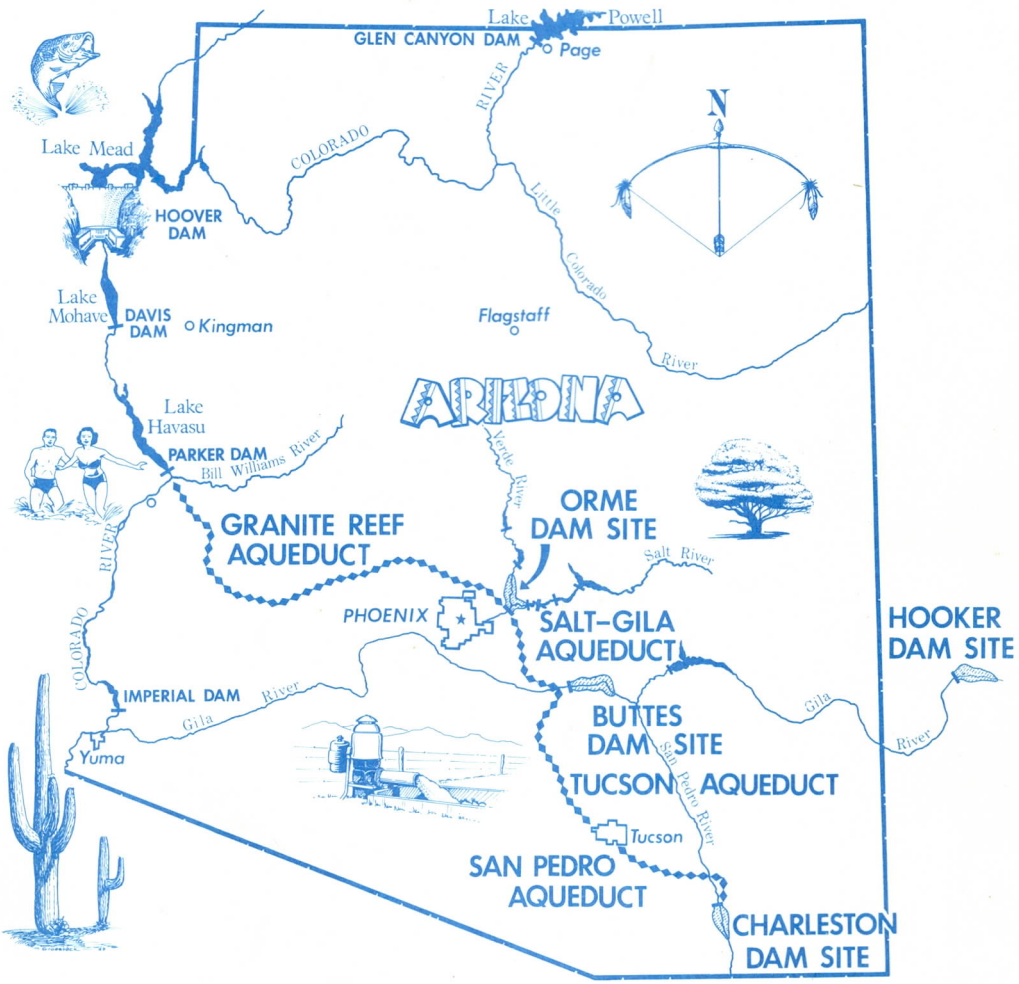
CENTRAL ARIZONA PROJECT

ENVIRONMENTAL STATEMENT



FINAL

8C.4 -4- 09/72

DEPARTMENT OF THE INTERIOR

FES 72 - 35

FINAL
ENVIRONMENTAL STATEMENT

PROPOSED
CENTRAL ARIZONA PROJECT

Prepared by
Bureau of Reclamation
Department of the Interior

SEP 2 6 1972

Ellis L. Armstrong
Commissioner

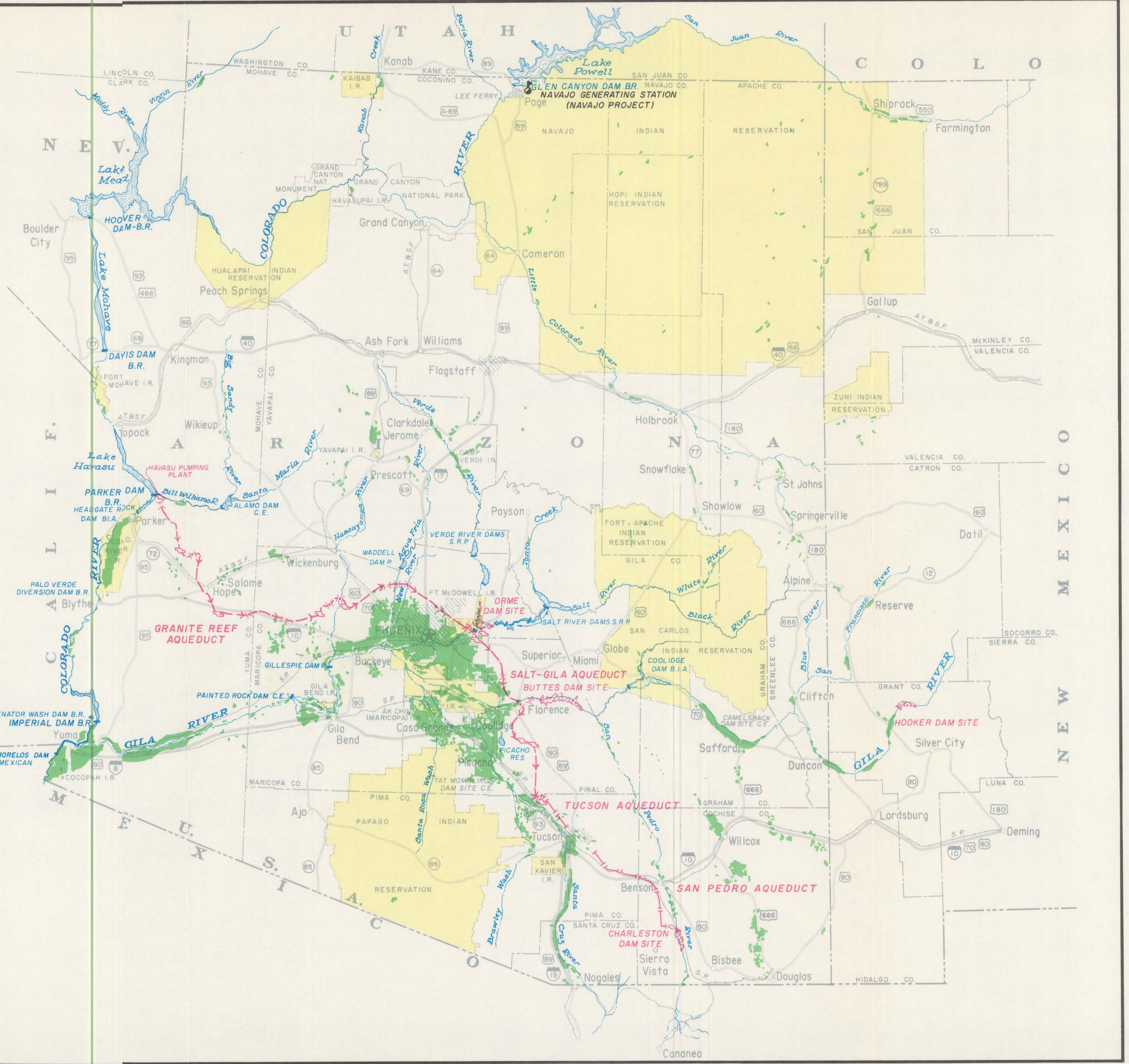
Interior-Reclamation, B.C., Nev. 9-72

EXPLANATION

UNDER AUTHORIZED CONSTRUCTION	EXISTING	FEATURES
		Aqueduct terminus
		Closed aqueduct
		Open aqueduct
		Dam and reservoir
		Generating station
		Pumping plant
		Siphon
		Tunnel
	I.R.	Indian reservation
		Water use areas

ABBREVIATIONS

- B.I.A. Bureau of Indian Affairs
- B.R. Bureau of Reclamation
- C.E. Corps of Engineers
- P. Private
- S.R.P. Salt River Project



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT – ARIZONA – NEW MEXICO

GENERAL LOCATION MAP

25 0 25 50 75
SCALE OF MILES

MAP NO. 344-314-944
AUGUST 1968

REV. 8-72

Interior-Reclamation, B.C., Nev. 9-72

SUMMARY

( ) Draft (X) Final

Department of the Interior, Bureau of Reclamation, Lower Colorado Region

1. Type of action: (X) Administrative ( ) Legislative

2. Brief description of action: Public Law 90-537 authorizes the Secretary of the Interior to construct the Central Arizona Project. Major project features involve the construction of one concrete and three earthfill dams; four aqueducts, including tunnels, a major pumping plant, and several smaller plants; and transmission facilities to provide power for the plants. Water will be transported from Lake Havasu via the aqueduct system for multipurpose uses in the project area. The project will provide municipal and industrial water for the Tucson and Phoenix metropolitan areas and water for lands in Maricopa, Pinal, and Pima Counties in Arizona and Grant County in New Mexico. Work is tentatively scheduled to begin in 1972 and continue through 1982.

