verde Rivers could be acquired and managed to promote riparian growth and wildlife utilization. Several parcels on Tonto Creek at Roosevelt Lake offer potential sites for riparian habitat development. Size, quantity, cost and availability of the parcels for purchase have not yet been determined.

(c) Additional or substitute areas at Cliff Reservoir such as Mullen Mesa or Deadman Wash or other National Forest Service lands outside of project area could be converted to cottonwood/willow communities. These are currently desert areas that occur in the proposed surcharge pool and will be inundated during high frequency flood events, thereby greatly reducing their existing habitat value. These same flood events would serve to encourage the establishment of mixed scrub habitat due to the increased availability of water. However, these areas would require greater effort to vegetate and maintain than the proposed areas due to differences in soil type and depth to ground water.

(d) Additional benefits could be obtained by creating "pot holes" in the bed of Horseshoe Reservoir for cattails. This would in turn increase the value of the area for wetland wildlife species and waterfowl.

b. Other Terrestrial Communities

(1) Commitments

The upland desert habitat represents the major vegetation type within the Cliff, Roosevelt, and Waddell site areas and will be subjected to the greatest acreage loss within the reservoir inundation zone. Opportunities for recovering lost acreages are limited, but qualitative mitigation is possible. Reclamation is committed to mitigating the loss of habitat value to the greatest extent practical or to compensate for the losses by increasing values in other habitat communities.

(2) Means of Accomplishing Commitment

(a) Reclamation will restrict grazing and off-road vehicle access by fencing the IDF and/or by obtaining management agreements on

project withdrawn lands at each project site (i.e., with the Forest Service at Cliff and Roosevelt Damsites and the Maricopa County Parks Department and/or the State Land Department at New Waddell Damsite). In addition permanent water sources will be provided in areas where water is not now available to wildlife.

(b) All areas of construction disturbance in the project sites not needed for permanent facilities will be returned to natural contours and revegetated with native species of plants occurring in the habitat.

(c) These mitigation measures will reduce habitat value losses by 92 percent (72 percent annualized) over time, but there will be a 38 percent loss in acreage. These residual impacts will require negotiations with wildlife and land management agencies to determine how best to further reduce these losses.

(3) Additional Opportunities

(a) Additional land may be available at New Waddell if the size of the county park there is increased. If this occurs, Reclamation could negotiate a management agreement with the County that would increase wildlife values through the elimination of cattle grazing in the same manner as in the proposed measure.

(b) Additional land could be acquired to mitigate losses of habitat value. There appears to be an adequate supply of desert upland habitat that could be used. However, to regain the lost habitat value through management, the present habitat value of any acquired land would need to be taken into account, so that the required acreage would be 12,000 to 18,000 acres.

e. Perennial Streams

(1) Commitment

Reclamation is committed to replacing all of the habitat value lost due to the construction and operation of Plan 6. Reclamation is further committed to avoiding impacts to the native fisheries in perennial streams caused by the increased water storage elevations at Cliff and New Waddell Damsites which could introduce non-native reservoir fish into currently isolated native fish habitat.

(2) Means of Accomplishing the Commitment

(a) Up to 7 miles of river will be available after draining Horseshoe Reservoir. Reclamation will reclaim these 7 miles through stream management techniques which will replace the habitat value lost from the 6 miles of river inundated by Cliff Dam and Reservoir.

(b) Because of recent high flows on the Verde and resultant storage in Horseshoe Reservoir, the necessary physical parameters needed to choose the proper methods of reclamation of the river have not been

determined. Therefore, the first step is to collect and analyze this information. The second step will then be to select the proper methods for stabilizing the stream channel and creating habitat for riverine fishes and wildlife. Such habitat manipulation would be directed toward providing a heterogeneous mixture of pools, riffles, and backwaters. If these measures are successful the loss of 15,819 habitat units will be fully mitigated and possible enhancement of 6,421 habitat units could occur. These anticipated gains are predicted on rehabilitation during the first 10 years of project operation. If rehabilitation is delayed or takes longer than expected, the overall gains will be less. Given the accuracy of the forecasted flow regime, a quantitative increase of 1 stream mile could be gained.

(c) The avoidance of impacts to native stream fish will be accomplished by placing fish barriers above the IDF elevation on streams in the project area which contain native fish populations.

(d) Where possible, construction impacts to riverine resources will be avoided by locating haul roads away from water courses and minimizing river crossing areas.

(3) Additional Opportunities

(a) Instream flow releases could be made to downstream sections of the Salt and Verde Rivers to compensate or enhance riverine habitat. Instream flow studies are needed to determine the best flow regime as there may be conflicts between the requirements of the native and non-native fish populations in these systems.

(b) Minimum flows in the Salt and Verde Rivers could be maintained to prevent dry-up periods or to minimize the extent of the dry-up periods.

d. Reservoir Aquatic Communities

(1) Commitments

Beneficial effects will result from the implementation of Plan 6 for most aquatic dependent species. Reclamation's commitment with regard to adversely impacted game fish is to replace the lost habitat values to the greatest extent practical, compensate for these values by increasing habitat values elsewhere, or by increasing the density of game fish in project reservoirs as measured by the catch/unit effort.

A potential problem may exist with the introduction of Colorado River ichthyofauna and its effect on the fishery at New Waddell. Through a cooperative effort with the Arizona Game and Fish Department, the Fish and Wildlife Service and other interested parties, Reclamation will investigate the effect of the introductions or possible means of preventing its occurrence. The knowledge gained from this investigation will be used to confirm or modify the mitigation measures to gain the greatest value for the effort.

(2) Means of Accomplishing Commitments

(a) Reclamation is committed to reducing the rate of drawdown at New Waddell Reservoir to 5 feet or less during March and the first half of April as often as is practical to provide suitable spawning conditions for largemouth bass and other fish with similar spawning requirements. The time period for the reduced drawdown rate will be extended for as long as possible dependent on annual variations in power marketing and other considerations such as seasonal climatic conditions which may affect the needs of the water users. At a minimum, conditions suitable for largemouth bass spawning would be provided during normal and surplus water years.

(b) Reclamation is further committed to reducing conservation pool clearing to the minimum possible level. Currently, a total of 2,486 acres will be cleared at Cliff and Waddell Damsites primarily for human safety and navigation considerations, predicated on expected boat usage. This will reduce initial impacts to terrestrial habitats and increase habitat values in the reservoirs over the unmitigated value by providing protective cover for fish.

(c) Minimum pools will be incorporated into the sediment and inactive storage pools at Cliff and New Waddell Reservoir sites. At Cliff Reservoir site this pool would be 1,030 acres in size with an average depth of 30 feet; at New Waddell Reservoir site the pool would be 1,540 acres in area and average 26 feet deep. These pools will provide carryover habitat in times when the reservoirs would normally be dry. This is considered an enhancement over present conditions.

(d) Because there will be a change in the water storage regime at Cliff Reservoir over the yearly evacuation of Horseshoe Reservoir, it is likely that the fisheries nursery effect of Horseshoe Reservoir on Bartlett Reservoir will be reduced. The construction of a harvest basin immediately downstream of Horseshoe Dam will facilitate the salvage of sport fish for stocking in Bartlett Reservoir, thereby reducing the impact. A management agreement will be required with the Arizona Game and Fish Department for such salvage and restocking operations.

(3) Additional Opportunities

(a) Largemouth bass could be stocked at New Waddell Reservoir. This would necessitate either buying fish or producing fish by building a warm water hatchery at New Waddell Reservoir.

(b) The fish habitat in reservoirs could be improved by creating artificial reefs for fish cover or by reducing the extent of clearing. This would be especially beneficial in the minimum pool areas.

(c) At Cliff Reservoir, sport fishery benefits could be gained if the Arizona Game and Fish Commission, in conjunction with the Forest Service, were to place horsepower limitations or no wake zone requirements on all or part of the reservoir. This would also reduce the amount of conservation pool clearing required for navigation and would increase protective cover for fish.

(d) Investigations could also be conducted into the feasibility of using Cliff Reservoir as compensation for a degradation in the centrarchid fishery at New Waddell damsite.

e. Special Use Areas

(1) Commitment

The Roosevelt waterfowl management area will incur direct and indirect impacts from the use of the proposed recreation facilities, within and adjacent to its boundaries, and the anticipated eight-fold increase in recreation use of the lake, reducing the value of this area to migrating waterfowl. Reclamation is commited to reducing the effect of this disturbance by increasing the value of the management area.

(2) Means of Accomplishing the Commitment

(a) The recreation sites that are developed by Reclamation within the waterfowl area would be closed during the winter use period. This measure will reduce the direct impacts of the recreation sites within the management area.

(b) Currently the Arizona Game and Fish Department plants winter food crops for waterfowl. By providing irrigation equipment (either portable or permanent) and sufficient water to irrigate 100 acres, the attractiveness of the area will be increased for waterfowl thereby reducing the indirect impacts of the disturbance caused by the increased use of the adjacent sites and the lake for recreation. This measure will increase the Arizona Game and Fish Department's ability to provide winter food crops by approximately 50 percent.

f. Endangered Species

(1) Commitment

(a) The Fish and Wildlife Service has issued a Biological Opinion under the Endangered Species Act. This opinion states that if Plan 6 is implemented as proposed, it will jeopardize the continued existence of the bald eagle in the Southwest. The Jeopardy Opinion was issued because of the impacts of the use of recreation developments and opportunities at Cliff and Roosevelt Reservoirs and because of construction impacts at Roosevelt and Stewart Mountain Dams. The Opinion also proposes reasonable and prudent modifications and conservation efforts which Reclamation is fully committed to successfully carrying out in order to both avoid jeopardizing the bald eagle and to conserve and protect the Gila topminnow.

(2) Means of Accomplishing the Commitments

(a) In accordance with established policy, Reclamation will work with the Fish and Wildlife Service, Arizona Game and Fish Department and the Forest Service to prepare an agreement to implement management strategies and actions to avoid adverse impacts on nesting bald eagles resulting from the increased recreation activities in the Plan 6 area.

(b) Reclamation is currently participating in and providing funding for the collection of information on the foraging and nesting ecology and prey base of the Stewart Mountain, Chalk Mountain, and Pinal Creek eagle pairs through an Interagency Agreement between the Fish and Wildlife Service and Reclamation. Additionally, Reclamation will continue to support the Forest Service's efforts to maintain nest wardens and provide liaisons between construction forces. The nest watch program will continue to receive funding from Reclamation for this effort.

(c) Reclamation supports breaching Horseshoe Dam in a manner to promote stream and riparian development in the exposed Horseshoe Reservoir and to avoid excessive erosion. Reclamation will coordinate with the Fish and Wildlife Service to develop the requirements for evacuation of Horseshoe Reservoir, to be included in the data submitted for final design and construction specifications.

(d) Borrow excavation will be avoided at Meddler Point, if possible. If not, construction specifications will require the removal of materials during the eagle nonbreeding season and the stockpiling of materials outside the eagle breeding and foraging territory. In accordance with standard Reclamation procedures, borrow areas will be restored to provide habitat suitable for eagle forage fish. Human use of this area will be addressed in the management strategies that are developed under the agreement discussed in Commitment (a).

(e) Award of the construction contracts associated with Stewart Mountain Dam will be scheduled to permit initiation of construction in April or May and then continue uninterrupted except for blasting. Construction specifications will exclude initiation of construction from October through March. Blasting activities will be prohibited from December through March.

(f) Reclamation will work with the Fish and Wildlife Service to design and evaluate a positive cutoff above the inflow design flood (IDF) elevation to provide a barrier to the movement of fishes upstream on Tule Creek into the Gila topminnow habitat. The positive cutoff will be constructed unless unforeseen design problems or extreme costs are encountered.

(g) Reclamation will participate in fishery investigations as part of the Interagency Agreement discussed in Commitment (b). The detailed scope of additional fishery investigations beyond those in the Interagency Agreement will be clarified prior to making a final commitment.

g. Additional Considerations

(1) Project Monitoring

(a) To ensure the adequacy of mitigation and compensation measures proposed in this plan and to facilitate monitoring the effects of the project, pre- and post-construction studies will be conducted. Investigations may be needed on such topics as spawning in pre- and post-project reservoirs,

effects of flood attenuation on downstream riparian areas, riparian reestablishment studies for Cliff Reservoir, alteration of temperature regimes and nutrient blockage on the Verde River, effects of upstream water exchanges on proposed riparian mitigation at Cliff Reservoir, investigations into the effects of the introduction of Colorado River ichthyofauna in conjunction with current studies, and river rehabilitation studies at Cliff Reservoir. Recommendations stemming from these studies suggesting additional mitigation would be evaluated and implemented if found to be justified.

2. Cultural Resources

a. Commitment

Cultural resources are objects, buildings, sites, districts and structures that reflect cultural values. Cultural resources are nonrenewable and it is Federal and Arizona State policy to conserve them. Therefore, the goal of the CAWCS cultural resource mitigation is to implement State and Federal policy and conserve those cultural values embodied in the hundreds of cultural resources present within the CAWCS impact areas.

b. Means for Accomplishing Objectives

Cultural values within all CAWCS impact areas have been identified or estimated, and recorded prehistoric and historic sites have been classified into types as described in Chapter III. Mitigation measures identified include:

(1) implementing data recovery and research studies to recover the information embodied in some of the archaeological and historical sites to be immediately and directly affected by the project.

(2) developing a program for monitoring, managing and studying those archaeological and historical sites situated in less directly affected areas such as flood pools within the proposed Cliff and Roosevelt Dam sites and surrounding areas that may be affected by increased recreational use.

(3) development of a program for public distribution and interpretation of the study results so that the scientific and historic values can be appreciated by interested professionals and the general public.

Plans to implement these measures are described in the following sections and have been summarized on Figure IV-4A.

A programmatic memorandum of agreement (PMOA) has been negotiated in compliance with Section 106 of the National Historic Preservation Act. The Section 110(f) requirement has been addressed through preperation of a document describing the full range of alternatives considered and presents support for the conclusion that substantial alteration of the Roosevelt Dam National Landmark is justified to achieve overriding project goals. Under the terms of the PMOA a general historic preservation plan is

being developed for the entire CAP and the proposed mitigation for Plan 6 will be refined and coordinated with this plan as construction specifications are developed.

It may be feasible to avoid and therefore preserve in place some sites in certain types of impact zones. For example, proposed haul road, transmission lines and borrow areas may be modified to avoid particular sites. The potential for this type of protection in place by means of project modification is relatively minor in terms of overall predicted impacts. However, there is potential for managing the 2,000 sites or more that are situated within secondary impact zones around the proposed reservoirs or within upper reservoir flood pools where inundation would be infrequent and the associated impacts relatively minor. This mitigation would be especially applicable at Cliff and Roosevelt where adjacent land are under Federal control.

Current impact analyses indicate that at least 300 prehistoric and historic sites will be destroyed or severely altered as a result of the proposed plan. A major part of the mitigation plan would consist of recovering information from this group of sites prior to their destruction. This would be accomplished through professional studies involving archaelogical, architectural, and engineering investigations including surface mapping, mapping of buried features by remote sensing, surface artifact collection, test and full scale excavation, historical documentary research, and documentation through compilation of narrative histories, site descriptions, scaled drawings and photographs.

Study priorities would be based upon consideration of the relative significance of affected resources and the extent of impacts. The unrecovered data would represent a sacrifice of cultural resources. In addition, sites such as Roosevelt Dam embody values other than information potential. Even if the physical characteristics and significance are documented, the destruction or alteration of this site will represent a sacrifice of cultural values.

The details of a mitigation plan remain to be developed. An essential task to complete the plan is a refinement of the impact analysis on a site-by-site basis when specific construction and operation plans are developed. A second task includes development of a management/monitoring plan for sites in upper reservoir pools and adjacent areas. Successful implementation is dependent upon funding and development of a plan that is acceptable to all involved agencies.