3. Summary of environmental impacts and adverse environmental effects: A long-term average of 1.2 million acre-feet of water will be pumped annually from Lake Havasu for multipurpose uses. This new supply of water will be managed with local supplies to provide flexibility in meeting the demand for water imposed by municipal, industrial, and agricultural uses. Project water will be used as a replacement for ground water. The aqueduct system will be about 371 miles long and require about 16,000 acres of right-of-way supporting mostly desert shrub vegetation. The four reservoirs will require about 38,000 acres typically supporting deciduous trees near the channel and mesquite, grasses, forbs, cacti, and associated desert shrubs on the adjacent terraces.

   The existing biota and esthetic values will be influenced by the construction of reservoirs and the physical modification of topography and vegetation resulting from construction of project features. Some Indian lands and primitive and wilderness areas will be affected.

4. Alternatives considered:
   a. Alternative diversion routes to central Arizona
   b. Alternative water sources
   c. The alternative of no action
   d. Alternative power sources
   e. Alternatives to major features of the project

5. List of entities from whom comments have been requested or received with responders indicated by "*"

   See attached list.

6. Date made available to CEQ and the public:

   Draft statement: September 27, 1971

   Final statement: SEP 2 6 1972

CENTRAL ARIZONA PROJECT

LIST OF FEDERAL, STATE, AND LOCAL AGENCIES FROM WHICH COMMENTS HAVE BEEN REQUESTED OR RECEIVED WITH RESPONDERS INDICATED BY "*"

* Advisory Council on Historic Preservation, Washington, D.C.
Assistant to the Secretary for Policy Planning and Research, Washington, D.C.
Chairman, Council on Environmental Quality, Washington, D.C.
* Department of Agriculture, Washington, D.C.
* Department of the Army, South Pacific Division, Corps of Engineers, San Francisco, California
Department of Defense, Washington, D.C.
* Department of Health, Education and Welfare, Washington, D.C.
* Department of Housing and Urban Development, Los Angeles, California
Department of Transportation, Washington, D.C.
Environmental Protection Agency, Washington, D.C.
* Environmental Protection Agency, San Francisco, California

* Arizona Archeological Center, University of Arizona, National Park Service, Tucson, Arizona
* Commissioner, Bureau of Indian Affairs, Washington, D.C.
* Director, Bureau of Land Management, Washington, D.C.
* Director, Bureau of Mines, Washington, D.C.
* Director, Bureau of Outdoor Recreation, Washington, D.C.
* Director, Bureau of Sport Fisheries and Wildlife, Washington, D.C.
* Director, Geological Survey, Washington, D.C.
* Director, National Park Service, Washington, D.C.

Ak-Chin (Maricopa) Community Council, Maricopa, Arizona
Fort McDowell Community Council, Scottsdale, Arizona
Gila River Community Council, Sacaton, Arizona
Hopi Indian Agency, Keams Canyon, Arizona
Hopi Tribal Council, Oraibi, Arizona
Hualapai Tribal Council, Peach Springs, Arizona
Navajo Tribal Council, Window Rock, Arizona
Papago Community Council, Sells, Arizona
Salt River Pima-Maricopa Community Council, Scottsdale, Arizona

Governors of Arizona, California, Colorado, Nevada, New Mexico, and Utah
State Clearinghouses of Arizona, California, Colorado* (Colorado Division of Planning), Nevada, New Mexico* (New Mexico State Planning Office), and Utah

* Advisory Commission on Arizona Environment, Phoenix, Arizona
* Arizona Game and Fish Department, Phoenix, Arizona
* Arizona Outdoor Recreation Coordinating Commission, Yuma, Arizona
Arizona State Land Department, Phoenix, Arizona
* Arizona State Parks Board, Phoenix, Arizona
* Arizona State Reclamation Association, Phoenix, Arizona
* Arizona Water Commission, Phoenix, Arizona
Central Arizona Water Conservation District, Mesa Arizona
Department of Economic Planning and Development, Phoenix, Arizona
Gila County Board of Supervisors, Globe, Arizona
Greenlee County Board of Supervisors, Clifton, Arizona
Maricopa Association of Governments, Phoenix, Arizona
* Maricopa County Board of Supervisors, Phoenix, Arizona
* Maricopa County Flood Control District, Phoenix, Arizona
Military Department of Arizona, Phoenix, Arizona
Mohave County Board of Supervisors, Kingman, Arizona
Pima Association of Governments, Tucson, Arizona
Pima County Board of Supervisors, Tucson, Arizona
Pinal County Board of Supervisors, Florence, Arizona
* Yuma County Board of Supervisors, Yuma, Arizona
* Colorado River Board of California, Los Angeles, California
* Department of Water and Power, The City of Los Angeles, Los Angeles, California
* The Resources Agency of California, Sacramento, California
* Clark County Comprehensive Health Planning, Las Vegas, Nevada
* Colorado River Commission of Nevada, Las Vegas, Nevada
Nevada Department of Fish and Game, Reno, Nevada
Catron County Board of Supervisors, Reserve, New Mexico
Grant County Board of Supervisors, Silver City, New Mexico
Hidalgo County Board of Supervisors, Lordsburg, New Mexico
* Museum of New Mexico, Santa Fe, New Mexico
* New Mexico Department of Game and Fish, Santa Fe, New Mexico
* New Mexico Interstate Stream Commission, Santa Fe, New Mexico
* State of New Mexico Environmental Improvement Agency, Santa Fe, New Mexico
Department of Natural Resources, Salt Lake City, Utah

Arizona Conservation Council, Phoenix, Arizona
Arizona Environmental Health Association, Scottsdale, Arizona
Arizona Electric Power Cooperative, Inc., Benson, Arizona
Arizona Public Service Company, Phoenix, Arizona
Arizona Republic, Phoenix, Arizona
* Arizona Water Sports Council, Phoenix, Arizona
* Arizona Wildlife Federation, Phoenix, Arizona
* Museum of Northern Arizona (Colorado Plateau Environmental Advisory Council), Flagstaff, Arizona
Salt River Project Agricultural Improvement and Power District, Phoenix, Arizona
Sierra Club, Green Valley, Arizona
* Sierra Club, Tucson, Arizona
* State Chairman of Environmental Quality Programs for League of Women Voters, Sedona, Arizona
Tucson Gas and Electric Company, Tucson, Arizona
Tucson Urban Area Regional Reviewing Committee, Tucson, Arizona
Yuma Valley Rod and Gun Club, Yuma, Arizona
* Native American Rights Fund, Boulder, Colorado
Rocky Mountain Center on Environment, Denver, Colorado
National Wildlife Federation, Washington, D.C.
Nevada Power Company, Las Vegas, Nevada
* Four Corners Regional Commission, Farmington, New Mexico
* National Resources Defense Council, Inc., Washington, D.C.

* DNA - A Legal Services Program, Chinle, Arizona
* Frank Welsh, P.E., Tempe, Arizona
Best, Best and Krieger, Riverside, California
* Dr. Bruce J. Hayward, Associate Professor of Biological Sciences, Western New Mexico University, Silver City, New Mexico

TABLE OF CONTENTS

	Page
I. DESCRIPTION OF THE PROPOSAL	1
A. Introduction	1
B. Problems in Central Arizona and Western New Mexico Related to the Project	2
C. Objectives of the Central Arizona Project	6
D. Legislative History and Requirements	7
1. Legislative History	7
2. Legislative Requirements	9
a. Protection of Current Rights to Water Affected by the Project	9
b. Protection of Indian Reservations	10
c. Provisions Regarding Irrigation of Lands and Irrigation Systems	10
d. Provision for Development in Western New Mexico	11
E. Description and Function of the Project	11
1. General Project Description	11
2. General Project Operation	12
3. Description and Function of Key Features in the Project	13
a. Havasu Intake Channel, Pumping Plant, and Buckskin Mountains Tunnel	13
(1) The Intake Channel	13
(2) The Pumping Plant	15
(3) The Buckskin Mountains Tunnel	16
b. Granite Reef Aqueduct	18
(1) Route	19
(2) Design Features	21
(3) Operation	23
c. Orme Dam and Reservoir	23
(1) Location	23
(2) Design Features	24
(3) Operation	25
d. Salt-Gila Aqueduct	26
(1) Route	26
(2) Design Features	26
(3) Operation	28
e. Buttes Dam and Reservoir	29
(1) Location	29
(2) Design Features	29
(3) Operation	30

TABLE OF CONTENTS (Continued)

	Page
f. Tucson Aqueduct	31
(1) Route	31
(2) Design Features	31
(3) Operation	32
g. San Pedro Aqueduct	32
h. Charleston Dam and Reservoir	32
(1) Location	32
(2) Design Features	33
(3) Operation	34
i. Hooker Dam and Reservoir	34
(1) Location	34
(2) Design Features	34
(3) Operation	35
j. Power and Transmission Requirements	36
(1) Design/Operation Criteria	38
(2) Location of Proposed Transmission Lines	42
k. Communication System	43
l. Irrigation Distribution System	44
m. Drainage and Reuse Facilities	45
II. DESCRIPTION OF THE ENVIRONMENT	47
A. The Present Environment of the Project Area	47
1. Topography	47
2. Soils and Geology	48
a. Subsidence	49
b. Earthquake Potential	50
3. Climate	51
4. Vegetation and Wildlife	52
a. Vegetation	52
(1) Coniferous Forest	52
(2) Woodland	52
(3) Chaparral or Mountain Brush	53
(4) Streamside - Including Riparian and Marsh	53
(5) Southern Desert Shrub	56
(6) Ephemeral Desert Shrub	56
(7) Southern Grassland	56
(8) Cultivated and Irrigated Areas	56
b. Fish and Wildlife	57
(1) Invertebrates	57
(2) Fish	58
(a) Native Fishes	58
(b) Non-Native Fishes	59
(c) Rare and Endangered Species	60
(3) Terrestrial Vertebrates	61
(a) Amphibians and Reptiles	61

TABLE OF CONTENTS (Continued)

Page

(b) Birds 61
(c) Mammals 62
5. Ecological Interrelationships 63
6. Cultural Factors and Land Use 65
a. Land Use Pattern. 65
b. Land Ownership. 66
c. Archeological and Historical Sites. 67
d. Recreation. 69
7. Environmental Quality in Central Arizona. 69
a. Air 69
b. Water 70
c. Noise 71
8. Colorado River. 72
a. Flow. 72
b. Salinity. 74
B. The Projected Future Environment of the Project Area Without the Central Arizona Project 75
C. Present Environment at Specific Sites of Project Features. 79
1. Environment of the Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel. . . . 79
a. Climate 79
b. Topography. 80
c. Vegetation. 80
d. Fish and Wildlife 80
e. Cultural Factors and Land Use 81
2. Aqueduct Systems. 82
a. Granite Reef Aqueduct 82
b. Salt-Gila Aqueduct. 82
c. Tucson Aqueduct 83
d. San Pedro Aqueduct. 83
3. Reservoirs. 83
a. Historical Conditions and Changes 83
(1) Orme Reservoir Site. 84
(2) Buttes Reservoir Site. 84
(3) Charleston Reservoir Site. 85
(4) Hooker Reservoir Site. 85
(5) Summary and Discussion of Changes. 85
b. Present Environment of Orme Dam and Reservoir 86
(1) Topography 86
(2) Geology. 87
(3) Mineralization 87
(4) Vegetation 87
(5) Invertebrates. 89
(6) Fish 89
(7) Amphibians and Reptiles. 89
(8) Birds. 89
(9) Mammals. 89
(10) Archeological. 90
(11) Land Use Patterns. 90

TABLE OF CONTENTS (Continued)

Page

c. Present Environment of Buttes Dam and Reservoir 91
(1) Topography 91
(2) Geology 92
(3) Mineralization 92
(4) Vegetation 92
(5) Invertebrates 93
(6) Fish 94
(7) Amphibians and Reptiles 94
(8) Birds 94
(9) Mammals 94
(10) Archeological 94
(11) Land Use Patterns 95
d. Present Environment of Charleston Dam and Reservoir 95
(1) Topography 95
(2) Geology 95
(3) Mineralization 96
(4) Vegetation 96
(5) Invertebrates 96
(6) Fish 97
(7) Amphibians and Reptiles 97
(8) Birds 97
(9) Mammals 97
(10) Archeological 98
(11) Land Use Patterns 98
e. Present Environment of the Hooker Dam and Reservoir Site 98
(1) Topography 98
(2) Geology 99
(3) Mineralization 99
(4) Vegetation 99
(5) Invertebrates 100
(6) Fish 100
(7) Amphibians and Reptiles 100
(8) Birds 101
(9) Mammals 101
(10) Archeological 101
(11) Land Use Patterns 101

III. ENVIRONMENTAL IMPACT OF THE CENTRAL ARIZONA PROJECT 103

A. Definitions for Impact Evaluation 103
1. Beneficial 103
2. Adverse 103
3. Problematical 103
B. General Statement of Impact 103
1. Natural Resource Impacts 103
2. Human Impacts 105

	Page
C. Direct Impact of the Project	107
1. Impacts Related to Construction Activities	107
a. Borrow Areas	107
b. Construction Access Roads and Camps	108
c. Waste Material Disposal	109
d. Dust	109
e. Storage of Materials	110
f. Equipment Storage and Service Areas	110
g. Lighting	111
h. Noise	111
i. Increase in Traffic Patterns	111
j. Temporary Disturbance of Vegetation and Wildlife	112
k. Turbidity of Streams and Lakes During Construction	112
l. Erosion of Disturbed Areas	113
m. Water Supply for Construction	113
2. Impact Upon the Colorado River	113
a. Flow	113
b. Salinity	114
3. Impacts of CAP Water on the Project Area	115
a. Water Quality	115
b. Water Quantity	117
4. Impacts of Key Features of the Project	119
a. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel	119
(1) Vegetation	119
(2) Havasu National Wildlife Refuge	119
(3) Fish and Wildlife	119
(4) Water Flow and Quality	121
(5) Other Impacts	121
b. Inline Relift Pumping Plants	122
c. Aqueducts	122
(1) Granite Reef Aqueduct	123
(a) Fish and Wildlife	123
(b) Vegetation	124
(c) Other Impacts	125
(2) Salt-Gila Aqueduct	125
(a) Fish and Wildlife	125
(b) Vegetation	126
(c) Archeological	126
(d) Other Impacts	127
(3) Tucson Aqueduct	127
(a) Fish and Wildlife	127
(b) Vegetation	127
(c) Archeological	127
(d) Other Impacts	128
(4) San Pedro Aqueduct	128
(a) Fish and Wildlife	128
(b) Vegetation	128
(c) Archeological	128
(d) Other Impacts	128

TABLE OF CONTENTS (Continued)

Page

d. Reservoirs 129
(1) Reservoir Inundation and Subsequent Successional Changes 129
(a) Fish, Amphibians, and Reptiles 131
(b) Birds 132
(c) Mammals 133
(2) Orme Dam and Reservoir 133
(a) Inundation of Lands 133
(b) Mineralization 133
(c) Vegetation 134
(d) Fish and Wildlife 134
(e) Recreation 136
(f) Archeological 136
(g) Indian Lands 136
(h) Water Rights 137
(i) Hydrologic Regimen 137
(j) Water Quality 137
(k) Flood Control 137
(l) Other 138
(3) Buttes Dam and Reservoir 138
(a) Inundation of Lands 138
(b) Mineralization 138
(c) Vegetation 139
(d) Fish and Wildlife 139
(e) Recreation 140
(f) Indian Lands 141
(g) Archeological and Historical Sites . . . 141
(h) Existing Facilities 141
(i) Water Rights 141
(j) Streamflow Regimen 141
(k) Water Quality 142
(4) Charleston Dam and Reservoir 142
(a) Inundation of Lands 142
(b) Mineralization 142
(c) Vegetation 142
(d) Fish and Wildlife 143
(e) Recreation 144
(f) Archeological 144
(g) Water Rights 145
(h) Streamflow Regimen 145
(i) Water Quality 145
(j) Land-Use Patterns 145
(5) Hooker Dam and Reservoir 145
(a) Inundation of Lands 145
(b) Mineralization 146
(c) Vegetation 146
(d) Fish and Wildlife 146
(e) Recreation 148
(f) Archeological 148
(g) Wilderness and Primitive Areas 148
(h) Water Rights 148
(i) Streamflow Regimen 149
(j) Water Quality 149

Page

(6) Fish Hatcheries 149
e. Irrigation Distribution System 149
f. Drainage and Reuse Facilities 150
g. Transmission System 150
h. Communication System 151
5. Local and National Economic Impact Resulting from Project Construction 151
6. Impacts Related to Physical Operation and Maintenance of the Project 152
a. Operation 152
b. Maintenance 153
7. Indian Water Rights Affected by the Project 154
D. Indirect Impacts of the Project 155
1. Relationship of the Project to Population Growth . . 155
2. Changes in Patterns of Water Use 156
E. Unquantified Amenities 156

IV. ENVIRONMENTAL CONSIDERATIONS INCLUDING MITIGATION AND ENHANCEMENT FEATURES INCLUDED IN THE PROPOSED ACTION 158

A. General 158
1. Research and Monitoring 158
2. Analyzing Alternative Features 159
3. Standard Reclamation Rules for Design and Construction 159
B. Protective Measures and Mitigation Features Included as Part of the Project 162
1. Granite Reef and Salt-Gila Aqueducts 162
a. Fencing 162
b. Bridges 162
c. Escape Facilities 163
d. Wildlife Water Sites 164
e. Wildlife Oases 164
2. Reservoirs 165
a. Fish Hatcheries 165
b. Orme 166
c. Buttes 167
d. Charleston 167
e. Hooker 167
C. Potential Enhancement Measures Not Authorized Under Public Law 90-537 168
1. Other Wildlife Habitat Potential 169
2. Parks-Recreation Potential 169
3. Fishing Lakes 169
D. Historic and Archeological Sites 171