To date, no sites affected by Plan 6 have been identified that have special cultural or religious value to Native Americans or other social groups, but Plan 6 would severely alter or destroy Roosevelt Dam, a National Historic Landmark. Although exact mitigation plans have yet to be developed, any mitigation of impacts to Roosevelt Dam would be incomplete. The general mitigation strategy would involve architectural and engineering documentation and development of a public information program regarding the historical significance of the dam and its role in water resource development in the West.

Figure IV-4A
FRAMEWORK FOR CULTURAL RESOURCE MITIGATION,
REGULATORY STORAGE DIVISION, CENTRAL ARIZONA PROJECT

MITIGATIVE ACTION	PLAN 6 ELEMENTS			
	NEW WADDELL	STEWART MOUNTAIN	ROOSEVELT	CLIFF
Data Recovery Studies				
historic	combined historic archeology study focusing on water resource development sites historic analysis of social, economic and political aspects of water resource development in Central Arizona Historic American Building Survey/Historic American Engineering Record documentation			
prehistoric	no further study anticipated	no further study anticipated	major study of one Salado platform mound complex	major study of Sinagua site complex and Hohokam villages
Monitoring/Management			interagency agreement with Tonto Forest for long-term (10 year) study of sites in less immediate and indirect impact zones	
Public Interpretation			develop visitor facilities with Forest Service, Salt River Project, or Tonto National Monument	

d. Future Direction

A Programmatic Memorandum of Agreement (PMOA) for the Central Arizona Project, Arizona and New Mexico affecting historic properties was ratified on August 5, 1983, by the Advisory Council on Historic Preservation (ACHP). This completed the consultation required under Section 106 of the National Historic Preservation Act. The PMOA is between the Arizona and New Mexico State Historic Preservation Officers (SHPO) the ACHP and Reclamation. Stipulation of the PMOA require that Reclamation prepare an overall preservation plan for CAP. In addition, project feature specific plans will be prepared in consultation with the appropriate SHPO. In accordance with these stipulations, an overall plan is in preparation and is expected to be available in draft form early in 1984. A preliminary "Cultural Resource Mitigation Plan, Regulatory Storage Division, Central Arizona Project" has been prepared for submission to the Arizona SHPO. This plan outlines proposed mitigation activities for cultural properties affected by the proposed project and is in agreement with the above overall CAP preservation plan.

3. Social Resources

a. Commitment

Impacts to people because of relocation occur in the Cliff and Roosevelt site areas with Plan 6. Reclamation is committed to reducing the severity of the impacts or to avoid the impacts.

b. Means for Accomplishing Commitments

The means for achieving the commitments includes measures that reduce the number of people who are required to relocate (and hence eliminate the impacts to these people) and measures that ameliorate impacts to the people who are required to relocate.

(1) People living around Roosevelt Lake could be required to relocate if they live within the area defined by the top of flood surcharge space (top of IDF) for New/Modified Roosevelt Dam (2,200 foot elevation). Approximately 350 people live in the area below this elevation. A means to reduce the impact could be to relocate only the people who live in the area defined by the top of the 200-year flood pool (2,171 foot elevation). The rationale for this is the very low risk of reservoir inundation in the flood surcharge space. If only the people who live in the area below the 2,171 foot elevation were relocated only 90 families would have to be moved.

(2) For the full-time residents who would be required to relocate, Forest Service land bordering Roosevelt Lake Estates will be made available for resettlement. The provision of this land would require an exchange agreement between Reclamation and the Forest Service.

(3) An accurate, reliable system for disseminating information to relocatees could be established so that they are well informed about relocation proceedings.

(4) Monetary compensation will be provided to relocatees to cover costs of relocation. The provision of the Uniform Relocation and Real Property Acquisition Act of 1970 include replacing the homes of relocatees with "safe, sanitary, and decent housing."

c. Future Direction

Negotiations over exchange land have occurred between Reclamation and the Forest Service, and these will continue. An agreement has been reached that exchange land will be made available to relocatees. A system for disseminating information to relocatees will be established. The relocations will be carried out in accordance with, and within the limitations of, the Uniform Relocation Act.

4. Mitigation of Construction-Related Impacts

The mitigation initiatives described above are aimed at reducing or eliminating long-term project impacts. Short-term environmental disruption would occur during the construction period of dams and related facilities. Impact mitigation initiatives for these short-term impacts are discussed in the following sections.

The environmental and safety concerns associated with construction activities would be stipulated in the specifications prepared for each construction contract. The specifications outline the proposed construction activity and methods to be used to insure safety and alleviate the environmental impacts associated with construction. The specifications prepared by Reclamation serve as the basis for the contractor's bid and are used by Reclamation to oversee the activities of the contractor.

Several major contracts would be awarded for construction of Plan 6. The contracts would be for various features of the plan. Each would have an individual specification outlining the measures to be used to insure public and worker safety and protect the environmental resources specific to that contract or construction activity.

Reclamation Instructions additionally outline methods and procedures to insure safety and preserve the environment during construction. The implementation of these instructions is expected to reduce construction-related impacts.

The start of construction for each of the features in Plan 6 cannot be determined at this time because of uncertainties about funding and priorities for construction. The lengths of construction have been estimated for each site and are as follows:

Facility	Construction Time (years) New Construction	Modification Only
Cliff Dam	4	-
New/Modified Roosevelt Dam	5	3.5
New/Modified Stewart Mountain Dam	4	2
New Waddell Dam	4	-
CAP Pumping Facility	1.5	-

Construction of each of the new or modified dams will require about 250 workers on site during the construction period. About 100 workers will be required to construct the CAP pumping facilities near Granite Reef Diversion Dam.

a. Construction and Public Safety

Safety conditions would be monitored by Reclamation to avoid situations which could result in accidents involving construction workers, visitors, or travelers in the area. Signs, flagmen, barricades, and other safety devices would be used to warn of potential hazards. Safety regulations would be written in accordance with applicable State and Federal laws. The enforcement of safety regulations is primarily Reclamation's responsibility, but could also involve State and other Federal agencies.

b. Blasting Control

Whenever blasting is required, the contractor would submit a blasting plan which would be evaluated prior to authorization of the initiation of blasting. Blasting will probably be required at each of the four dam sites. Areas which may require blasting include excavation of dam foundations, cutoff trench, outlet works, and spillways. In addition, the reversible canal at the New Waddell site and the CAP pumping facilities near the Granite Reef Diversion Dam may also require blasting. Final design may require that riprap be obtained by blasting in some borrow areas.

c. Dust Control and Air Pollution

Dust from construction would be controlled by maintaining proper soil moisture conditions. The contractor would establish watering programs to maintain the proper moisture level but, during periods of high winds, dust could become a noticeable problem. Speed limits to reduce dust problems would be enforced based on the road conditions. Vehicles and equipment that show excessive emission of exhaust gases would not be operated until corrective repairs or adjustments are made. The burning of combustible materials not needed in construction would be initiated only with concurrence of local pollution-control and fire-prevention authorities. (See IV.B.7.a. for air quality impacts.)

d. Noise Abatement

Reclamation has initiated a construction noise monitoring program to maintain acceptable sound levels. Noise pollution levels would not exceed 75 decibles during nighttime operations nor 80 decibles during daytime operations as measured outdoors from areas considered to be noise-sensitive, such as residential areas. (See IV.B.7.c. for noise impacts.)

e. Water Pollution Abatement and Waste Material Disposal

Specifications would require the contractor to prevent construction-related pollution of ground water and surface water. The contractor would comply with applicable Federal and state laws and regulations concerning control and abatement of water pollution. Specific measures for abatement of construction-related pollution will be outlined in the construction specifications (See IV.B.2. for water quality impacts of construction).

Potential water pollution problems associated with construction activities result from disposal of construction wastewater. Specifically, liquid sanitary waste, wash water from cement batching, and water from dewatering of foundation excavation, will be disposed in accordance with construction specifications. The disposal process for construction-related wastewater is shown in Figure IV-4.

Figure IV-4 also displays the process required for disposal of solid wastes from construction sites. Solid waste disposal would be accomplished through burning, burial, or removal to specified sites. The contractor would be required to remove all unused construction materials and other rubbish from the work area after construction. Established landfills would be used where possible and burning would only be used when the responsible regulatory agencies approved. If additional landfill sites are needed, written approval would be obtained from the Arizona Department of Health Services.

Existing sanitary landfills nearest to each dam construction site which accept various types of waste are shown in Table IV-47.

f. Erosion Control

All earthwork interrupted for an extended period would be left in such a manner as to discourage erosion caused by wind or rain. Excavated slopes would be bermed, terraced, or corrugated to prevent erosion and aid revegetation after construction. Whenever deep cut slopes are required, they would be benched or terraced and protected from cross-drainage by diking. The dikes would probably be constructed using the excavated material. Also, to prevent erosion of the cut slope, surface drains would be used at the tow of each beach or terrace. To prevent erosion on smaller slopes, the slope would be corrugated.

g. Prehistoric and Historic Cultural Resources

Any identified adverse impact will be avoided where practicable or mitigated through data recovery or management/monitoring. If evidence of previously unrecorded cultural resources is discovered during construction, operations in the vicinity of the discovery would cease. Mitigation studies would be conducted as appropriate prior to resuming construction.

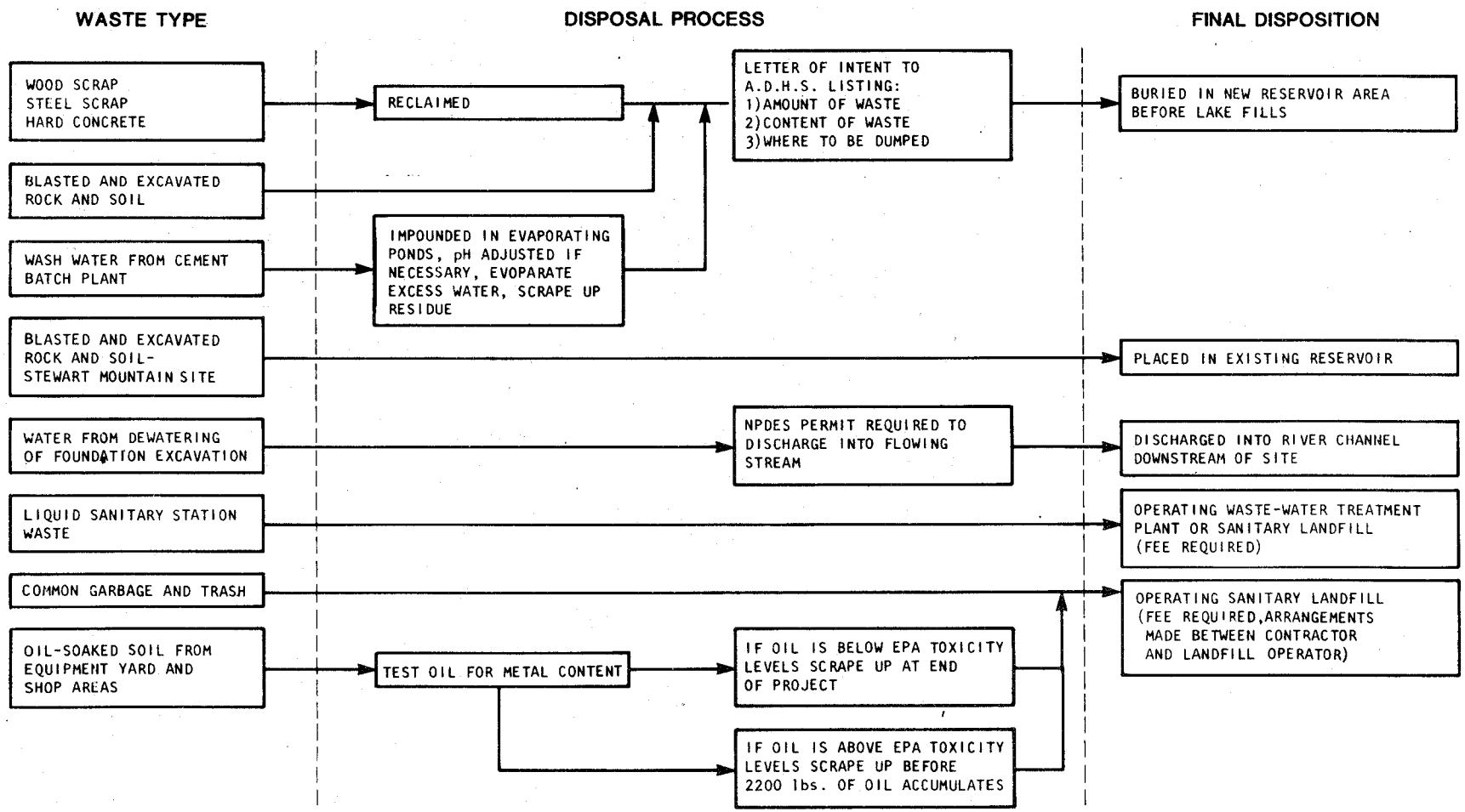


FIGURE IV-4

CONSTRUCTION WASTE DISPOSAL

Table IV-47

SANITARY LANDFILLS IN VICINITY
OF PLAN 6 CONSTRUCTION SITES

Site	Sanitary Waste	Garbage and Trash	Oil-Soaked Soil
Cliff	Cave Creek Landfill (Operated by Maricopa County)	Cave Creek Landfill	27th Ave. Landfill (Operated by City of Phoenix)
New Waddell	Cave Creek Landfill	New River Landfill (Operated by Maricopa County)	27th Ave. Landfill
Roosevelt	City of Globe Sewage Lagoons (Operated by City of Globe)	Roosevelt Lake Landfill (Operated by Gila County)	Roosevelt Lake Landfill
Stewart Mountain	27th Ave. Landfill	Tri-City Landfill (Operated by Salt River Pima-Maricopa Indian Community)	Tri-City Landfill

h. Vegetation

Removal or transplanting of protected native plants, when required, would be coordinated with the Arizona Commission of Agriculture and Horticulture in accordance with the Arizona Native Plant Law (ARS, Chapter 7, Article 1).

All construction sites located outside of the MSP pool where vegetation has been cleared or severely changed would be reclaimed. Disturbed areas susceptible to vegetative growth will be revegetated by seeding with native species or by other viable techniques. Haul roads will be scarified prior to seeding and barricaded to deter off-road vehicle use. Seeding and planting programs would be supervised by appointed Reclamation biologists.

The vegetation would be cleared from the MSP (conservation) pool. The cover would not be restored following construction within the zone. The conservation and land management agencies that manage the resources affected by construction would be advised of the construction schedule for plan implementation and of its effect on the committed resources. Reclamation is coordinating its planning with such agencies.

i. Wildlife

The construction contractor would be prohibited from collecting or unnecessarily disturbing threatened or endangered wildlife in the site area. Personnel would be advised of Arizona Game and Fish Department regulations pertaining to protected wildlife species. Construction activities would, as much as possible, accommodate the welfare of state-protected wildlife and wildlife habitat as determined by the Arizona Game and Fish Department.

D. Cumulative Impacts of the Proposed Action and Other Reclamation Projects

The Regulatory Storage Division of the CAP is one of nine major projects in the Lower Colorado River Basin (LCRB) under construction or in advance planning by the Bureau of Reclamation. These projects are:

CAP Aqueduct and Pumps
CAP Transmission Lines
CAP Regulatory Storage Division (Plan 6)
Buttes Dam (or suitable alternative)
Hooker Dam (or suitable alternative)
Colorado River Front Work and Levee System
Colorado River Basin Salinity Control Project (Title I)
Colorado River Water Quality Improvement Program (Title II)
Hoover Dam Modifications

The location of these projects within the LCRB is shown on Figure IV-5

Cumulative impacts of these Reclamation projects are assessed in this section of the EIS. The impact assessment has been scoped to focus on four major issues: socioeconomics (including impacts to crop production, power development, recreation, and employment opportunities), biological resources (including aquatic and terrestrial biotic communities), water development and availability, and water quality (salinity). Existing data from environmental impact statements and planning reports for the projects were used to perform the assessment. A major source of baseline data was the Lower Colorado Region Comprehensive Framework Study prepared by the Lower Colorado Region State-Federal Interagency Group for the Pacific Southwest Interagency Committee (1972).