V. ADVERSE IMPACTS WHICH CANNOT BE AVOIDED 175

A. Impacts Related to Construction Activities 175
B. Impacts Associated with the Project 176

Page

C. Impacts Associated with Key Features of the Central Arizona Project 176
1. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 176
2. Granite Reef Aqueduct 177
3. Salt-Gila Aqueduct 177
4. Tucson and San Pedro Aqueducts 177
5. Orme Reservoir 177
6. Buttes Reservoir 178
7. Charleston Reservoir 178
8. Hooker Reservoir 178
9. Transmission System 179
10. Distribution Systems 179
11. Drainage and Reuse Facilities 179

VI. THE RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY 180

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE CENTRAL ARIZONA PROJECT 182

A. Water Resources 182
B. Land, Mineral, and Vegetative Resources 182
C. Power Resources 183
D. Wildlife and Recreation Resources and Esthetic Values 183
E. Historical and Archeological Sites 184
F. Indian Culture 185
G. Economic Resources 185

VIII. ALTERNATIVES TO THE PROJECT 186

A. Alternative Diversion Routes to Central Arizona 186
1. Marble Canyon (Verde River) Route 187
2. Bridge Canyon (Big Sandy) Route 188
B. Alternative Water Sources 189
1. Use of Recycled Water Produced in the Area 189
2. Precipitation Management 190
3. Conservation of Irrigation Water 191
4. Increased Watershed Runoff 192
5. Import from Other Basins 193
6. Geothermal Sources 193
7. Desalting of Ocean or Other Brackish Waters 194
C. The Alternative of No Action 195
D. Alternative Power Sources 198
E. Alternatives to Major Features of the Project 199
1. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 199
a. Description of Alternatives 199
b. Description of the Present Environment 201
c. Impacts of the Alternatives 202

TABLE OF CONTENTS (Continued)

	Page
2. Granite Reef Aqueduct	204
a. Description of Alternatives	204
b. Present Environment of Alternative Locations	206
c. Environmental Impact of Alternatives	207
3. Orme Dam and Reservoir	207
a. Description of Alternatives	207
b. Present Environment of the Alternatives	208
c. Environmental Impacts of the Alternatives	209
4. Salt-Gila Aqueduct	210
a. Description of Alternatives	210
b. Present Environment of the Alternatives	210
c. Environmental Impacts of the Alternatives	210
5. Buttes Dam and Reservoir	210
a. Description of Alternatives	210
b. Present Environment of the Alternatives	211
c. Impacts of the Alternatives	211
6. Tucson Aqueduct	211
a. Description of Alternatives	211
b. Description of the Present Environment	212
c. Impacts of the Alternatives	212
7. San Pedro Aqueduct	212
a. Description of Alternatives	212
b. Present Environment of the Alternatives	213
c. Impacts of the Alternatives	213
8. Charleston Dam and Reservoir	213
a. Description of the Alternatives	213
b. Present Environment of Alternatives	214
c. Impacts of the Alternatives	214
9. Hooker Dam and Reservoir	214
a. Description of the Alternatives	214
b. Present Environment of the Alternatives	215
(1) Conner Site	216
(a) Geology and Topography	216
(b) Mineralization	216
(c) Vegetation	216
(d) Invertebrates	216
(e) Fish	216
(f) Amphibians and Reptiles	216
(g) Birds	217
(h) Mammals	217
(i) Archeological	217
(j) Land Use Patterns	217
(2) Telegraph Site	217
(a) Geology and Topography	217
(b) Mineralization	217
(c) Vegetation	218
(d) Invertebrates	218
(e) Fish	218
(f) Amphibians and Reptiles	218
(g) Birds	218

	Page
(h) Mammals.	218
(i) Land Use Patterns.	219
(j) Archeological.	219
(3) Gila-Mangas Site.	219
(a) Geology and Topography	219
(b) Mineralization	219
(c) Vegetation	219
(d) Invertebrates.	219
(e) Fish	219
(f) Amphibians and Reptiles.	220
(g) Birds.	220
(h) Mammals.	220
(i) Archeological.	220
(j) Land Use Patterns.	220
(4) Alma Site	221
(a) Geology and Topography	221
(b) Mineralization	221
(c) Vegetation	221
(d) Invertebrates.	221
(e) Fish	221
(f) Amphibians and Reptiles.	221
(g) Birds.	222
(h) Mammals.	222
(i) Archeological.	222
(j) Land Use Patterns.	222
(5) Reserve Site.	222
(a) Geology and Topography	222
(b) Mineralization	223
(c) Vegetation	223
(d) Invertebrates.	223
(e) Fish	223
(f) Amphibians and Reptiles.	223
(g) Birds.	223
(h) Mammals.	224
(i) Archeological.	224
(j) Land Use Patterns.	224
c. Impacts of the Alternatives	224
IX. CONSULATION AND COORDINATION.	226
A. Consultation and Coordination during Development of the Proposal and during the Preparation of the Draft of Environmental Statement.	226
1. Public Participation Leading to Project Authorization	226
2. Federal and State Studies Associated with Development of Project Proposals.	227
3. Involvement of Advisory Group and Public Entities in Environmental Concerns.	227

TABLE OF CONTENTS (Continued)

		Page
	4. Dissemination of CAP Information through News Media.	228
B.	Coordination during Review of the Draft of Environmental Statement	228
	1. Distribution of the Draft of Environmental Statement	228
	2. Special Consultation during Draft Review Period.	228
	3. Responses to the Draft of Environmental Statement	229
C.	Recent Studies Reflected in Final Statement	229
D.	Disposition of Comments Received by Official Letter or Obtained through Meetings with Agencies and Individuals	230

LIST OF TABLES

Table No.		Following Page
1	Average Yearly Declines of Ground Water for Basins in Central Arizona	3
2	Summary of Expressions of Interest in Contracting for Central Arizona Project	3
3	Dissolved Salts Concentration in the Ground Water in Various Areas of Arizona	5
4	Location, Pump Lift, Flow, and Energy Requirements for Havasu and Four In-Line Pumping Plants	23
5	Allocation of Reservoir Space in Orme Reservoir . . .	25
6	Land Areas Inundated by Orme Reservoir at Various Water Levels	25
7	Allocation of Storage Space in Buttes Reservoir . . .	29
8	Initial Allocation of Reservoir Space in Charleston Reservoir	33
9	Tentative Space Allocation for Hooker Reservoir . . .	35
10	Lands Inundated at Various Water Levels in the Proposed Hooker Reservoir	35

LIST OF TABLES (Continued)

Table No.		Following Page
11	Power Requirements for the Central Arizona Project	37
11A	Lower Colorado Region--General Land Characteristics and Suitability for Use	47
12	Acres of Riparian Vegetation Classified as Good Dove Habitat	55
13	Special Areas--Lower Colorado Region	67
14	Diversion Rights (Acre-Feet) of Each of the Colorado River Main Stem Indian Tribes as Provided under the Supreme Court Decree in Arizona v. California	153
15	Estimated Costs for Fishing Lakes (Unlined)	170
16	Unlisted Sites of Historical Interest That Will Be Affected by the Central Arizona Project	170

LIST OF FIGURES

Figure No.		Following Page
1	General Location Map. Map No. 344-314-944	Frontispiece
2	Ground-Water Level Declines, Spring 1923 through Spring 1964	3
3	Ground-Water Level Declines, 1940-1965	3
4	Depth to Water, 1964-1966	3
5	Index of Yearly Ground-Water Pumpage	5
6	Site Location of Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel (North Portal) on South Shore of Bill Williams Arm of Lake Havasu. Photograph No. P344-300-9851	15
7	Artist's Conception of Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel (North Portal). Photograph No. P344-300-12523	15

LIST OF FIGURES (Continued)

Figure No.		Following Page
8	Typical Plan and Profile Sheet, Granite Reef Aqueduct, Mile 12.00 to Mile 24.00. Drawing No. 344-314-929	19
9	Site Location of Buckskin Mountains Tunnel and a Portion of the Granite Reef Aqueduct Looking Northwest across the Buckskin Mountains toward the Bill Williams Arm of Lake Havasu. Photograph No. P344-300-12302	19
10	Site Location of Orme Dam and Reservoir Looking North. Photograph No. P344-300-11947	23
11	Artist's Conception of Orme Dam and Reservoir. Photograph No. P344-300-12303	23
12	Site Location of Buttes Dam and Reservoir Looking East. Photograph No. P344-300-8668	29
13	Artist's Conception of Buttes Dam and Reservoir. Photograph No. P344-300-8603	29
14	Site Location of Charleston Dam and Reservoir Looking Southwest. Photograph No. P344-300-12289	31
15	Artist's Conception of Charleston Dam and Reservoir. Photograph No. P344-300-12524	31
16	Site Location of Hooker Dam and Reservoir Looking Northeast. Photograph No. P344-300-8636	33
17	Artist's Conception of Hooker Dam and Reservoir. Photograph No. P344-300-8604	33
17E	Central Arizona Project Proposed Transmission System. 344-330-33	37
17A	Comprehensive Framework Study, Lower Colorado Region, Physiographic Provinces, M7-N-21431K	47
17B	Comprehensive Framework Study, Lower Colorado Region, General Land Characteristics, M7-S-21431F-N	47
17C	Location of Earth Fissures, 1969, and Water-Level Declines, 1923-64 in Western Pinal County	49
17D	Profiles of Land Subsidence in 1948-67, and Water-Level Declines, 1923-64, in Western Pinal County. From H. H. Schumann and J. F. Poland	49

LIST OF FIGURES (Continued)

Figure No.		Following Page
18	Earth Fissure Near a Suburban Housing Development East of Mesa, Arizona. Photograph No. P25-300-7527	49
19	Typical Earth Fissure Near Chandler Heights, Arizona. Photograph No. P344-300-8675	49
19A	Comprehensive Framework Study, Lower Colorado Region, Normal Annual Precipitation. M7-S-21431G-N	51
19B	Comprehensive Framework Study, Lower Colorado Region, Vegetal Cover. M7-S-21431B-N	51
19C	Comprehensive Framework Study, Lower Colorado Region, Gila Subregion Irrigated Land 1965, 1019-314-42	65
19D	Comprehensive Framework Study, Lower Colorado Region, Land Ownership and Administration M7-S-21431A-N	67
19E	Comprehensive Framework Study, Lower Colorado Region, Special Areas, June 1970	67
19F	General Map--Buckskin Mountains Tunnel--Map No. 344-314-1116	81
20	Within the proposed Orme Reservoir looking northeast across the Salt River which is just below the canyon wall. Photograph No. P344-300-12304	85
21	Within the proposed Orme Reservoir showing typical vegetation type. Photograph No. P344-300-12305	85
22	Within the proposed Buttes Reservoir looking east. The Gila River is at the bottom of the valley with railroad tracks on the south side. Dense stands of mesquite and saltcedar are found along the river. Saguaro cactus are present on the upland desert slopes. Photograph No. P344-300-12306	91
23	Within the proposed Buttes Reservoir showing typical vegetation type. Pricklypear is in the foreground and cholla in the center. Shrub vegetation primarily consists of mesquite, creosote bush, and bur-sage. Photograph No. P344-300-12307	91

LIST OF FIGURES (Continued)

Figure No.		Following Page
24	Within the proposed Charleston Reservoir looking southeast with the San Pedro River in the center of the photograph. The large light colored trees are cottonwood. Shrubs are mostly mesquite. Photograph No. P344-300-12308	95
25	Within the proposed Charleston Reservoir looking northwest with the San Pedro River flowing away from the photographer. The large trees are cottonwoods. Photograph No. P344-300-12309	95
26	Within the proposed Hooker Reservoir just below the confluence of Turkey Creek with the Gila River looking downstream. Vegetation on the slopes is mostly pinyon-juniper. Photograph No. P344-300-12310	97
27	Within the proposed Hooker Reservoir just below the confluence of Turkey Creek with the Gila River. Large trees are sycamore. Photograph No. P344-300-12311	97
27A	Location Map, Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel, Map No. 344-314-1114	119
27B	Orme Dam Site and Reservoir Area, Reservoir Functional Pools, Drawing No. 344-330-40	133
27C	Buttes Dam Site and Reservoir Area, Reservoir Functional Pools, Drawing No. 344-330-41	137
27D	Charleston Dam Site and Reservoir Area, Reservoir Functional Pools, Drawing No. 344-330-38	141
27E	Hooker Dam Site and Reservoir Area, Reservoir Functional Pools, Drawing No. 344-330-39	145
28	Value of materials, equipment and supplies needed for project construction--geographic area	151
29	Location Map, Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel, Map No. 344-314-1117	200

APPENDED MATERIAL

APPENDIX A

Page

Explanation of Tables in Appendix A . . . . . A-i

Table No.

1 Native ichthyofauna of the Gila River System, emphasizing the Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico, ca. 1850, and at present (1970); from Minckley[34] A-1

2 Ecological relationships of native fishes of the Gila River basin, Arizona-New Mexico; from Minckley[34] A-3

3 Estimates of past environmental features of Orme, Buttes, Charleston, and Hooker Reservoir sites as compared to present conditions within the sites; from Minckley[34] A-6

4 Non-native fishes within, or upstream from, Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico, with an estimate of the probability of their establishment in the various reservoirs, or a lack of that probability; from Minckley[34] A-11

5 Herpetofauna of the Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico; from Minckley[38] A-14

6 Ecological relationship of the herpetofauna of Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico; from Minckley[38] A-21

7 Composite list of birds with critical life history data and predicted effects following inundation in the Central Arizona Project dam construction; from Ohmart[39] A-24

8 Composite list of mammals with level of riparian dependency and predicted effects following inundation in the Central Arizona Project dam construction; from Ohmart[39] A-32

9 List of the birds known to the area of the proposed Orme Reservoir site; from Ohmart[39] A-35

TABLE OF CONTENTS (Continued)

APPENDED MATERIAL (Continued)

APPENDIX A (Continued)

Table No.		Page
10	List of the mammals known to the area of the proposed Orme Reservoir site; from Ohmart[39]	A-39
11	List of the birds known to the area of the proposed Buttes Reservoir site; from Ohmart[39]	A-41
12	List of the mammals known to the area of the proposed Buttes Reservoir site; from Ohmart[39]	A-43
13	List of the birds known to the area of the proposed Charleston Reservoir site; from Ohmart[39]	A-45
14	List of the mammals known to the area of the proposed Charleston Reservoir site; from Ohmart[39]	A-48
15	List of the birds known to the area of the proposed Hooker Reservoir site; from Ohmart[39]	A-50
16	List of the mammals known to the area of the proposed Hooker Reservoir site; from Ohmart[39]	A-55
	Cazier's[33] summary statement accompanying compilation of the invertebrate fauna of the environs of the four reservoir sites	A-57
	APPENDIX B	
	References cited	B-1
	APPENDIX C	

Appendix C contains copies of comments received by the Bureau of Reclamation from Federal, State, and local entities on the September 1971 Draft of Environmental Statement. In many instances, more than one letter was received from the same entity. In those cases, copies of the letters are located together in Appendix C but only the first page of the group is referenced by page number.

Letter	Page
Advisory Council on Historic Preservation, Washington, D.C.	1
Department of Agriculture, Washington, D.C.	2
Department of the Army, South Pacific Division, Corps of Engineers, San Francisco, California	6
Department of Health, Education and Welfare, Washington, D.C.	7
Department of Housing and Urban Development, Los Angeles, California	8
Environmental Protection Agency, San Francisco, California	9

Letter	Page
Arizona Archeological Center, University of Arizona, National Park Service, Tucson, Arizona	14
Commissioner, Bureau of Indian Affairs, Washington, D.C.	21
Director, Bureau of Land Management, Washington, D.C.	24
Director, Bureau of Mines, Washington, D.C.	33
Director, Bureau of Outdoor Recreation, Washington, D.C.	35
Director, Bureau of Sport Fisheries and Wildlife, Washington, D.C.	37
Director, Geological Survey, Washington, D.C.	40a
Director, National Park Service, Washington, D.C.	41
State Clearinghouses of Colorado (Colorado Division of Planning - page 43) and New Mexico (New Mexico State Planning Office - page 44)	43 & 44
Advisory Commission on Arizona Environment, Phoenix, Arizona	49
Arizona Game and Fish Department, Phoenix, Arizona	53
Arizona Outdoor Recreation Coordinating Commission, Yuma, Arizona	64
Arizona State Parks Board, Phoenix, Arizona	68
Arizona State Reclamation Association, Phoenix, Arizona	70
Arizona Water Commission, Phoenix, Arizona	75
Maricopa County Board of Supervisors, Phoenix, Arizona	76
Maricopa County Flood Control District, Phoenix, Arizona	77
Yuma County Board of Supervisors, Yuma, Arizona	78
Colorado River Board of California, Los Angeles, California	79
Department of Water and Power, The City of Los Angeles, Los Angeles, California	80
The Resources Agency of California, Sacramento, California	81
Clark County Comprehensive Health Planning, Las Vegas, Nevada	83
Colorado River Commission of Nevada, Las Vegas, Nevada	84
Museum of New Mexico, Santa Fe, New Mexico	85
New Mexico Department of Game and Fish, Santa Fe, New Mexico	103
New Mexico Interstate Stream Commission, Santa Fe, New Mexico	107
State of New Mexico Environmental Improvement Agency, Santa Fe, New Mexico	108
Arizona Water Sports Council, Phoenix, Arizona	111
Arizona Wildlife Federation, Phoenix, Arizona	117
Museum of Northern Arizona (Colorado Plateau Environmental Advisory Council), Flagstaff, Arizona	119
Sierra Club, Tucson, Arizona	121
State Chairman of Environmental Quality Programs for League of Women Voters, Sedona, Arizona	142

Letter	Page
Native American Rights Fund, Boulder, Colorado	144
Four Corners Regional Commission, Farmington, New Mexico	155
National Resources Defense Council, Inc., Washington, D.C.	155a
DNA - A Legal Services Program, Chinle, Arizona	156
Frank Welsh, P.E., Tempe, Arizona	159
Dr. Bruce J. Hayward, Associate Professor of Biological Sciences, Western New Mexico University, Silver City, New Mexico	162

CHAPTER I

DESCRIPTION OF THE PROPOSAL

I. DESCRIPTION OF THE PROPOSAL

A. Introduction 68,69,70,199

The Central Arizona Project (CAP) was authorized for construction under Public Law 90-537, 82 Stat. 885, approved September 30, 1968. The CAP is a multipurpose water resource development and management project which will provide supplemental water to central Arizona and western New Mexico. Improvement of the water conveyance facilities and construction of new storage facilities within the two states will also allow more efficient management of the total water resource. Benefits also will accrue to the two states and the Nation in the functional areas of water conservation, flood control, recreation, and fish and wildlife resources. However, there will be environmental costs, largely defined in terms of loss of wildlife habitat and reduction in numbers and diversity of certain wildlife species in the project area. The project area is generally located within the 50,900-square-mile drainage area of the Gila River and its principal tributaries from above Painted Rock Dam in Arizona, to the upper reaches of the Gila River in southwestern New Mexico. Major features of the project are shown on the frontispiece map.