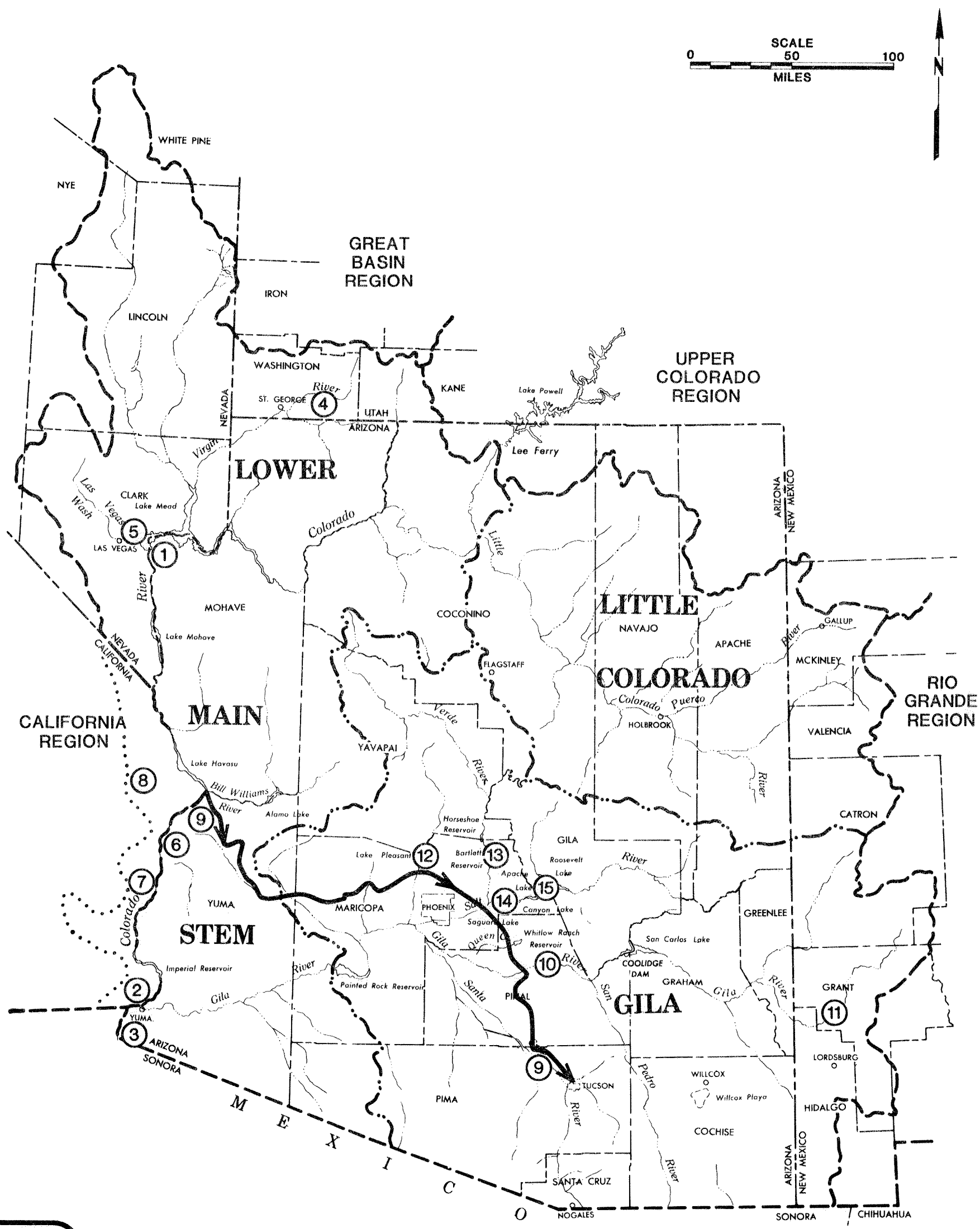
Impacts were assessed using the following major assumptions:

1) existing, accessible baseline data would be used

2) Reclamation projects in the LCRB under construction or in advance planning would constitute the action being assessed

3) projects would be operational by the year 2000

4) biological impacts would be assessed as the difference between future-without the future-with conditions in the year 2000



HOOVER DAM MODIFICATIONS ..... (1)

COLORADO RIVER BASIN SALINITY CONTROL PROJECT (TITLE I)

- YUMA PROJECT ..... (2)
- MOJAVE – COACHELLA PROJECT ..... (3)

COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM (TITLE II)

- LAVERKIN SPRINGS UNIT ..... (4)
- LAS VEGAS WASH UNIT ..... (5)
- COLORADO RIVER INDIAN RESERVATION UNIT (6)
- PALO VERDE IRRIGATION DISTRICT UNIT ..... (7)

COLORADO RIVER FRONT AND LEVEE SYSTEM (EXTENDS DOWNSTREAM FROM LAKE MOHAVE) .. (8)

CENTRAL ARIZONA PROJECT

- AQUEDUCTS, PUMPS AND TRANSMISSION LINES (9)
- BUTTES DAM ..... (10)
- HOOKER DAM ..... (11)
- PLAN 6
  - WADDELL DAM ..... (12)
  - CLIFF DAM ..... (13)
  - STEWART MOUNTAIN DAM ..... (14)
  - ROOSEVELT DAM ..... (15)

FIGURE IV-5

RECLAMATION PROJECTS UNDER CONSTRUCTION OR PROPOSED FOR THE LOWER COLORADO RIVER BASIN

5) socioeconomic and water resources impacts would be assessed using a zero baseline

1. Socioeconomic Resources

Table IV-48 presents a summary of anticipated socioeconomic impacts of water resource development projects, either planned or under construction, in the LCRB. Two categories of projects are assessed: reservoir/aqueduct projects and water quality improvement projects. Because the character of these projects is not comparable, impacts associated with each category or type are discussed separately.

a. Reservoir/Aqueduct Projects

As shown in Table IV-48, as a result of the construction of components to the CAP and Hoover Dam Modifications, approximately 1,020 temporary construction jobs and 9 permanent jobs would be created. Additionally, recreation facility demand of the new water bodies has been estimated at approximately 44,600 annual recreation days for stream-oriented use and approximately 1.8 million annual recreation days for reservoir-oriented use.

b. Water Quality Improvement Projects

As a direct result of the water quality improvement projects in the LCRB, there will be an increase of approximately 57,000 acres of productive cropland. Approximately 100 construction jobs and 47 permanent jobs would be created by these projects. Due to the purpose and nature of the projects, there will be no impacts for power development or recreation.

c. Combined Impacts

An estimate of total reported socioeconomic impacts in the year 2000 for water development projects in the LCRB is as follows:

CROP PRODUCTION: 57,000 acres net gain

EMPLOYMENT

Construction: 1,120 construction jobs
Operation: 56 O&M jobs

POWER DEVELOPMENT: 370 to 1520 megawatt potential at Hoover Dam

RECREATION DEMAND

Stream-Oriented: 44,600 annual recreation days
Reservoir-Oriented: 1,807,600 annual recreation days

TABLE IV-48

SUMMARY OF ESTIMATED SOCIOECONOMIC IMPACTS OF
WATER RESOURCE DEVELOPMENT PROJECTS, PLANNED OR UNDER CONSTRUCTION,
LOWER COLORADO RIVER BASIN, YEAR 2000

PROJECT TYPE/TITLE	EMPLOYMENT[b] (Number of Jobs) (Construction or O&M)	CROP PRODUCTION (1,000 acres)	POWER DEVELOPMENT (GWh/yr)[e]	RECREATION[f] (1,000 recreation days) (stream or reservoir)
o RESERVOIR/AQUEDUCT PROJECTS				
Central Arizona Project (FEIS 1972)[a]				
Regulatory Storage Division (DEIS 1983)	IU[c]	NA[d]	-224.6	12.6 (str) 986.9 (res)
Pumps and Transmission Lines	IU	NA	-2,073.0	NA
Buttes Dam	3 (O&M)	NA	IU	NA
Hooker Dam	3 (O&M)	NA	IU	32.0 (str) 820.7 (res)
Granite Reef Aqueduct	-	-	NA	-
Salt-Gila Aqueduct	600 (const)	NA	NA	NA
Tucson Aqueduct	IU	NA	NA	NA
Hoover Dam Modifications (DEIS 1980)	420 (const) 3 (O&M)	NA	+1,493.0	NA
RESERVOIR/AQUEDUCT SUBTOTAL	1,020 (const) 9 (O&M)	NA	-804.6	44.6 (str) 1,807.6 (res)
o WATER QUALITY IMPROVEMENT PROJECTS				
Colorado River Basin Salinity Project (Title I)			-424.0	
Mojave- Coachella (DEIS 1974)	IU	37.3 (loss)		NA[f]
Yuma Project (DEIS 1976)	3 (O&M)	0.4 (gain)		NA
Colorado River Water Quality Improvement Project (Title II)				
Colorado River Indian Reservation Unit (FEIS 1976)	IU	93.0 (gain)	IU	NA
Las Vegas Wash (FEIS 1976)	IU	0.8 (loss)	-62.8	NA
La Verkin Springs Unit Utah (Feasibility Report 1973)	24 (O&M)	NA	-30.3	NA
Palo Verde Irrigation District Unit (FEIS 1976)	IU	IU	IU	NA
WATER QUALITY IMPROVEMENT SUBTOTAL	100 (const) 47 (O&M)	56.5 (net gain)	-522.5	NA
TOTAL	1,120 (const) 56 (O&M)	471.0-427.7 (net gain)	-1,327.1	44.6 (str) 1,807.6 (res)

[a]Date in parentheses indicates year that environmental impact statement was published.

[b]Estimate of number of new jobs created through construction or operations and maintenance as a direct result of proposed project.

[c]Information unavailable.

[d]NA denotes not applicable.

[e]Estimated annual power generated (+) or consumed (-) in gigawatt hours.

[f]Recreation demand estimated for year 2000 in annual recreation days with separate projections for stream-oriented as opposed to reservoir-oriented.

2. Biological Resources

The biological resource baseline of the LCRB includes biotic communities ranging from desertscrub to alpine tundra. The natural biotic communities as described in data (Lower Colorado Region Framework Study) include not only the natural communities shown in Figure IV-6 but aquatic riparian communities and agricultural and developed urban lands. Table IV-49 gives the approximate range of these communities.

As can be seen in Figure IV-6 and the data presented in Table IV-49, desertscrub and woodlands, scrub, and grasslands formations constitute the major portion of the cover types occurring in the Lower Colorado Region. Riparian and aquatic communities, as shown in Figure IV-7, are identified with the drainage pattern, of which some 1,700 miles are represented on the main drainage as perennial stream. The drainage pattern with minor perennial streams includes some 2,500 miles of drainage. The major source of the Lower Colorado River drainage is the Mogollon Rim and White Mountain area, represented as the cross-hatched area in Figure IV-7. Lakes and reservoirs represent approximately 531 square miles of water surface.

The estimated change between the 1972 baseline and the future-without Reclamation projects is shown in Table IV-46. Clearly the major percentage change anticipated is in the agricultural and developed lands and riparian communities. Some 48 percent growth in urban and developed lands is anticipated over the 1972 baseline at year 2000. Agricultural lands will be converted to urban lands, and approximately 2.5 percent of the riparian communities will be lost by the year 2000.

The future-with Reclamation projects at year 2000 shows that, again, most of the important change will occur with urban land and riparian communities. In addition, perennial stream and lakes/reservoirs will undergo change between the future-without and future-with. A composite loss of about 7 percent of the riparian communities is expected by the year 2000, of which approximately 5 percent results from Reclamation projects. This represents a rather important change in this limited resource. Riparian communities are known to harbor a great deal of wildlife in the Southwestern deserts and the loss, therefore, is significant from the standpoint of resource quality, wildlife diversity, and unique resource.

The CAP will involve conveyance of water to central Arizona. This will serve as a new water source for interior Arizona. Some 14 square miles of additional water surface are expected to be developed by the year 2000 because of Reclamation projects, most of them associated with CAP. This gain in lake and reservoir surface area will not necessarily enhance the quality of fisheries, although several new bodies of water will be added to the watershed. These include the Cliff Reservoir on the Verde River and an enlarged Waddell Reservoir at Lake Pleasant, as well as reservoirs associated with Hooker and Buttes Dams on the Gila River. Some 21 miles of existing perennial streams will be lost by the enlargement of reservoirs and development of new impoundments. The loss of the perennial stream will affect riverine fisheries and riverine aquatic communities associated with these specific locales.

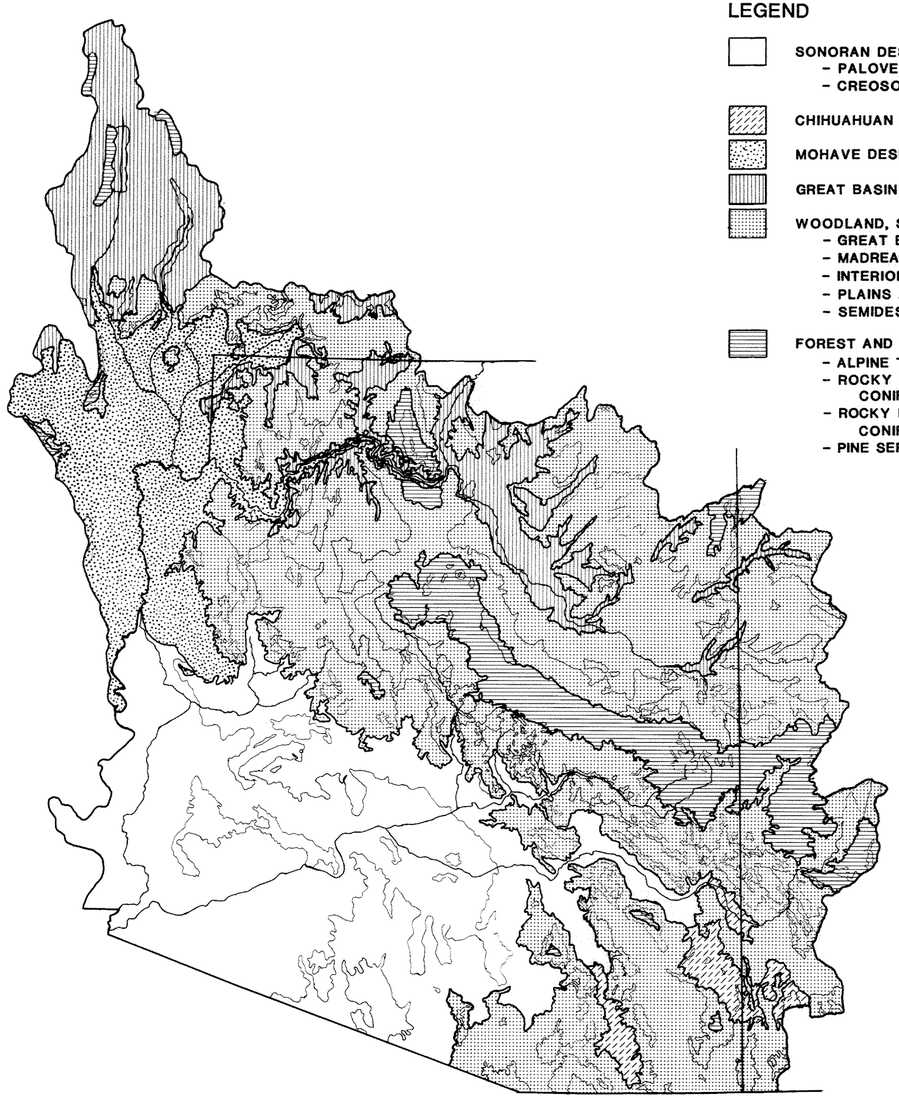
TABLE IV-49

BIOTIC COMMUNITIES OF THE LOWER COLORADO RIVER BASIN[a]

	Existing[b] Condition	Future Without	Future-without change (%)	Future-With	Impact	Impact Change (%)
Sonoran Desertscrub	35,671	35,540	-0.4	35,491	-49	-0.1
Chihuahuan Desertscrub	2,009	2,009	0	2,008	-1	T
Mohave Desertscrub	12,534	12,534	0	12,532	-2	T
Great Basin Desertscrub	13,355	13,355	0	13,255	0	0
Woodlands, Scrub, and Grassland Formations	62,923	62,923	0	62,922	-1	T
Forest and Tundra Formation	10,191	10,191	0	10,191	0	0
Agricultural Lands	2,838	2,581	-9.1	2,580	-1	T
Urban and Developed Lands	801	1,193	+48.9	1,241	+48	+4.0
Riparian Communities	166	162	-2.4	154	-8	-4.9
Perennial stream and Riverine Communities	(1,700 miles in major drainage)	(1,700)	0	(1,679)	(-21)	-1.2
Lakes and Reservoirs (Lacustrine Communities)	531	531	0	545	+14	+2.6
Miscellaneous (Non-vegetated Landscape)	119	119	0	119	0	0
TOTAL	141,138	141,138		141,138		

[a]Communities given in square miles, except perennial stream (miles).

[b]Lower Colorado Region Framework Study, State-Federal Interagency Group, 1972. Lower Colorado Region Framework Study: Fish and Wildlife, Appendix XIII.



LEGEND

SONORAN DESERTSCRUB
- PALOVERDE - MIXED CACTI SERIES
- CREOSOTEBUSH - BURSAGE SERIES

CHIHUAHUAN DESERTSCRUB

MOHAVE DESERTSCRUB

GREAT BASIN DESERTSCRUB

WOODLAND, SCRUB, AND GRASSLAND FORMATIONS
- GREAT BASIN CONIFER WOODLAND
- MADREAN EVERGREEN WOODLAND
- INTERIOR CHAPARRAL
- PLAINS AND GREAT BASIN GRASSLAND
- SEMIDESERT GRASSLAND

FOREST AND TUNDRA FORMATION
- ALPINE TUNDRA
- ROCKY MOUNTAIN SUBALPINE CONIFER FOREST
- ROCKY MOUNTAIN MONTANE CONIFER FOREST
- PINE SERIES

VICINITY MAP

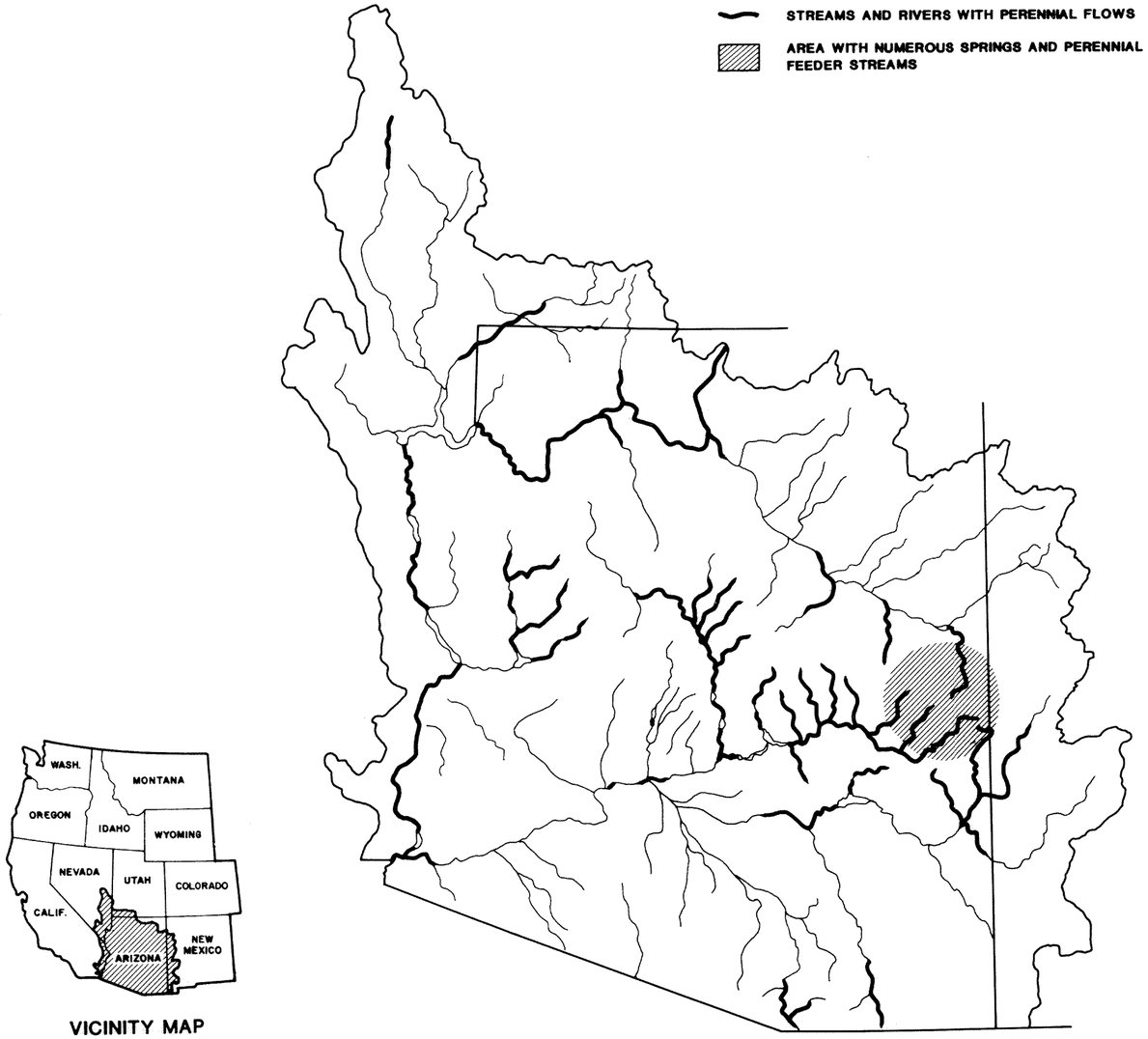
N

SCALE
0 100
MILES

FIGURE IV-6

BIOTIC COMMUNITIES OF THE LOWER COLORADO RIVER BASIN

ADOPTED FROM BROWN AND LOWE, 1977.



VICINITY MAP

PARTIALLY ADOPTED FROM BROWN et al, 1978

FIGURE IV-7

RIPARIAN BIOTIC COMMUNITIES ASSOCIATED WITH PERENNIAL STREAMS OF THE LOWER COLORADO RIVER BASIN

Several Federal endangered species occur within the Lower Colorado region and will be affected by the various projects mentioned above. The bald eagle, peregrine falcon, Yuma clapper rail, Gila topminnow, Colorado River squawfish, woundfin, humpback chub, and bonytailed chub utilize riparian and aquatic habitats in the drainage. These species will not, for the most part, be affected by these projects except in localized areas. The effects of the Regulatory Storage Division of CAP (Plan 6) have already been discussed in this EIS (Chapter IV. B.1.). The other projects will have little effect on these endangered species except for the loss of some Yuma clapper rail habitat in the extreme southern reach of the Colorado River at the International Boundary.

3. Water Development and Availability

a. Water Sources and Allocations

Water in the LCRB comes mainly from three sources: direct precipitation, the Colorado River, and the ground water system. Some of this water is used more than once through irrigation tailwater collection systems and wastewater treatment plants.

Precipitation over the LCRB varies with time of year, elevation, and location. Much of the precipitation falls on areas away from potential users. The portion of this water which does not evaporate either infiltrates into the soil or becomes overland flow towards the Colorado River. Significant efforts have been made in parts of the LCRB to control these flows and store the water for beneficial use at the locations and times when users need the water, through construction of reservoir impoundments and other measures.

The Colorado River enters the LCRB from the Upper Colorado River Basin at Lees Ferry in north central Arizona. This dividing point was established as part of the Colorado River Compact of 1921. The Compact further apportions to both the upper and lower basins 7,500,000 af of water per year from the Colorado River system. Article III(b) apportions an additional 1,000,000 af annually for beneficial use to the Lower Basin. In the summer of 1952, the State of Arizona initiated an interstate suit in the Supreme Court of the United States against California and others to confirm its title to Colorado River water. On June 3, 1963 the Supreme Court rendered an opinion on Arizona's entitlement to Colorado River water. Subsequently, on March 9, 1964, the Supreme Court decree in Arizona vs. California confirmed Arizona's entitlement to 2,800,000 af annually of the first 7,500,000 acre-feet of Colorado River main stem flow available to the Lower Basin states, plus 46 percent of flows in excess of 7,500,000 af (Central Arizona Project Final EIS, USBR, 1972).

Allocations of Colorado River water are shown below:

Allottee	Allocation (af/yr)
California	4,400,000
Arizona	2,800,000
Nevada	300,000
New Mexico	18,000
Total Individual Allocations	7,518,000
LCRB Entitlement	7,500,000

In addition there is 1,500,000 af of Colorado River supply required for Mexico. As can be seen from this information, more water is allocated than is normally available. An order of precedence has been established to guarantee minimum deliveries to senior water users. Users with lower precedence may not receive their total allocations in years when the runoff is less than the total shown above and main stem storage reservoirs are low.

Ground water is used extensively in the LCRB. This is especially true in arid regions where ground water levels have been falling significantly in recent years as pumping exceeds recharge.

b. Water Control Facilities

Existing facilities for water control in the LCRB consist of water conservation and distribution facilities. Along the main stem of the Lower Colorado River, there are three water reclamation dams and three diversion dams. The Gila River basin includes numerous facilities to store and divert water as well as several flood control features. Major water control features in the LCRB are listed below:

Location	Name	Purpose
Colorado River Main Stem		
	Hoover Dam	Water Development
	Davis Dam	Water Development
	Parker Dam	Water Development
	Imperial Dam	Diversion
	Laguna Dam	Diversion
	Morelos Dam	Diversion
Gila River Basin		
Gila River	Coolidge Dam	Water Development
	Ashurst-Hayden Dam	Diversion
	Gillespie Dam	Diversion
	Painted Rock Dam	Flood Control

Salt River	Theodore Roosevelt Dam	Water Development
	Horse Mesa Dam	Water Development
	Mormon Flat Dam	Water Development
	Stewart Mountain Dam	Water Development
	Granite Reef Dam	Diversion
Verde River	Horseshoe Dam	Water Development
	Bartlett Dam	Water Development
Aqua Fria River	Waddell Dam	Water Development

These water development features serve to capture surface water for use in the service areas of the respective water user groups. Much of the potential runoff is controlled and used beneficially for agricultural, municipal, and industrial purposes in the LCRB. Infrequent runoff events exceed the storage capacity of the existing reservoirs and flooding occurs with a loss of potentially useful water.

The facilities now exist to completely divert or store all of the surface water in the LCRB. Consequently, only on rare occasions does the Colorado River flow into the Gulf of California.

c. Cumulative Impacts to Water Availability

Reclamation has various water-related projects proposed or under construction in the LCRB. Table IV-50 shows the changes in water supply which will result from operation of the projects.

The table shows a loss of 206,000 af/yr from the Colorado River main stem as a result of reservoir/aqueduct projects. All of this water would not necessarily reach the main stem under existing conditions, as much of the water would enter the ground water system before reaching the Colorado River.

The cumulative impact of the the Reclamation projects is that water will be taken from the Colorado River main stem. This water will come from allocations already made to the new users (those who will divert the water). It is not anticipated that normal flows in the Colorado River would be affected by the projects. Most of the water developed by the proposed projects is flood water which will be prevented from entering the main stem of the Colorado River. Floodwaters are known to recharge ground water systems along the rivers, and the full extent of reduced flood flows has not yet been determined. The impacts caused by the projects listed above of reduced flood flows along the main stem are considered insignificant.

4. Water Quality

a. Existing Conditions

Water quality, primarily salinity varies greatly over the LCRB. Most surface water is of good quality and with standard water treatment

TABLE IV-50

LCRB WATER AVAILABILITY IMPACTS

PROJECT TYPE/TITLE	Annual Volume of Main Stem Colorado River Water Affected (af)	Comments
o RESERVOIR/AQUEDUCT PROJECT		
Central Arizona Project (FEIS 1972)[a]	(1,034,000)	Arizona allocation of Colorado River water now delivered to California (no gain or loss)
Regulatory Storage Division (DEIS 1983)	-138,000	Increased yield through operation includes local flood water and excess flow on Colorado main stem
Pumps and Transmission Lines	NA	
Buttes Dam	-50,000	Flood water captured for irrigation use
Hooker Dam	-18,000	New Mexico LCRB allocation of Colorado River water through exchange
Granite Reef Aqueduct	NA	
Salt-Gila Aqueduct	NA	
Tucson Aqueduct	NA	
Hoover Dam Modifications (DEIS 1980)	NA	
RESERVOIR/AQUEDUCT SUBTOTAL	-206,000	
o WATER QUALITY IMPROVEMENT PROJECTS		
Colorado River Basin Salinity Project (Title I)		
Mojave - Coachella (DEIS 1974)	+132,000	Canal lining and other improvements reduce irrigation losses
Yuma Project (DEIS 1976)	+16,200	Canal lining and other improvements reduce irrigation losses
Colorado River Water Quality Improvement Project (Title II)	IU[b]	
Colorado River Indian Reservation Unit (FEIS 1976)		
Las Vega Wash (FEIS 1976)	-3,600	Water lost from Las Vegas Wash during salt reduction operation
La Verkin Springs Unit Utah (Concluding Report 1981)	-2,470	Water lost from La Verkin Springs Unit during salt reduction operation
Palo Verde Irrigation District Unit (FEIS 1976)	IU	
WATER QUALITY IMPROVEMENT SUBTOTAL	+143,130	
TOTAL	- 63,870	

[a] Date in parentheses indicates publication date of environmental impact statement.

[b] Information unavailable.

methods meets drinking water requirements. In general, ground water is of poorer quality than the surface water but can also be treated to meet drinking water standards. There are, however, locations where the surface water and/or ground water qualities are significantly lower than the rest of the basin.

The Colorado River Basin is a large basin with substantial agricultural and increasing urban development. The quality of return flows to the Colorado River has been declining and the diversions from the main stem have depleted the flow substantially. As a result, the quality of the water in the Colorado River as well as some other tributaries has been declining. Salts from natural sources such as saline springs, as well as manmade sources, i.e., return flows of irrigated farmlands are the primary contributors to this decline.

Although a number of water quality-related legislative actions have been taken on the State and Federal levels, four Federal acts are of special significance to the Colorado River Basin: (1) The Water Quality Act of 1965 and related amendments, (2) the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500), (3) the Colorado River Basin Salinity Control Act of 1974, and (4) the Clean Water Act of 1977. Also central to water quality issues are agreements with Mexico on Colorado River system waters entering that country.

The first of these, the Water Quality Act of 1965 (Public Law 89-234), amended the Federal Water Pollution Control Act and established a Federal Water Pollution Control Administration (now EPA). Among other provisions, it required states to adopt water quality criteria for interstate waters inside their boundaries. The seven basin states initially developed water quality standards which did not include numeric salinity criteria for the Colorado River primarily because of technical constraints. In 1972, the states agreed to a policy which called for the maintenance of salinity concentrations in the Lower Colorado River system at or below existing levels while the Upper Basin states continued to develop their compact apportioned waters. The states suggested that the Bureau of Reclamation should have primary responsibility for investigating, planning, and implementing the proposed Colorado River Basin Salinity Control Program with the assistance of the Federal Office of Saline Water and EPA.