This environmental statement on the overall project is submitted in compliance with the National Environmental Policy Act of 1969 (83 Stat. 852, 42 U.S.C. 4321, et seq.), the Council on Environmental Quality Guidelines (36 F.R. 7724, April 23, 1971), Department of the Interior regulations (36 F.R. 19343, October 2, 1971), and Bureau of Reclamation directives (37 F.R. 1126, January 25, 1972). This statement describes the existing conditions which create a need for the project, the objectives of the project, the legislative guidelines and requirements, physical features and operations of the project, the description of the environment, and the evaluation of environmental impacts.

This statement does not cover the environmental effects of the Navajo Project, authorized under Section 303 of Public Law 90-537, which will provide electric energy for pumping requirements of the project. The Bureau of Reclamation will use 24.3 percent of the Navajo Generating Station capacity. The remaining capacity of the plant will be used by other power users. A final environmental statement for the Navajo Project was filed with the Council on Environmental Quality (CEQ) on February 4, 1972. Neither does this statement cover Section 306 of Public Law 90-537 which relates to water salvage and ground-water recovery programs, which in part have been accomplished through other Federal programs and private clearing of riparian vegetation for agricultural and recreational purposes.

Initial construction of the CAP is scheduled to begin in 1972 with project completion tentatively scheduled in 1982. In view of the time required to construct the project, individual environmental statements for major features of the project will be prepared during assembly of field design data prior to initiation of construction on the respective

components. These major features are defined in this statement as: Orme, Buttes, Charleston, and Hooker Dams and Reservoirs; and the Granite Reef, Salt-Gila, Tucson, and San Pedro Aqueducts. The Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel are the initial works of the Granite Reef Aqueduct but are considered a major feature of the project. Discussion of transmission lines, communication systems, distribution systems, drainage facilities, and other features will be incorporated into the discussions of major features. The individual statements will be distributed for review and comment. This will insure that cumulative environmental aspects will be kept current and any changes that occur in present conditions at the feature sites will be fully considered. The first individual draft environmental statement (DES 72-40) for a major feature - the Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel - was filed with CEQ on March 7, 1972

A list of references used in preparation of this statement is included in the Appended Material. These references refer to documents covering engineering, economic, contractual, legislative, environmental, and sociological matters. They were, however, too many in number and too large in volume to include as part of this statement. These references are referred to throughout this statement by the number which corresponds to the number assigned each of them on the list in the Appended Material.

B. Problems in Central Arizona and Western New Mexico Related to the Project 1,2,3,7,65,74,130,145,198

In 1971, the Comprehensive Framework Study for the Lower Colorado Region was completed and published. The main report with its 16 supporting appendices was compiled by 16 Federal and five state agencies involved in economic and social research and resource planning of the region. The study covered the needs of the region and the subregions of which the Gila River subregion in essence encompasses the service area of the CAP. The report describes the land and water resources and the needs of the people associated with the growth that can reasonably be anticipated in the Lower Colorado River Basin. From the study, the needs were found to be: agricultural production at approximately the present level; continued production of mineral resources - principally copper; additional recreational and fishing facilities to overcome the present deficit and partially meet the projected deficit; flood control; electric power; forest products, wildlife and range livestock forage; soil and erosion control; sediment reduction; and additional water conservation and control which can be accomplished by increased storage capacity and reclamation of waste water effluent. The Framework Study substantiated and updated many earlier investigations by the Bureau of Reclamation concerning the problems and needs of the project area.

Most of the problems are centered in the Phoenix and Tucson metropolitan areas; Pima, Pinal, Cochise, and Maricopa Counties, Arizona; and Grant County, New Mexico. Specific problems in the CAP area are described in greater detail in the following paragraphs.

1. Early in the formulation period, the CAP was considered as a partial solution to the water problems of the agricultural economy which then predominated in the state. Arizona has some 30 million acres of potentially irrigable land and a favorable crop growing climate. Water is the resource which has limited Arizona's agricultural productivity. Irrigators have developed land beyond the safe-yield capability of the water supplies, and thus an overdraft situation has resulted, i.e., more water is being consumed each year than is being added to the natural supply.

Over the years the project area has also become attractive for other developments. The capacity of modern air conditioning to overcome the discomfort to man of living in a desert environment contributed to the influx of new industries and new residents to the state. From 1940 to 1970, the population of the three counties which make up the anticipated central service area in Arizona increased from 288,000 to 1,389,000. New water uses and water problems are developing with this population growth.

The largest cities, Phoenix and Tucson, have experienced most of the growth in the area. In the Phoenix area, most of the urban expansion has been onto irrigated farmland, and a conversion from agricultural use of water to municipal and industrial use is accommodating most of these new water needs. In the Tucson area, urban expansion has been almost entirely on desert lands. New water requirements are being met by additional withdrawals from ground water. As expansion takes place, there has developed a concern that the central Arizona urban complex will find itself in a water-short situation in the near future even though this complex could sustain itself under reoriented economic, esthetic, and ecological conditions by the purchase of irrigated agricultural lands and water rights and transfer of the water acquired from the retired agricultural lands. As the result of the increased importance of the municipal-industrial complex as a water consumer, the agricultural water problem in central Arizona has compounded into an urban-agricultural problem.

Over 60 percent of the water used in the central Arizona area is being produced from underground sources. An average annual withdrawal in recent years of about 3.8 million acre-feet has produced an estimated overdraft of about 2.1 million acre-feet per year.

The water level declines associated with this overdraft are widespread throughout the project service area. Total decline of over 300 feet has been recorded in some areas of Maricopa and Pinal Counties from the early 1920's to the mid-1960's (see Figure 2). Declines of over 100 feet have occurred near Marana in the period 1940-1965 and have reached as much as 75 feet in the metropolitan Tucson area (see Figure 3). Average yearly declines during the most recent periods for basins within the service area range from about 2 feet to nearly 14 feet per year as

shown in Table 1. Considering that costs of pumping ground water average 3 cents per acre-foot per foot of lift in the service area, declines of the magnitudes shown in Table 1 cause increases in costs of pumping water of 5 to 40 cents per acre-foot per year. Total depths to ground water range from 20 to over 500 feet in the project area (see Figure 4).

Associated with this continued ground-water decline is land subsidence which has also become a major problem. About 1,000 square miles in the project area have been affected. The areas most severely affected are the agricultural areas dependent on ground water in Pinal County where the subsidence has exceeded 7 feet during the last 20 years. Earth fissures which accompany land subsidence occur primarily along the periphery of the subsiding areas and are often miles in length. Until ground-water overdraft can be alleviated, damages can be expected to continue and the area affected by subsidence can be expected to increase. Subsidence is a real concern in evaluating long-range water resource needs and further exploitation of this underground water resource.