Enactment of the Federal Water Pollution Control Act Amendments of 1972 affected salinity control in that the legislation was interpreted by EPA to require numerical standards for salinity in the Colorado River. In response, the basin states founded the Colorado River Basin Salinity Control Forum to develop numeric salinity criteria and a basinwide plan of implementation for salinity control. The Basin States held public meetings on the proposed standards as required by the enacting legislation. The forum recommended that the individual Basin States adopt the Proposed Water Quality Standards for Salinity Including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System. The proposed water quality standard called for maintenance of flow-weighted average TDS concentrations of 723 mg/L below Hoover Dam, 747 mg/L below Parker Dam, and 879 mg/L below Imperial. Included in the plan of implementation were four salinity control units and possibly additional units, the application of

effluent limitations, and use of saline water whenever practicable and for future studies. The standards are to be reviewed at 3-year intervals. All of the Basin States adopted the 1975 Forum-recommended standards.

The Colorado River Basin Salinity Control Act of 1974 (Public Law 93-320) provided the means to comply with United States obligations to Mexico which included as a major feature a desalting plant and brine discharge canal. These facilities will enable the United States to deliver to Mexico water having an average salinity no greater than 115 ppm±30 ppm (Mexican count) over the annual average salinity of Colorado River waters at Imperial Dam. Units authorized for construction under Title II of that Act, are Paradox Valley Unit and Grand Valley Unit, Colorado; Crystal Geyser Unit, Utah; and Las Veags Wash Unit, Nevada.

Planning Units are:

Irrigation sources -
- Colorado River Indian Reservation Unit, Arizona
- Lower Gunnison Basin Unit, Colorado
- Unita Basin Unit, Utah
- McElmo Creek Unit, Colorado
- Palo Verde Irrigation District Unit, California

Point sources -
- LaVerkin Springs Unit, Utah
- Lower Virgin River Unit, Nevada-Arizona
- Glenwood-Dotsero Springs Unit, Colorado
- Meeker Dome Unit, Colorado

Diffuse sources -
- Big Sandy River Unit, Wyoming
- Price-San Rafael Rivers Unit, Utah
- Dirty Devil River Unit, Utah

Of the 12 units listed above, 10 (excluding Colorado River Indian Reservation Unit and Palo Verde Irrigation District) were approved for feasibility study by Public Law 96-375 in October 1980. Other studies include Blue Springs Unit, Saline Water Use and Disposal Opportunities Unit, and the Aquatrain Project.

In 1978, the Forum reviewed the salinity standards which were adopted by all of the seven basin states, and recommended the construction of 3 of the 4 salinity control units and 10 of the 12 projects identified in the 1974 Act, the placing of effluent limitations on industrial and municipal discharges, and the reduction of the salt loading effects of irrigation return flows, The plan also called for the inclusion of Water Quality Management Plans to comply with Section 208 provisions after the plans' adoption by the states and approval of EPA. It also contemplated the use of saline water for industrial purposes and future salinity use/control methods.

b. Cumulative Impacts to Water Quality

Because of the manner in which the impacts of individual projects are analyzed, it is not practical to sum up the total impact of all LCRB projects. Table IV-51 and Table IV-51A show the effect of selected Water Quality Improvement Projects being constructed or proposed in the basin. Generally, however, the proposed water quality improvement projects will reduce the Colorado River main stem TDS. This will help to meet the requirements of Minute No. 242 as well as to help stabilize the salinity of the lower Colorado River below the project locations. This water quality improvement is considered to be significantly beneficial in that the many users along the lower Colorado River will have water of better and more dependable quality.

E. Energy Requirements and Conservation for the Proposed Action (Plan 6)

Energy required for the operation of Plan 6 will come from the Navajo Generating Station, a feature of the Central Arizona Project. Energy will be required to pump water through the CAP aqueduct from the Colorado River and from the aqueduct into the regulatory storage reservoir at New Waddell. Hydroelectric energy will also be produced by the operation of Plan 6, by generating facilities which will use water as it is released from the reservoirs. The average additional net energy consumption of Plan 6 is 145 gigawatt hours (GWH = one billion watts) per year over the life of the project.

There is no net energy conservation associated with Plan 6; however, the energy management capability provided by regulatory storage for the CAP would allow coal-fired electricity to be substituted for electricity produced by higher priced oil and natural gas. This would be achieved by using Navajo Generating Station power (coal-fired) to pump water into storage during off-peak periods, such as winter months or at night. The peak period power which is not used by the CAP would be sold to other users, who would replace oil and gas-fired electricity with Navajo power. The energy which could be shifted from peak periods to off-peak periods in Plan 6 is 1084 GWH per year; this includes power produced by the hydroelectric powerplant included in the plan.

This shift of pumping energy from peak periods to off peak periods requires more energy than is available from Navajo Generating Station during the winter months if Arizon's full allotment of Colorado River water is pumped when it is available. Currently a task force of local interest groups is investigating ways to provide adequate energy for the pumping of Arizona's entitlement of Colorado River water. For the purpose of the analysis, because winter energy is normally available from several sources, it was assumed that adequate energy would be available to economically pump Arizona's Colorado River entitlement.

TABLE IV-51

ANNUAL IMPACTS TO WATER QUALITY

PROJECT TYPE/Title	Annual Impacts to Water Quality
o RESERVOIR/AQUEDUCT PROJECTS	
Central Arizona Project (FEIS 1972)[a]	Same Main Stem withdrawal from different location but reduction in basin depletion.
Regulatory Storage Division (DEIS 1983)	Additional withdrawal of 138,000 af main stem and local surface water
Pumps and Transmission Lines	NA
Buttes Dam	-50,000 af withdrawn from Gila River at dam site
Hooker Dam	-18,000 af withdrawn from Gila River at dam site
Granite Reef Aqueduct	NA
Salt-Gila Aqueduct	NA
Tucson Aqueduct	NA
Hoover Dam Modifications (DEIS 1980)	NA
o WATER QUALITY IMPROVEMENT PROJECTS	
Colorado River Basin Salinity Project (Title I)	lowers TDS at Morelos Dam from 1,355 to 910 mg/l
Mojave - Coachella (DEIS 1974)	
Yuma Project (DEIS 1976)	
Colorado River Water Quality Improvement Project (Title II)	
Colorado River Indian Reservation Unit (FEIS 1976)	IU[b]
Las Vega Wash (FEIS 1976)	Reduce TDS at Imperial Dam by 8 mg/l
La Verkin Springs Unit Utah (Feasibility Report 1973)	Removal of 103,000 tons of salts from Virgin River salt load
Palo Verde Irrigation District Unit (FEIS 1976)	IU

[a]Date in parentheses indicates publication date of environmental impact statement.

[b]Information unavailable

Table IV-51A

WATER QUALITY IMPROVEMENT PROJECTS

COLORADO RIVER BASIN

Unit	Primary Feature	Salinity Reduction at Imperial Dam (mg/L) 1/	Tons of Salt Removed
* Paradox Valley	Deep well injection	18	180,000
* Grand Valley (Stage I)	Canal/lateral lining	2.5	24,000
(overall)		27	280,000
* Las Vegas Wash	Bypass channels	6.2	71,000
LaVerkin Springs	Desalting/ponds	2/ 8.4	103,000
Lower Gunnison Basin	Canal/lateral lining Recommended plan	14	141,000
Uinta Basin	Selective canal/lateral lining	2.4	24,000
McElmo Creek Basin	Combining canals/selective lining	2.4	24,000
Palo Verde Irrigation District (10 percent of area)	Lateral lining + onfarm + IMS (joint project with SCS)	8	4/ 67,400
Glenwood-Dotsero Springs	Collection/evaporation ponds (preferred plan)	31	314,000
Big Sandy River	Industrial use	8	75,000
Saline water use and disposal opportunities 3/	Local use for energy development	84	878,000
	Long distance export disposal	77-194	768,000-1,975,000
	Coal slurry pipeline	15-50	351,000-531,000

1/ All concentration reductions were calculated using CRSS projected 2010 flow and salt load conditions. The concentrating effect of water depletion was not considered in this calculation.
2/ Annual equivalent value of salinity reduction. The ultimate value after a 22-year buildup period would be 11 mg/L.
3/ Early appraisal or inventory estimates.
4/ Tons of salt removed would decrease to 50,200 by 2010 and an associated mg/L of 6.

* Under construction

F. Relationship Between Short-Term Uses of the Environment and Long-Term Enhancement for the Proposed Action (Plan 6)

The long-term effects of Plan 6 would be more efficient management of the CAP system, an increase in the amount of Colorado River water imported to central Arizona and concomitant reduction in ground water use, and a level of flood control for metropolitan Phoenix which would substantially reduce or eliminate major property damage and transportation disruptions.

Short-term disturbances to the environment would occur during construction of the dams in Plan 6 (Chapter IV.C). Long-term impacts would also result from implementation of the plan (see Chapter IV.A.) Land required for the structures, reservoirs, and rights-of-way would not be available for other uses during the life of the project. Other long-term impacts would include the loss or alteration of environmental resources required for construction or operation of the project, and impacts to people relocated as a result of the project.

Table IV-52 summarizes the short- and long-term impacts associated with Plan 6. Short-term impacts are assumed to occur immediately or during construction of the project, and long-term impacts would result over the life of the project (100 years) or permanently. Impacts described in Table IV-52 represent unmitigated impacts. A description of proposed mitigation initiatives for Plan 6 is given in Chapter IV.C.

G. Irreversible and Irretrievable Commitment of Resources

The construction and operation of Plan 6 would irreversibly and irretrievably commit physical and environmental resources to the project. An irreversible commitment of these resources is considered the permanent loss of the resource. Loss of resources is described for the typical-year and represents unmitigated impacts unless otherwise noted.

1. Biological Resources

Biological resources lost as a result of Plan 6 include 110 acres of riparian/wetland habitat, 11,060 acres of terrestrial habitat, and 1,039 animal unit months (AUMs) for special use and management areas. These resources would be inundated by reservoirs included in the plan.

2. Cultural Resources

In Plan 6, at least 158 prehistoric sites would be destroyed by construction activities, including artifact scatters, domestic and agricultural sites, petroglyphs, trash mounds, and water-soil control features.

Construction and operation of Plan 6 would destroy at least 39 historic sites. The most significant site to be affected is Theodore Roosevelt Dam, which is a National Historic Landmark. The dam would be destroyed by construction of New Roosevelt Dam or altered by modification.

Table IV-52

RELATIONSHIPS AND TRADEOFFS BETWEEN SHORT-TERM USES OF THE ENVIRONMENT AND LONG-TERM ENHANCEMENT FOR THE PROPOSED ACTION

Resource	Short-Term	Long-Term	Tradeoffs
Riparian & Wetland Communities	Loss of high-quality cottonwood-willow, mesquite, and cattail habitat, loss of habitat for important Arizona wildlife.	Loss of high-quality cottonwood-willow, mesquite, and cattail habitat, loss of habitat for important Arizona wildlife.	Loss of habitat traded for increased water storage and flood control capacity. No enhancement.
Other Terrestrial Communities	Loss of desert upland vegetation such as paloverde-mixed cacti habitat.	Same.	Loss of vegetation traded for increased water storage capacity. No enhancement.
Perennial Stream/ Riverine Communities	Disruption of perennial stream and riverine habitat due to erosion and high turbidity.	Gain of 1 mile of perennial stream. Instream flow below Bartlett Dam would remain 50 cfs.	None identified. Enhancement would occur if quaranteed 200 cfs instream flows are provided; remaining riverine communities would be improved.
Reservoir Aquatic Communities	Disturbance of reservoir communities during construction.	Gain in acres of reservoir habitat, and 1 guaranteed minimum pool for fisheries at New Waddell.	Short-term disruption traded for gain in habitat quantity. No enchancement of habitat quality.

Table IV-52 (continued)

Resource	Short-Term	Long-Term	Tradeoffs
Threatened & Endangered Species	Possible loss of breeding productivity in bald eagle breeding areas during construction.	Loss of bald eagle preferred habitat.	Habitat management programs would improve quality and restrict accessibility of remaining bald eagle habitat, and may improve productivity.
Special Use & Management Areas	Loss of riparian habitat rehabilitation sites in Cliff area, loss of rangeland (AUMs).	Loss of riparian habitat rehabilitation sites at Cliff, implementation of riparian and rangeland rehabilitation programs in Confluence & Roosevelt areas.	Rehabilitation sites at Cliff traded for additional management sites at Confluence and Roosevelt. Enhancement expected in site-specific areas.
Water Quality	Increases in turbidity and suspended sediment load from construction-related activities.	Changes in the average level of water quality constituents in CAP and MCMWCD#1 water supplies, (increased potential for reservoir eutrophication,) increased potential for THM production.	Change in quality of local water supplies is traded for increased supply, reliability of supply during peak use periods, and reduction of groundwater pumping. No enhancement.
Stream-Oriented Recreation	Existing recreation resources and facilities would be disrupted as a result of construction.	Increase in maximum annual recreation days and development of additional facilities for camping & picnicking; gain of 1 stream mile.	Short-term disturbance of recreational facilities and activities traded for gain of stream and increased stream-oriented facilities. Enhancement would occur.

Table IV-52 (continued)

Resource	Short-Term	Long-Term	Tradeoffs
Reservoir-Oriented Recreation	Existing recreation resources and facilities would be disrupted during construction.	Increase of surface acres of water during the recreation season and gain in recreation days for boating, camping, picnicking, and swimming.	Short-term disturbance of recreational facilities traded for increased resources and facilities at Roosevelt and New Waddell. Enhancement would occur.
Prehistoric Resources	Sites destroyed or altered by construction activities; documentation and data recovery of selected sites prior to construction.	Sites destroyed or altered as a result of construction, operation and increased site visitation; collected information and and artifacts preserved but sites lost for further study.	Future research potential and existence of sites traded for immediate site documentation and data collection. No enhancement.
Historic Resources	Roosevelt Dam and other sites destroyed or altered by construction activities; documentation and data recovery of sites prior to construction.	Sites on or eligible for inclusion on the National Register of Historic Places destroyed, altered, or impaired; loss of public educational/recreational value of sites.	Future research potential and existence of sites traded for immediate site documentation and data collection. No enchancement.

Table IV-52 (continued)

Resource	Short-Term	Long-Term	Tradeoffs
Social	People relocated from around Roosevelt Lake and from KA Ranch.	Decrease in personal autonomy, satisfaction with lifestyle, self-sufficiency, and community cohesion. Increase in mortality and illness rates for relocatees; elimination or reduction of flood-related problems for residents of downstream floodplain.	Relocation of upstream residents traded for flood control and elimination of dam safety hazard for downstream residents. Enhancement expected for downstream residents.
Economic Resources	Expenditure for construction and interest payments.	Repayment of local costs over life of the project; benefits realized yearly from regulatory storage and flood control exceed cost.	Construction and repayment costs are traded for national economic development benefits of project. Enhancement expected.
Air Quality	Temporary increase in dust emissions (TSP) and vehicular emissions during construction of dams and recreation sites.	No state or federal ambient air quality standards would be violated in any site area.	None identified. No enhancement.
Aesthetics	Temporary disruption of visual quality during construction.	Gain of acres of Visual Quality Zone 1, representing a shift from low to high quality visual resources.	Disruption of existing visual resources traded for long-term gain of higher quality resources. Enhancement expected.

Table IV-52 (continued)

Resource	Short-Term	Long-Term	Tradeoffs
Noise	Temporary increase in noise in excess of EPA's short-term goal for residents in the Roosevelt area during construction.	Day-night sound levels in all site areas would remain in compliance with EPA's long-term goals.	None identified. No enhancement.
Sand & Gravel Resources	None identified.	Some sand and gravel deposits enhanced by reduced flooding.	None identified. Enhancement expected.
Prime Farmland	Acquisition of prime farmland at Cliff site for construction.	Protection of downstream prime farmland from flooding; possible conversion of some downstream prime farmland to urban uses.	Loss of prime farmland upstream traded for protection of downstream prime farmland. No enhancement.
Land	Changes in land use within affected site areas due to construction of dams and facilities; changes in land ownership due to federal acquisition of lands required for construction at New Waddell.	Land use conversions and increased development in downstream areas due to flood control, including Rio Salado and Sky Harbor Airport expansion.	None identified - no major incompatible land uses are anticipated. Enhancement of downstream lands expected.

3. Economics

Economic resources committed to the construction and operation of Plan 6 would not be available for other uses.

4. Aesthetics

There would be irreversible changes in the aesthetic quality of the affected site areas in Plan 6. These changes would result from the construction of the dams and appurtenant facilities and from the operation of the reservoirs.

5. Geology/Soils

Approximately 130 acres of prime farmland would be acquired for Plan 6 and subsequently inundated. Additionally, sand, gravel, and other soil fill materials will be committed for the construction of the dams and facilities. These resources would come from borrow areas near the dam sites or from commercial sources.

6. Land Resources

Land required for the construction of Plan 6, including dam sites, reservoir areas, and rights-of-way would be irreversibly committed to the project and would be unavailable for other uses.

H. Conflicts with Other Agency Programs, Plans, and Policies

Letters were sent on January 19, 1982 to members of the CAWCS Governor's Advisory Committee and Technical Agency Group, representing over 80 agencies. The letters requested notification if whether the "planning or implementation of any CAWCS alternative action (Plans 1, 2, 3, 6, or 7) presents conflicts with your agency's programs, policies, or plans".

Letters were received from 12 agencies in response. The following agencies presented possible conflict with their policies, programs, or plans which must be considered in implementing an alternative.

1. Arizona Department of Transportation

The Department and the Federal Highway Administration are jointly participating in a plan to upgrade and realign a 14-mile segment of State Route 188, including the portion which crosses Roosevelt Dam. This road would require relocation under CAWCS alternatives. Reclamation is working with the Department of Transportation to coordinate planning of Route 188 modifications. The Department also has plans to extend State Route 74 for possible connection with New River in the vicinity of Lake Pleasant, and has several material pits in the area. Reclamation planning of New Waddell Dam construction and operation will consider these sites and avoid impacting them if possible. Compensation will be made for land and facilities required to construct New Waddell Dam and Reservoir.

2. Maricopa County Department of Planning and Development

The Advance Planning Division may have potential zoning conflicts if construction of New Waddell Dam and Reservoir creates significant growth impacts in the area. Planning for impacts caused by an influx of workers during dam construction is also a concern of the Planning Department. These factors have been considered in CAWCS planning, and Reclamation does not expect significant development impacts either during the construction period or as a long-term result of dam construction, mainly because of the public ownership and management of land around the proposed dams.

3. Maricopa County Parks and Recreation Department

The Parks Department operates Lake Pleasant Regional Park. The enlargement of New Waddell Dam and Reservoir presents several conflicts with the Department's policies, plans, and programs. Reclamation is working closely with the Parks Department to coordinate plans for development of the area.

4. City of Mesa

Implementation of Plan 6 may present conflicts with the proposed operation of the City of Mesa water treatment plant by either reducing the amount of water available to the city or increasing the turbidity of water delivered to the treatment plant. These conflicts are being investigated by the Reclamation.

5. Rio Salado Development District

Plans 2, 8, and 9 conflict with Rio Salado development plans because Plan 8 provides no flood control and the level of flood control provided by Plan 2 is not considered by the District to be sufficient to allow implementation of the Rio Salado concept.

6. Fish and Wildlife Service

The Fish and Wildlife Service stated that Plan 3 is in conflict with its policies for preserving and managing habitat identified as Resource Category 1. Such habitat would be destroyed by construction of Confluence Dam and Reservoir.

7. Arizona Game and Fish Department

Delivery of Colorado River water into New Waddell Reservoir as proposed in Plans 6 and 7 could potentially introduce Colorado River ichthyofauna into that reservoir. Such introduction would be in conflict with the Arizona Game and Fish Department's policies on importation and introduction of non-native fish species, and management criteria for the Lake Pleasant sport fishery. The Arizona Game and Fish Department has expressed a strong concern about the potential adverse impacts on the Lake Pleasant fishery, specifically due to the importation of, and competition and predatory impacts from, the blue tilapia and striped bass.

CAP water deliveries to the Salt River Project at Granite Reef Dam also present the same potential problems with regard to introducing these Colorado River species into the lower Salt and Verde Rivers. This potential problem is present even without any action under CAWCS. However, CAWCS Plans 6 and 7 would compound this potential problem by providing a means for white bass to move from New Waddell Reservoir into the lower Salt and Verde Rivers via the reversible canal and the Granite Reef Aqueduct.

I. Plan 6 Compliance With Other Environmental Statutes

Federal environmental statutes which have application to Plan 6 are listed in Table IV-53. Requirements of these statutes, as well as the status of Plan 6 compliance, are also described.

J. Environmental Commitments

Although the actual quantity and quality of the mitigation measures are not identified, Reclamation is committed to use the initiatives to provide mitigation at a sufficient level to either minimize or eliminate the impacts caused by the proposed action. The environmental commitments are displayed for only the proposed action because that is the action Reclamation expects to implement.

Other environmental commitments are listed, even though they do not take the form of mitigation. For example, Recalmation has committed itself to accomplish several studies as part of the Regulatory Storage Project. Although these studies are not mitigation, they are environmental commitments.

1. Construction Consideration

a. Construction and Public Safety

Safety conditions would be monitored by Reclamation to avoid accidents. Signs, flagmen, barricades, and other safety devices would be used to warn of potential hazards.

b. Blasting Control

Whenever blasting is required, the contractor would submit a blasting plan which would be evaluated prior to authorization of the initiation of blasting.

c. Dust Control and Air Pollution

Dust from construction would be controlled by establishing watering programs. Speed limits to reduce dust problems would be enforced based on the road conditions. Vehicles and equipment that show excessive emission of exhaust gases would not be operated until corrective repairs or adjustments are made. The burning of combustible materials not needed in construction would be initiated only with concurrence of local pollution-control and fire-prevention authorities.

Table VI-53

STATUS OF PLAN 6 COMPLIANCE WITH OTHER ENVIRONMENTAL STATUTES

Affected Resource	Statute	Requirements	Plan 6 Complaince Status
Water Quality	Federal Water Pollution Control Act of 1972 (PL 92-500)/Section 404, Clean Water Act of 1977.	Requires a Corps of Engineers permit for the discharge of dredged or fill material into navigable waterways. An individual permit is not required if conditions of a Nationwide Permit apply. Plan 6 complies with the conditions for Nationwide Permits (see Appendix E).	Full Compliance. A Section 404 evaluation is included as Appendix E of this report. This evaluation satisfies the requirement for Reclamation compliance with Section 404.
Wild & Scenic Rivers	Wild and Scenic Rivers Act of 1968 (PL 90-542)	Section 7 prohibits federal agencies from assisting or licensing water resource projects on or affecting any river designated for study as a potential component of the national wild and scenic river system. Section 5 requires consideration of wild and scenic rivers in planning water resource projects.	Full Compliance. Tonto Creek from its source to Roosevelt Lake is listed on the Nationwide Rivers Inventory and is eligible for inclusion in the Wild & Scenic Rivers System. The U.S. Forest Service has recommended that a 39.5 miles segment of the Verde River from Clarkdale approximately to Table Mountain be included in the National Wild and Scenic River System. (see Verde River Wild and Scenic River Study Report, Final EIS, U.S. Forest Service, September 1982). A small segment of Tonto Creek would be affected only under

Table IV-53 (continued)

Affected Resource	Statute	Requirements	Plan 6 Compliance Status
Wild & Scenic Rivers (continued)			200-year flood conditions. The Verde River segment would only be affected under IDF conditions. Due to the infrequency of these events, Plan 6 is not likely to diminish the wild and scenic value of these rives.
Floodplains & Wetlands	Executive Order 11988, Avoid Impacts Associated with Occupancy Modification of Floodplains, May 24, 1977 / Executive Order 11990, Avoid Adverse Impacts to Wetlands, May 24, 1977.	Agencies must determine whether their actions will affect floodplains and wetlands, consider alternatives, and include all practical measures to minimize impacts.	Full Compliance. Impacts to floodplains and wetlands are addressed in Appendix D of this report, and have been included in the impacts and effects analyses for biological and social resources (Chapter IVB).
Biological Resources	Endangered Species Act of 1973, as amended (PL 93-205).	Section 7 required consultation with the U.S. Fish & Wildlife Service to determine if federal project actions will affect threatened or endangered wildlife species, and to insure that any action authorized, funded, or carried out does not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of habitat which is determined to be critical.	Full Compliance. A Biological Opinion rendered by the Fish & Wildlife Service in compliance with Section 7 of the Endangered Species Act is included as Appendix F of this report.

Table IV-53 (continued)

Affected Resource	Statute	Requirements	Plan 6 Compliance Status
Biological Resources (continued)	Fish & Wildlife Coordination Act (PL 85-624).	Requires coordination with federal and state wildlife agencies (Fish & Wildlife Service and Arizona Game & Fish Department) for the purpose of mitigating and compensating for project-caused losses to wildlife resources.	Full Compliance. A Fish & Wildlife Coordination Report is included as Appendix G of this report.
Prime Farmland	Council on Environmental Quality Memorandum, Analysis of Impacts on Prime and Unique Farmlands, August 30, 1976.	Requires that federal agencies analyze the effects of their actions on prime and unique farmland, document these effects in an EIS where appropriate, and develop alternatives and/or mitigation measures.	Full Compliance. Plan 6 impacts and effects to prime farmland, and mitigation measures, are described in Chapter IVB of the EIS.

Table IV-53 (continued)

Affected Resource	Statute	Requirements	Plan 6 Compliance Status
Cultural Resources	National Historic Preservation Act of 1966; Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971 and implementing regulations under the Archaeological and Historic Preservation Act of 1974 (PL 92-291).	Federal agencies are responsible for the identification, protection, managment, and nomination to the National Register of Historic Places of signficant cultural resources which are located on federal lands and/or which would be affected by federal actions. Consultation with the Advisory Council on Historic Preservations and the State Historic Preservation Officer (SHPO) is required when a federal action may affect cultural resources on or eligible for inclusion on the National Register (Section 106 of the National Historic Preservation Act). In addition, there is a specific requirement to minimize alteration or destruction of National Historic Landmarks, such as Roosevelt Dam (Section 110(f) of the National Historic Preservation Act).	Complaince Ongoing. A programmatic memorandum of agreement (PMOA) has been negotiated in compliance with Section 106 of the National Historic Preservation Act. The Section 110(f) requirement has been addressed through preparation of a document describing the full range of alternatives considered and presents support for the conclusion that substantial alternatives of the Roosevelt Dam National Landmark is justified to achieve overriding project goals. Under the terms of the PMOA a general historic preservation plan is being developed for the entire CAP and the proposed mitigation for Plan 6 will be refined and coordinated with this plan as construction specifications are developed.

Table IV-53 (continued)

Affected Resource	Statute	Requirements	Plan 6 Compliance Status
Recreational Resources	Federal Water Project Recreation Act, 16 USC 4601.	Provides for outdoor recreational and fish and wildlife enhancement for federal water projects, in coordination with existing and planned recreational developments.	No compliance required. Conceptual Recreation Plans have been develped for the Plan 6 affect site areas. Descriptions of recreational sites proposed in conjunction with the plan and analyses of the effects of use of such sites on existing and planned recreational development are outlined in Chapter IV. (also see Recreation Supporting Document USBR, September 1982 for details of the recreation plans.)
Air Quality	Clean Air Act of 1963, as amended 1970, Public Law 88-206.	Provides for the improvement, strengthening, and acceleration of program for the prevention and abatement of air pollution.	Watering program and speed limits established during construction to keep down dust. Construction vehicles will be kept in repair to prevent undue emissions. Burning of materials will be done only with concurrence of local pollution-control authorities.

d. Noise Abatement

Reclamation will monitor noise levels to insure that noise levels would not exceed 75 decibles during nighttime operations nor 80 decibles during daytime operations.

e. Water Pollution Abatement and Waste Material Disposal

The contractor would comply with applicable Federal and state laws and regulations concerning control and abatement of water pollution.

Solid waste disposal would be accomplished through burning, burial, or removal to specified sites.

f. Erosion Control

Excavated slopes would be bermed, terraced, or corrugated to prevent erosion and aid revegetation after construction. Deep cut slopes would be benched or terraced and protected from cross-drainage by diking. The dikes would probably be constructed using the excavated material. Surface drains would be used at the toe of each beach or terrace.

g. Prehistoric and Historic Cultural Resources

If evidence of previously unrecorded cultural resources is discovered during construction, oprations in the vicinity of the discovery would cease. Mitigation studies would be conducted as appropriate prior to resuming construction.

h. Vegetation

Removal or transplanting of protected native plants, when required, would be coordinated with the Arizona Commission of Agriculture and Horticulture in accordance with the Arizona Native Plant Law (ARS, Chapter 7, Article 1).

All construction sites where vegetation has been cleared or severely changed would be reclaimed. Disturbed areas susceptible to vegetative growth will be revegetated by seeding with native species or by other viable techniques. Haul roads will be scarified prior to seeding and barricaded to deter off-road vehicle use. Seeding and planting programs would be supervised by appointed Reclamation biologists.

i. Wildlife

The contractor would be prohibited from collecting or unnecessarily disturbing threatened or endangered wildlife in the site area. Personnel would be advised of Arizona Game and Fish Department regulations pertaining to protected wildlife species.

j. Riverine Resources

Construction impacts to riverine resources will be avoided where possible by locating haul roads away from water courses and minimizing river crossing areas.

2. Biological Resources

In developing, operating, and maintaining Plan 6 facilities, the goal of Reclamation is to incur no net loss of environmental values, and where possible, to enhance these values.

a. Riparian/Wetland Communities

The objective of Reclamation is to replace 100 percent of the habitat values of the Riparian/Wetland Communities upstream of Bartlett and Stewart Mountain Dams and at Lake Pleasant. The methods for meeting this commitment will include revegetating cottonwood/willow and mesquite habitat types in suitable areas within the exposed bed of Horseshoe Reservoir above elevation 1940. Based on current information, sufficient area will be exposed to recover all of the habitat value lost to construction and operation of Plan 6, including losses at Roosevelt and New Waddell Dams.

The revegetation of 250 acres of cottonwood-willow and 690 acres of mesquite will be done at the Cliff site.

The mixed scrub at all sites and cattail habitat at Cliff Dam will recover without revegetation through natural succession. To ensure full development of the habitat values, livestock grazing and ORV use would need to be eliminated in this riparian area and fencing may be required.

The draining of Horseshoe Reservoir and the breaching of Horseshoe Dam will be scheduled to coincide with the seeding and germination period of cottonwood and willow species in March and April.

All riparian habitat in the construction areas not required for construction purposes will be protected from damage. All lands containing riparian habitat which is removed due to construction outside the impoundment area will be contoured and revegetated to preconstruction conditions.

b. Other Terrestrial Communities

The upland desert habitat represents the major vegetation type within the Cliff, Roosevelt, and Waddell site areas and will be subjected to the greatest acreage loss within the reservoir inundation zone. Reclamation is committed to mitigating the loss of habitat value to the greatest extent practical or to compensate for the losses by increasing values in other habitats.