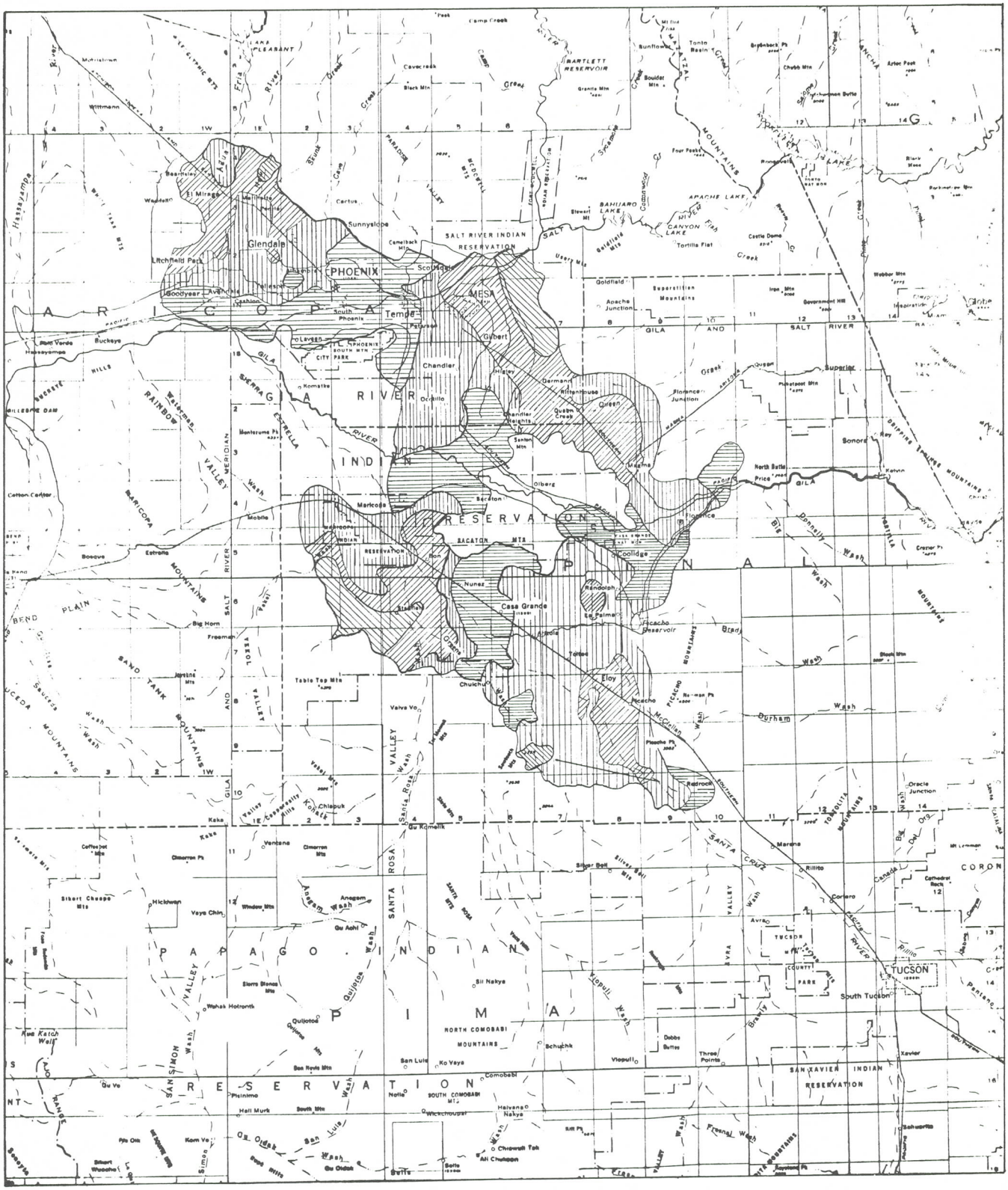
Indicative of the water users' attempts to provide an end to the ground-water overdraft condition and to provide for long-range water requirements are the expressions of interest in contracting for CAP water. A summary of these expressions which are being used as a guide for project water allocation and contracting purposes for the project service area is tabulated in Table 2. The total quantity of water in the expressions of interest is over 5.3 million acre-feet annually which is more than four times the long-range amount estimated to be available from the CAP.

Some of the requests have been for additional uses along the Colorado River, and if served may not be directly associated with the project.

2. Serious flooding occurs in the Phoenix metropolitan area which disrupts the highway system and the economic and cultural life of the communities. Interruption of air transporation has also occurred from flood damage to the Phoenix Sky Harbor International Airport runway. Necessary extension of the primary runway cannot be accomplished until provisions are completed to control the floodflows in the Salt River. Flooding also damages lands and property in the vicinity of Florence and on the Gila River Indian Reservation.

3. Sediment transported as bedload under low flow conditions and additionally as suspended sediment under floodflow conditions in the rivers creates costly operation and maintenance problems in the canal systems and at the diversion dams of the Salt River Project and the San Carlos Indian Irrigation Project.

4. Water-oriented recreational opportunities are not distributed throughout the service area in a manner which effectively serves the present population. In the recently completed Comprehensive Framework Study, this geographic imbalance of supply and demand was cited as a major recreation problem. Distances between urban centers and recreational sites have the effect of denying water-based recreation experience to

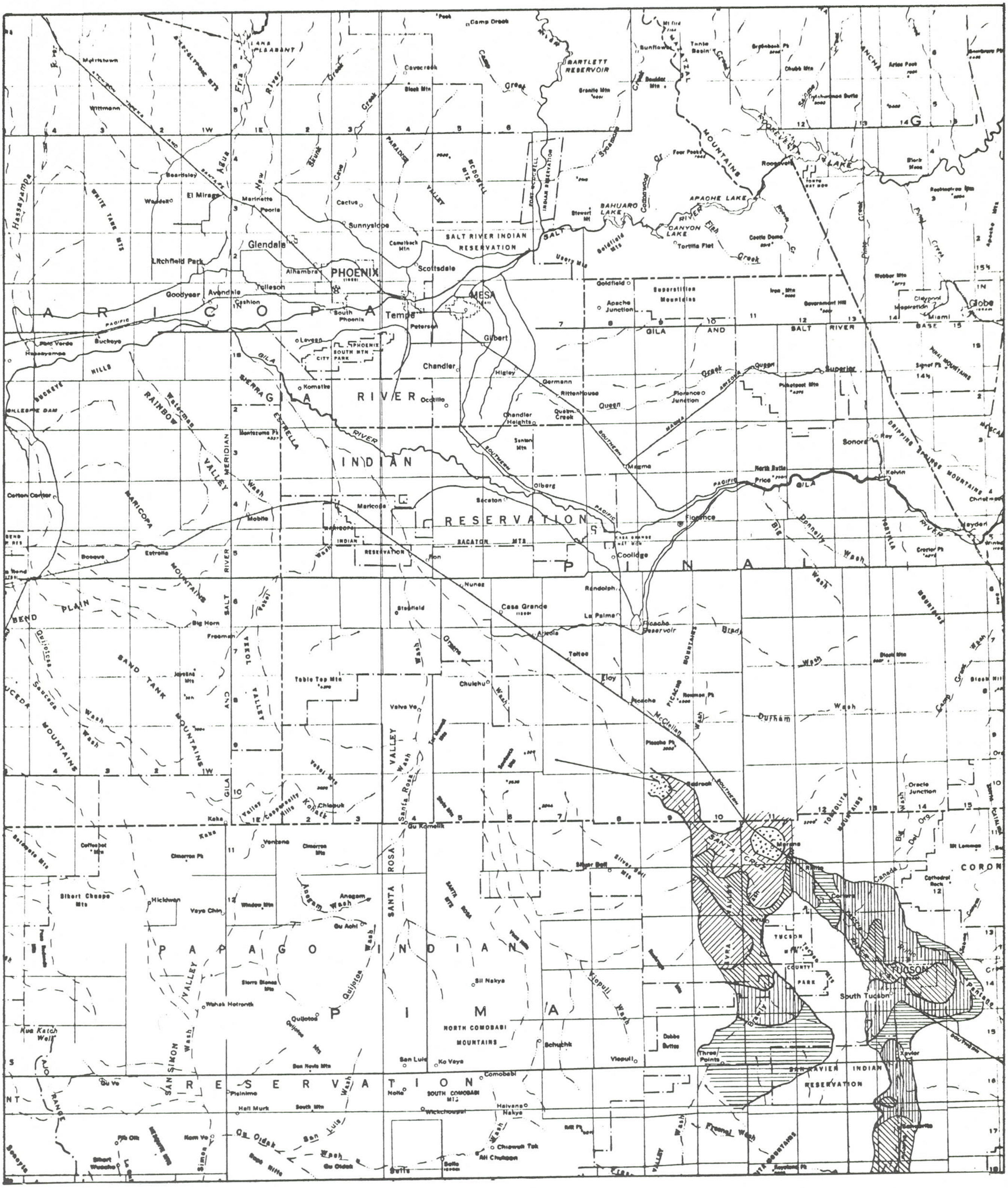


Explanation

0 to -100 feet
-100 to -200 feet
-200 to -300 feet
-300 and over

GROUND-WATER LEVEL DECLINES,
Spring 1923 Through Spring 1964
(Provided by the Arizona Water Commission)