Vegetation clearing plans, which call for only partial conservation pool clearance in order to provide fish cover, will be put into effect at New Waddell and Cliff Reservoir sites. No clearing will occur in the conservation pool at Roosevelt Reservoir site.

The most practical means of decreasing losses is to manage the IDF areas at Waddell, Cliff and Roosevelt Damsites for wildlife by restricting grazing and off road vehicles. This management would increase habitat values by 87 percent over the unmitigated project action. An additional 5 percent of the lost value can be regained by providing permanent water sources in areas where water is not now available to wildlife.

Reclamation will restrict grazing and off-road vehicle access by fencing the IDF and/or by obtaining management agreements on project withdrawn lands at each project site, i.e. with the Forest Service at Cliff and Roosevelt Damsites, and the Maricopa County Parks Department and/or the State Land Department at New Waddell Damsite.

All areas of construction disturbance in the project sites not needed for permanent facilities will be returned to natural contours and revegetated with native species of plants.

c. Perennial Streams

Reclamation is committed to replacing all of the habitat value lost due to the construction and operation of Plan 6. Reclamation is further committed to avoiding impacts to the native fisheries in perennial streams caused by the increased water storage elevations at Cliff and New Waddell Damsites which could introduce non-native reservoir fish into currently isolated native fish habitat.

Up to 7 miles of river will be available in Horseshoe Reservoir. Reclamation's objective is to reclaim these 7 miles through stream management techniques which will replace the habitat value lost from the 6 miles of river inundated by Cliff Dam and Reservoir.

Reclamation will work with the Fish and Wildlife Service to design and evaluate a positive cutoff above the inflow design flood (IDF) elevation to provide a barrier to the movement of fishes upstream on Tule Creek into the Gila topminnow habitat. Fish barriers will be placed above the IDF elevation in the project area which contain native fish populations to avoid impacts to native stream fish.

d. Reservoir Aquatic Communities

Reclamation is committed to replace the lost habitat values to the greatest extent practical, compensate for these values by increasing habitat values elsewhere, or by increasing the density of game fish in project reservoirs as measured by catch/unit effort.

Reclamation will investigate the possible impacts of the introduction of Colorado River ichthyofauna into the New Waddell Reservoir through a cooperative effort with the Arizona Game and Fish Department, the Fish and Wildlife Service, and other interested parties.

Reclamation is committed to reducing the rate of drawdown at New Waddell Reservoir to 5 feet or less during March and the first half of April as often as is practical.

Reclamation is further committed to reducing conservation pool clearing to the minimum possible level. Currently, a total of 2,486 acres will be cleared at Cliff and Waddell Damsites primarily for human safety and navigation considerations as predicated on expected boat usage.

Minimum pools would be incorporated into the sediment and inactive storage pools at Cliff and New Waddell Reservoir sites. At Cliff Reservoir site this pool would be 1,030 acres in size with an average depth of 30 feet; at New Waddell Reservoir site the pool would be 1,540 acres in area and average 26 feet deep.

The construction of a harvest basin immediately downstream of Horseshoe Dam will facilitate the salvage of sport fish for stocking in Bartlett Reservoir. A management agreement will be required with the Arizona Game and Fish Department for such salvage and restocking operations.

e. Special Use Areas

The Roosevelt waterfowl management area will incur direct and indirect impacts from the anticipated eight-fold increase in recreation use of the lake which will reduce its value to migrating waterfowl. Reclamation is commited to reducing the effect of this disturbance by increasing the value of the management area.

The recreation plan for Roosevelt Reservoir calls for closing the recreation sites that are within the waterfowl area during the winter use period. Reclamation will provide irrigation equipment (either portable or permanent) and sufficient water to irrigate 100 acres of winter food crops for waterfowl. This measure will increase the Arizona Game and Fish Department's ability to provide winter food crops by approximately 50 percent.

f. Endangered Species

The Fish and Wildlife Service has issued a Biological Opinion under the Endangered Species Act that Plan 6 as proposed will jeopardize the continued existence of the bald eagle in the Southwest. The Jeopardy Opinion was issued because of the impacts of the use of recreation developments and opportunities at Cliff and Roosevelt Reservoirs and because of construction impacts at Roosevelt and Stewart Mountain Dams.

In accordance with established policy, Reclamation will work with the Fish and Wildlife Service, Arizona Game and Fish Department, and the National Forest Service to prepare an agreement to implement management strategies and actions to avoid adverse impacts on nesting bald eagles resulting from the increased recreation activities in the Plan 6 area.

Reclamation will continue to support the Forest Service's efforts to maintain nest wardens and provide liaisons between construction forces. The nest watch program will continue to receive funding from Reclamation for this effort.

Reclamation supports breaching Horseshoe Dam in a manner to promote stream and riparian development in the exposed Horseshoe Reservoir and to avoid excessive erosion. Reclamation will coordinate with the Fish and Wildlife Service to develop the requirements for evacuation of Horseshoe Reservoir to be included in the data submitted for final design and construction specifications.

Borrow excavation will be avoided at Meddler Point, if possible. If not, construction specifications will require the removal of materials during the eagle nonbreeding season and the stockpiling of materials outside the eagle breeding and foraging territory. Borrow areas will be restored to provide habitat suitable for eagle forage fish.

Award of the construction contracts associated with Stewart Mountain Dam will be scheduled to permit initiation of construction in April or May and then continue uninterrupted except for blasting. Construction specifications will exclude initiation of construction from October through March. Blasting activities will be prohibited from December through March.

Reclamation will work with the Fish and Wildlife Service to design and evaluate a positive cutoff above the inflow design flood (IDF) elevation to provide a barrier to the movement of fishes upstream on Tule Creek into the Gila topminnow habitat. The positive cutoff will be constructed unless unforeseen design problems or extreme costs are encountered.

Reclamation will participate in fishery investigations as part of an Interagency Agreement.

g. Project Monitoring

Reclamation will monitor the effects of the project and the success of all mitigation measures.

To ensure the adequacy of mitigation and compensation measures proposed in this plan and to facilitate monitoring the effects of the project, pre- and post-construction studies will be conducted. Studies may be required to investigate such topics as spawning in pre- and post-project reservoirs, effects of flood attenuation on downstream riparian areas, riparian reestablishment studies for Cliff Reservoir, alteration of temperature regimes and nutrient blockage on the Verde River, effects of upstream water exchanges on proposed riparian mitigation at Cliff Reservoir, investigations into the effects of the introduction of Colorado River ichthyofauna in conjunction with current studies, and river rehabilitation studies at Cliff Reservoir. Recommendations stemming from these studies suggesting additional mitigation would be evaluated and implemented if found to be justified.

3. Cultural Resources

Cultural values within all CAWCS impact areas have been identified or estimated, and recorded prehistoric and historic sites have been classifed into type.

Data recovery and research studies to recover the information embodied in some of the archaeological and historical sites to be immediately and directly affected by the project will be implemented.

A program will be developed for monitoring, managing, and studying those archaeological and historical sites situated in less directly affected areas such as flood pools within the proposed Cliff and Roosevelt Damsites and surrounding areas that may be affected by increased recreational use.

A program will be developed for public distribution and interpretation of the study results so that the scientific and historic values can be appreciated by interested professionals and the general public.

A Programmatic Memorandum of Agreement (PMOA) has been negotiated in compliance with Section 106 of the National Historic Preservation Act. Under the terms of the PMOA, a general historic preservation plan is being developed for the entire CAP and the proposed mitigation for Plan 6 will be refined and coordinated with this plan as construction specifications are developed.

4. Social Resources

Impacts to people because of relocation occur in the Cliff and Roosevelt site areas with Plan 6.

For the full-time residents who would be required to relocate, Forest Service land bordering Roosevelt Lake Estates will be made available for resettlement. The provision of this land would require an exchange agreement between Reclamation and the Forest Service.

An accurate, reliable system for disseminating information to relocatees could be established so that they are well informed about relocation proceedings.

Monetary compensation will be provided to relocatees to cover costs of relocation. One of the provisions of the Uniform Relocation Act of 1970 includes replacing the homes of relocatees with "safe, sanitary, and decent housing."

Negotiations over exchange land have occurred between Reclamation and the Forest Service, and these will continue. An agreement has been reached that exchange land will be made available to relocatees. A system for disseminating information to relocatees will be established. The relocations will be carried out in accordance with, and within the limitations of, the Uniform Relocation Act.

V. LIST OF PREPARERS

V. LIST OF PREPARERS

Major contributors to the environmental impact statement for the CAP Regulatory Storage Division (Central Arizona Water Control Study) were as follows:

Under contract to the Bureau of Reclamation, Dames & Moore and its subcontractors, including Battelle Institute (Columbus Division), Archaeological Research Services Inc., and Arizona State University, performed the environmental and social impact assessments for the CAWCS and conducted public involvement activities from July 1979 to December 1982. Dames & Moore, et al., prepared drafts of the EIS prior to December 1982.

The U.S. Bureau of Reclamation conducted CAWCS studies of economic-financial impacts and developed engineering designs and estimates for the alternatives, as well as supervising the work of all consultants. Reclamation reviewed drafts of the EIS prepared by Dames & Moore, and prepared the Draft EIS after the completion of Dames & Moore's contract in December 1982.

The U.S. Army Corps of Engineers conducted the hydrology studies for the CAWCS, developed analyses of flood damages and flood reduction benefits, and conducted studies of nonstructural flood damage reduction alternatives. The Corps did not participate in the preparation of the EIS.

Individuals involved in EIS preparation and review, or who contributed substantially to preparation of supporting documents and impact analyses, are listed in Table V-1.

Table V-1

LIST OF PREPARERS

Name	Firm	Qualifications	Participation
James E. Ayres	Archaeological Research Services, Inc.	M.A. Anthropology, 17 years experience, formerly Arizona State Historic Preservation Officer and Arizona State Museum staff.	Associate Principal Investigator, Historic Cultural Resources.
Richard G. Bauman	U.S. Bureau of Reclamation	B.S. Wildlife Biology, 10 years experience in natural resource protection and wildlife management, Wildlife Biologist.	HEP team member, Biology technical reviewer.
James E. Burton	Arizona Game & Fish Department	B.S. Fisheries Biology, 6 years experience, Habitat Evaluation Specialist.	HEP team member.
Thomas G. Burbey	U.S. Bureau of Reclamation	B.S. Civil Engineering, 21 years experience in water resource planning and project operations.	Technical reviewer for water quality and water resources.
Glenn R. Cass	Dames & Moore	B.S. Architectural Engineering, 8 years experience, Project Engineer, P.E.	Principal Investigator, Acoustics.
Randy Chandler	U.S. Bureau of Reclamation	B.S. Civil Engineering, 4 years experience, Hydraulic Engineer.	Computer programmer for water supply analysis.
Barbara A. Conrad	Dames & Moore	B.S. Zoology, M.S. Botany, 7 years experience, Certified Associate Ecologist, Ecological Society of America (ESA).	Associate Principal Investigator, Biological Resources.
Joe Dixon	U.S. Army Corps of Engineers	B.S. Geological Engineering, M.S. Sanitary Engineering, 12 years experience in planning and water resources development.	Corps of Engineers Study Manager.
Debra A. Duerr	Dames & Moore	B.A. Urban Affairs, 7 years experience in environmental planning, assessment, and regulation.	EIS Coordinator.
Bruce D. Ellis	U.S. Bureau of Reclamation	B.A. Anthropology, 5 years experience, Environmental Specialist.	Technical reviewer.
Carol Erwin	U.S. Bureau of Reclamation	B.S. Engineering, 9 years experience, Planner.	Team Leader for non-structural flood control analysis.
Wendy Espeland	Consultant	B.A., M.A. Sociology, Ph.D. candidate Sociology, 4 years experience in social assessment.	Principal Investigator, Social Resources.
Kenneth E. Evans	Dames & Moore	B.S. Mathematics/Physics, 10 years experience in meteorology.	Principal Investigator, Air Quality.

Table V-1 (continued)

Name	Firm	Qualifications	Participation
James W. Furlow	Dames & Moore	B.S., M.S. Geology, 16 years experience, Senior Geologist.	Principal Investigator, Geology/Soils.
Jennifer Fowler	U.S. Fish & Wildlife Service	B.S. Natural Resources Conservation, .S. Wildlife Science, 8 years experience, Fish & Wildlife Biologist.	HEP team leader.
Chris Gehlker	U.S. Bureau of Reclamation	B.A. Economics, 9 years experience, Economist.	Principal Investigator, Economics.
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R. Jan Henley	Dames & Moore	M.S. Resource Economics, 17 years experience in socio-economic assessment.	Principal Investigator, Future-Without-the-. Project.
Timothy J. Henley	U.S. Bureau of Reclamation	B.S. Civil Engineering, 7 years experience, Civil Engineer, P.E.	CAWCS Study Manager.
Rick Johnson	U.S. Bureau of Reclamation	B.S. Civil Engineering, 3 years experience, Civil Engineer, EIT.	CAWCS Project Engineer.
Joseph J. Kreutz	U.S. Bureau of Reclamation	B.S. Civil Engineering, 23 years experience, Supervisory Civil Engineer, P.E.	Engineer for Plans and Estimates.
Stephen V. Magnussen	U.S. Bureau of Reclamation	B.S. Civil Engineering, 21 years experience in water resources planning.	Technical and policy reviewer.
Eileen Marrinan	U.S. Army Corps of Engineers	B.A. Geography and Environmental Science, 5 years experience, Supervisory Outdoor Recreation Planner.	Team Leader for recreation planning.
Richard L. Maze	Dames & Moore	M.S. Biology, 10 years experience, Senior Biologist, Certified Senior Ecologist (ESA), Certified Wildlife Biologist (Wildlife Society).	Principal Investigator, Biological Resources, HEP team member.
Bob Michaels	U.S. Bureau of Reclamation	B.S. Forestry, M.S., Ph.D. Outdoor Recreation Planning, 11 years experience, Natural Resource Specialist.	Technical reviewer for recreation.
Larry D. Morton	U.S. Bureau of Reclamation	B.S. Engineering, 20 years experience, Civil Engineer, Environmental Engineer.	Technical and policy reviewer.
Rachel Most	Arizona State University	B.A., M.A., Ph.D. candidate, Anthropology, 6 years experience, Assistant Director, Office of Cultural Resource Management.	Associate Principal Investigator, Prehistoric Cultural Resources.
Barbara H. Murphy	Dames & Moore	B.A. Geology, 6 years experience, Certified Professional Geological Scientist (AIPG).	Associate Principal Investigator, Geology/ Soils.

Table V-1 (continued)

Name	Firm	Qualifications	Participation
Glen Rice	Arizona State University	B.A., M.A., Ph.D, Anthropology, 10 years experience, Director Office of Cultural Resource Management.	Principal Investigator, Prehistoric Cultural Resources.
Cynthia A. Richmond	Battelle Institute	M.C.R.P. City and Regional Planning, 5 years experience in environmental impact assessment and recreation planning.	Principal Investigator, Recreation and Aesthetics.
Allen E. Rogge	U.S. Bureau of Reclamation	Ph.D. Anthropology, 8 years experience, Archaeologist.	Technical reviewer for cultural resources.
Martha A. Rozelle	Dames & Moore	Ph.D. Community Management and Education, 12 year experience in public participation.	CAWCS Public Involvement Coordinator.
Deborah A. Saint	U.S. Bureau of Reclamation	B.A. Geography, 10 years experience, Social Factors Analyst	Technical reviewer for social assessment.
Carolyn M. Slatt	Consultant	B.A. Education, 10 years experience in technical writing.	Technical Writer.
Harry Smail	Battelle Institute	M.S. Natural Resources, M.C.R.P., 9 years experience, Land Use Planner, AICP.	Principal Investigator, Land Resources.
Larry Soehlig	U.S. Forest Service, Tonto National Forest	B.S. Forestry, 24 years experience, Lands and Minerals Staff Officer.	Tonto National Forest Coordinator for wildlife biology, recreation, and archaeology.
Lyle Stone	Archaeological Research Services, Inc.	Ph.D. Anthropology, 17 years experience in historical archaeology, Principal of ARS, Inc.	Principal Investigator, Historic Cultural Resources.
Natalie S. Waugh	Dames & Moore	B.A. Liberal Arts, M.A. English, 6 years experience in environmental regulatory compliance and multidisciplinary environmental planning.	Project Manager.
James R. Wagner	U.S. Bureau of Reclamation	B.S. Civil Engineering, 3 years experience in public health engineering.	Technical reviewer for air and water quality.
Guy Wilson	Consultant	M.A. Sociology, 2 years experience in social assessment.	Associate Principal Investigator, Social Recources.
Will Worthington	U.S. Bureau of Reclamation	M.S. Civil Engineering, 20 years experience, Chief of Dams Planning Branch, P.E.	Policy reviewer.
Terri Zaumseil	Dames & Moore	B.S. Natural Resources, 9 years experience.	Technical Editor.

GLOSSARY

GLOSSARY

Abutment
That part of existing topography into which the end of a dam is constructed.

Acre-Foot
The quantity of water required to cover one acre of land to a depth of one foot; equivalent to 43,560 cubic feet or 325,851 gallons (U.S.).

Air Quality Standards (National Ambient Air Quality Standards):

Primary - the maximum pollutant levels allowable to protect the public health with an adequate margin of safety.

Secondary - the maximum pollutant levels allowable to protect the public welfare from any known or anticipated adverse effect.

Alluvium
General term for clay, silt, sand, gravel, or unconsolidated detrital material deposited by a stream or other body of running water.

Ambient
Encompassing or surrounding.

Animal Unit Month (AUM)
The amount of forage necessary for sustenance of one cow or its equivalent for a period of one month.

Artifact
An object (such as a tool or ornament) made or modified by human beings.

Artifact Scatter
A type of site characterized by sherds and/or lithics on the surface and no evidence of surface or subsurface architecture.

Bajada
A nearly flat surface formed from confluent alluvial fans along the base of a mountain range.

Ballcourt
A large oval-shaped feature surrounded by a berm which is usually associated with ceremonial activities (may have been used as a dance arena or for competitive sporting events).

Biotic Community
An interrelated, complex aggregation of plant and animal populations distributed primarily according to physical factors in the environment.

Bosque
A densely wooded area along a stream or river.

CFS (cfs)
Cubic feet per second. A unit of measure of the rate of liquid flow past a given point equal to one cubic foot in one second.

Check Dams
Usually small dams located on tributaries to slow flowing water, allowing for greater infiltration, temporary storage or to control erosion.

Concrete Gravity dam
A water retaining structure which derives its strength to hold back the water because of the enormous weight of the dam itself.

Confluence
The point where two streams converge and unite.

Conservation Pool
In a reservoir, that part of the storage volume dedicated to storing water for future use.

Conservation Storage
See conservation pool.

Dam Crest
The top of the dam.

Decibel (dB)
A unit for expressing the relative intensity of sounds on a scale from zero for the average least perceptible sound to about 130 for the average pain level.

Destroyed
As used in the context of the CAWCS for impacts to cultural resources, the elimination of significant data values which characterize a site.

Drawdown
Lowering of the water level of a reservoir by releasing water from the dam.

Earthfill Dam
A dam constructed of engineered soils; a typical earthfill dam would have several types of soil with different properties placed in "zones" within the embankment.

Easements
An interest in land owned by another that entitles its holder to a specific limited use.

Earth Fissures
Cracks in the alluvium of basins which have land subsidence due to large water level declines.

Effect
An interpretation of the significance of the impact.

Energy Management
The operation of a system (in this case CAP) to maximize energy use when energy is relatively inexpensive (during the winter or at night) and to have excess energy available when demand (and price) is high.

Endangered Species
Any species determined by the U.S. Department of the Interior to be in danger of extinction throughout all or a significant portion of its range.

Enhancement
To improve or make better than the existing condition.

Eutrophication
The process by which waters become enriched with an influx of nutrients required for the growth of aquatic plants such as algae that are important for fish and animal life.

Flood event
100-year flood event - calculated by the U.S. Army Corps of Engineers to be a flow of 215,000 cfs for the City of Phoenix.

200-year flood event - calculated by the U.S. Army Corps of Engineers to be a flow of 275,000 cfs for the City of Phoenix.

Flood outlet
Large low level outlets designed to release flood waters at high flowrates.

Floodproofing
An adjustment to a building or its contents which is designed to stop the inflow of water or to reduce the effects of water entry.

Flood plain
The relatively level land adjacent to a river channel which is covered by water when the river overflows its banks at times of high water; (200-year flood plain - the flood plain which is under water during a 200-year flood event).

Fluctuating pool
Water level between the typical year low and the typical year high pool elevations (as defined by prehistoric cultural resources for the purpose of this project).

Geomorphic
Pertaining to the surface features of the earth.

Gridded gardens (or waffle gardens)
A type of terrace system which was used to enhance agricultural productivity.

Ground water
Water which is stored or moving between the soil particles below the earth's surface. When all voids between the soil particles are filled with water, the soil is saturated. The top surface of the saturated soil is the water table.

Ground water recharge
Replenishing of ground water.

Hydropower
Power generated from the movement of water.

Head (hydraulic)
Energy which water has because of the depth or velocity of the water.

Infiltration
The movement of water or solution into soil or rock.

Inflow Design Flood (IDF)
A flood event used by design engineers to size facilities for a new dam; this is usually a very large flood. For CAWCS, the IDF equals the maximum probable flood (MPF).

Impact
Measured change due to a project action; residual impacts are those impacts which remain after mitigation.

Inactive pool
That part of the reservoir storage pool which is below the outlet works.

Less-than-annual pool
Water level between typical year high and Standard Project Flood (SPF); term defined by prehistoric cultural resources for the purpose of this project.

Levees
An embankment built to prevent overflow.

Lithic
made of stone.

Low-level outlets
A water conveyance system designed to release water from behind a dam by gravity flow from near the bottom of the reservoir.

Maximum annual recreation day
See recreation days.

Maximum Probable Flood (MPF)
Determined by hydrologic analyses. That flood which would result from the most severe combination of critical meterological and hydrological conditions that are reasonably possible in the region (also known as PMF).

Maximum Storage Pool (MSP)
This represents the largest pool the reservoir would have when all space dedicated for the storage of conservation water is full.

Microclimate
Localized climate influenced by land form, elevation and other local environmental variables.

Minimum pool
This is the smallest pool a reservoir would have to meet specific requirements. For instance, a certain minimum pool may be required to support a fish population.

Mitigation
An action to reduce or eliminate an adverse impact.

Noise receptor
Residential, recreational, or other noise-sensitive land use.

Overdraft
Withdrawal of ground water in excess of replenishment.

Orogeny
The process of the formation of mountains.

Outlet works
A water conveyance facility designed to release water from behind a dam by gravity flow without having the water flow over the top of the dam.

Perennial stream
A stream that flows at all times.

Permanent pool
Water level up to the typical year low pool (defined by prehistoric cultural resources for the purpose of this project).

Petroglyphy
A carving or inscription on a rock.

Physiography
The study of the evolution of landforms.

Pithouse
A semi-subterranean brush house used as a permanent dwelling.

Prime farmland
Classification of U.S. Soil Conservation Service for lands with the soil quality, growing season, and moisture supply necessary to produce sustained high agricultural fields by modern farming methods.

Pueblo
A habitation site which is characterized by above ground, masonry architecture.

Pumping/generating facility
A reversible pump/turbine/motor/generator unit capable of pumping water from one elevation to a higher elevation using the motor to drive the pump. The unit can be operated in the reverse with water passing through to generate electricity.

Raptor
A bird of prey, e.g. eagle, hawk, etc.

Recreation day
A recreation day consists of an individual engaging in a specific activity for a significant period of time. The length of time is not defined but should be of such duration to clearly establish that the individual is participating in the specific activity by choice and the activity is for recreational purposes. Maximum annual recreation days are based on the carrying capacity of the resources and facilities as well as the length of the recreation season and the amount of recreation use that occurs on weekends. Maximum annual recreation days represent the capacity of the site without overcrowding. Only use at developed sites and on reservoirs is considered; no dispersed recreation activities are included.

Regulatory storage pool
That part of a reservoir allocated for the temporary storage of water so that flows in the rest of the delivery system can be better regulated.

Reversible canal
A level open-channel capable of passing flow in either direction.

Replacement pool
That part of a reservoir allocated to provide storage similiar to the storage which was previously available.

Riparian
Associated with the banks of rivers or other stable water bodies.

Riprap
Broken stones or boulders placed compactly or irregularly on dams, levees, dikes, or similar embankments for protection of earth surfaces against the action of waves or currents.

Right-of-way
The right of passage over another's land.

Riffle
A natural shallows in a stream or river bed over which the water flows swiftly and the water surface is broken in waves by obstructions wholly or partly submerged.

Rookery
A communal nest site for birds.

Safety of Dams (SOD)
1978 Reclamation Safety of Dams Act (P.L. 95-578).

Salt loading
An increase in the volume of salts in a basin usually brought about by interbasin transfer of water. Salt loading is most critical in the plant root zone and in any aquifers which might be affected by the imported salts.

Sediment pool
That part of a reservoir which is allocated for the storage of debris and sediment carried by inflowing waters. Sediment may actually be deposited at almost any point in the reservoir and this reduces the amount of storage volume available for water storage.

Service outlet
Outlet works designed to deliver water to designated users.

Sherd
A fragment of a broken ceramic vessel.

Spillway
A conveyance facility which allows for water to pass over or around an obstruction such as a dam. A gated spillway is one which can be closed or opened; an ungated spillway is one which is open all the time.

Spillway surcharge space
The volume above the spillway crest occupied by floodwaters as reservoir inflow exceeds outflow. This condition causes the water surface to rise temporarily.

Standard Project Flood (SPF)
The flood that may be expected from the most severe combination of meterologic and hydrologic conditions that are considered reasonably characteristic of the region.

Subsidence
A lowering of ground elevation as a result of excessive ground water pumping, dewatering of sediments, ground movements due to earthquakes, etc.

Surcharge pool
See spillway surcharge space.

Terrace (agriculture)
An artificial ridge or embankment of earth built for the purpose of conserving moisture, controlling runoff, or reducing erosion.

Threatened species
Any species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Turbidity
The state, condition, or quality of reduced clarity of a fluid due to the presence of suspended material in the fluid.

Typical-year pool

Water level of a reservoir during a "typical year" of operation based upon the Bureau of Reclamation computer model elevation - duration curves. These pools (high and low) were devised for use in impact assessment because they are representative of the way a reservoir could reasonably be expected to fluctuate.

Water exchange

An institutional arrangement utilizing physical facilities where one user's water is stored while his water needs are met by deliveries from a second user and then the second user has water "credits" against this first user; during a later period the second user may request that his credited water be released from the first user's storage facilities and delivered as required.

Water supply outlets

See service outlet.

Water yield

The volume of water which is available as a result of operations of a water system.

Visitor-days

A measure of impact; one visitor day equals twelve hours of use of a site.

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B. Description of Supporting Documents

The following briefly describes the contents of the EIS supporting documents. Information contained in these documents has been greatly abbreviated in the EIS. Readers wishing to consult the supporting documentation for details of the alternative plans, affected environment, assessment methodologies, and plan impacts and effects should contact the Bureau of Reclamation, Arizona Projects Office, Phoenix.

1. Designs and Estimates

This document includes all calculations for the designs and estimates used in making the November 1981 decision to choose Plan 6 as the agency proposed action. It also contains supporting designs and estimates for the draft environmental impact statement.

2. Plan Formulation

This report documents the activities undertaken in the CAWCS which led to the selection of a proposed action. It includes study background information, a description of the plan formulation process, a discussion of the candidate plans formulated and studied during Stage III, and a display of the proposed action (Plan 6).

3. New Waddell Sizing Study

This report documents the activities undertaken by the Bureau to develop and evaluate options to determine which New Waddell Dam size would be appropriate for feasibility design. The report contains a description of alternatives, including costs, benefits, and environmental and social effects. It also covers areas such as pump generator sizing, sediment distribution, and pumped storage.

4. Recreation Planning

This document identifies the recreational planning processes that were involved in the CAWCS Stage III work, the resulting conceptual plans which were developed and the anticipated facility costs and recreation days provided by each site. The document includes: a discussion of the Corps of Engineer's and Bureau of Reclamation's planning efforts and potential impacts of the plans; summaries of anticipated use by facilities and site; and a discussion of the economic aspects of the recreational plans.

5. Safety of Dams

This document contains two sections, one covering the Salt River dams and the other covering the Verde River dams. The report defines the Safety of Dams problems foreseen and possible solutions.

6. Nonstructural Flood Damage Reduction

This report documents a study completed by the U.S Army Corps of Engineers on nonstructural flood mitigation measures. It includes a definition of the flood problem, possible nonstructural mitigation measures, and an evaluation of these measures.

7. Economics - Financial

This report documents the economic analyses which occurred during CAWCS Stage III. It includes analysis of flood control benefits, water supply benefits, and hydropower benefits.

8. Hydrology

This document presents the hydrologic analysis of the Gila River drainage basin for CAWCS. It also includes data on water requirements, water rights, water quality and sedimentation. A hydraulic analysis of the Salt and Gila Rivers is also presented.

9. Social Impacts and Effects of CAWCS Plans

This report documents the social impacts and effects of Stage III plans, describes existing and future conditions for the affected populations, provides a summary of findings in the Social Well-Being (SWB) Account, and describes the social assessment process in CAWCS. It also provides a description of the methodology used for the social assessment.

10. Second Level Environmental Inventory

This document is a working paper that provides an inventory of environmental resources in the CAWCS study area. The inventory describes resources in biology, geology/soils, acoustics, water, air, land use, recreation, prehistoric and historic cultural resources, and visual quality. This report is the result of extensive literature reviews and agency contacts in all disciplines, and field studies in biology and cultural resources. The data were developed for the purpose of assessing the impacts of alternative plans.

11. Biological Assessment of Endangered Species

This report documents effects of CAWCS plans on Federal-designated threatened and endangered species in the CAWCS study area. The species include bald eagle, Yuma clapper rail, peregrine falcon, Gila topminnow, and Turk's head and Arizona hedgehog cacti.

12. Stage III Methodology for Environmental Quality Assessment

This document describes the methodology for assessing impacts to environmental quality in Stage III of the CAWCS. Impact assessment measures and criteria for determining effects are described for the following factors: biological resources, water quality, air quality, sound quality, visual quality, land quality, geological resources, cultural resources and recreation.

13. Regional Future Without the Project

This document forecasts the most likely future conditions in central Arizona without Central Arizona Project regulatory storage or flood control along the Salt and Gila Rivers through the Phoenix area. The purpose of this forecast is to provide a framework for assessing the impacts of alternative plans.

14. Summary and Evaluation of CAWCS Public Involvement Program

This report includes a summary and evaluation of public involvement activities conducted in the CAWCS from January 1979 to October 1981. The report describes these activities, details the results of major Stage III public involvement efforts, and presents an evaluation of public involvement activities from the perspective of CAWCS and participants in the public involvement process.

15. Environmental Impacts and Effects of Plans
(7 Volumes and Appendices)

These reports document the environmental impacts and effects of CAWCS Stage III plans. They describe existing and future conditions for the disciplines of biology, water quality, air quality, sound quality, visual quality, land quality, geology/soils, prehistoric and historic cultural resources, and recreation. A separate appendix accompanies each plan. Included in these are descriptive data, by plan component, for each discipline.

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