Figure 2



Explanation

- 0 to 25 feet
- 25 to 50 feet
- 50 to 75 feet
- 75 to 100 feet
- 100 and over

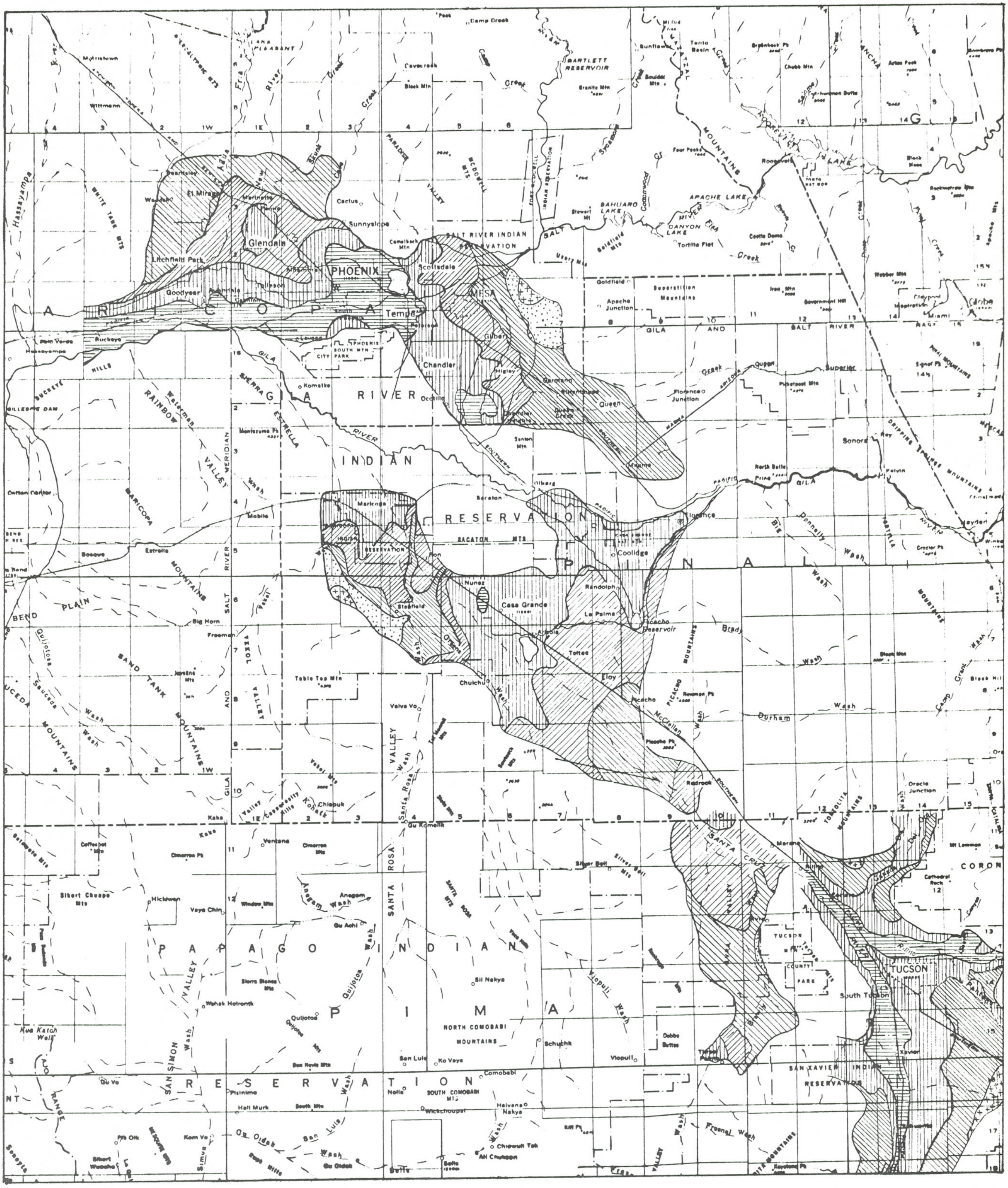
GROUND-WATER LEVEL DECLINES
1940 - 1965

(Provided by the Arizona Water Commission)

Figure 3

TABLE 1
AVERAGE YEARLY DECLINES OF GROUND WATER FOR BASINS IN CENTRAL ARIZONA

Modeled Area	Period	Total Average Decline Within Basin (Feet)	Average Yearly Decline (feet per year)
Tucson Basin	62-70	41	5.1
Avra Valley	65-70	61	4.1
Harquahala	58-67	124	13.7
McMullin Valley	59-66	36	5.1
Rainbow Valley	52-66	63	4.5
Central Arizona	57-64	57	8.1
Salt River Valley	64-69	9	1.8



Explanation

0 to -100 feet
-100 to -200 feet
-200 to -300 feet
-300 to -400 feet
-400 to -500 feet
-500 and over

DEPTH TO WATER
1964/1966
(Provided by the
Arizona Water Commission)

Figure 4

TABLE 2
SUMMARY OF EXPRESSIONS OF INTEREST IN CONTRACTING FOR
CENTRAL ARIZONA PROJECT WATER

	Irrigation		M&I		Total	
	No.	af/yr	No.	af/yr	No.[1]	af/yr
Arizona						
Direct Service[2]	26	2,658,173	24	992,146	50	3,650,319
Indian Reservation	5	1,111,168	3	108,000	5	1,219,168
Exchange Areas	7	208,839	8	170,714	11	379,553
Subtotal Arizona		3,978,180		1,270,860		5,249,040
New Mexico[2]	23	25,442	10	39,697	33	65,139[3]
TOTAL		4,003,622		1,323,150[6]	103[4]	5,326,772[5]

1/ Because of submittal for both irrigation and M&I water, total is not additive of separate request.

2/ Some entity areas overlay other entities and have not been reconciled.

3/ Priorities within New Mexico's 304(f)(1) (18,000 af/yr) and 304(f)(2) (additional 30,000 af/yr after Colorado River augmentation) have not been designated.

4/ Total number of expressions received and acknowledged, and includes duplication by Bureau of Land Management and New Mexico Interstate Stream Commission.

5/ Received through December 31, 1971.

6/ Includes requests for 208,400 af/yr of water for recreation and fish and wildlife purposes.

many people. The required expenditures of time and money to visit these sites are beyond their means. While the Tucson and Phoenix urban areas suffer most from this problem, other areas such as western New Mexico and southern Pinal County, Arizona, are affected to a lesser degree.

Future demand for recreation is also an important consideration. Discounting the geographic imbalance of supply and demand, the total regionwide resources for water-based recreation are currently statistically adequate. However, future demand as a function of population growth will far surpass the statewide supply if steps are not taken to expand recreational opportunities. The Comprehensive Framework Study[1] forecasts that water-based recreation demand will increase more than sixfold in Arizona from a 1965 level of 40 million user days to a 2020 level of 250 million user days.

5. The Salt River Pima-Maricopa Indian Community, the Gila River Indian Community, the Ak-Chin Indian Community, and part of the Papago Indian Community do not presently receive or have available sufficient water to meet their needs or their desires for social and economic improvement. A water supply from the project for industrial, recreational, and agricultural purposes would, in part, meet these needs. These Indian communities which can be served from the aqueducts of the CAP have submitted expressions of interest for 83,000 acre-feet of M&I water and 1,019,168 acre-feet of irrigation water. The Fort McDowell Yavapai-Apache Indian Community, being above the aqueducts, would receive its allocated water from Verde River flows or Orme Reservoir storage.

6. Quality of ground water in central Arizona varies by area and with depth depending primarily upon the mineralogical makeup of the aquifer from which water is pumped. The production wells in the project area typically produce water ranging from 300 ppm to 4,500 ppm total dissolved solids (TDS). Figure 5 shows the distribution by townships of the yearly pumpage for 1965 and the mineral content of the water. In a large part of the area, the dissolved solids exceed the U. S. Public Health Service recommended maximum concentration of 500 ppm in domestic supplies. Most of the major irrigation supplies would constitute a medium to high salinity hazard to irrigated crops according to the U. S. Salinity Laboratory classification system. The average total of the dissolved solids for 1965, as pumped from ground water in the CAP service area, was 955 ppm.

In some areas where there is continual pumping of ground-water reserves, the quality of the ground water has deteriorated. This is becoming a serious concern particularly as it relates to adverse effects on agricultural productivity and the suitability of the water for drinking and other purposes.

Several graphs of mineral content in the ground water versus time were prepared as a part of a study from which the data in Table 3

were obtained. These graphs are not reproduced in this statement. However, a discussion of the shape of the graphs is presented for illustrative purposes. Most of the graphs show a general decline in total dissolved solids (from the initial concentrations of the 1920's and 1930's) beginning in the late 1940's and the early 1950's. In the late 1950's and early 1960's, the concentrations usually began to slowly climb. The decline in concentrations beginning in the late 1940's corresponds with a sizable increase in pumpage and a large drop in water table levels in the area. Thus, the "as pumped quality" suggests that the water in the upper layers of the water aquifers was inferior to the quality of the water in aquifers at intermediate depth. The increase in total dissolved solids beginning in the late 1950's suggests that as water levels continue to drop beyond the intermediate aquifers, poor quality water found at the deeper depths is influencing the water quality of the pumped water.

7. Demands exist in New Mexico for water to support mineral resource development, agricultural production, water-oriented recreation, and wildlife management. Expressions of interest from potential users of project water in New Mexico total 65,139 acre-feet per year. Public Law 90-537 limits use of project water in New Mexico, through exchange, to 18,000 acre-feet per year. At such time as the Colorado River is augmented to take care of the Mexican Water Treaty and additional water is diverted to central Arizona and is available for exchange, this limit is increased to 30,000 acre-feet per year.

C. Objectives of the Central Arizona Project 4,193,196

The primary objective of the CAP is to deliver most of Arizona's remaining entitlement of Colorado River water to cities, industries, and farms in central Arizona. Other project benefits are:

1. To reduce the overdraft of ground water in central Arizona to the maximum extent possible by substituting most of Arizona's remaining entitlement in the Colorado River for a portion of the current ground-water overdraft.

2. To provide a supply of water for municipal and industrial uses in areas that have no surface-water rights available and are presently using an overdrafted ground-water resource, or a source of lower quality.

3. To provide supplemental water for sustaining the agricultural resource over a longer period of time than would otherwise be possible.

4. To conserve floodflows of the Gila River system to the maximum extent practicable by the inclusion of conservation capacity in Orme, Buttes, Charleston, and Hooker (or alternative) reservoirs.

5. To provide flood protection to various developments located downstream from the Orme, Buttes, Charleston, and Hooker Dams. Among

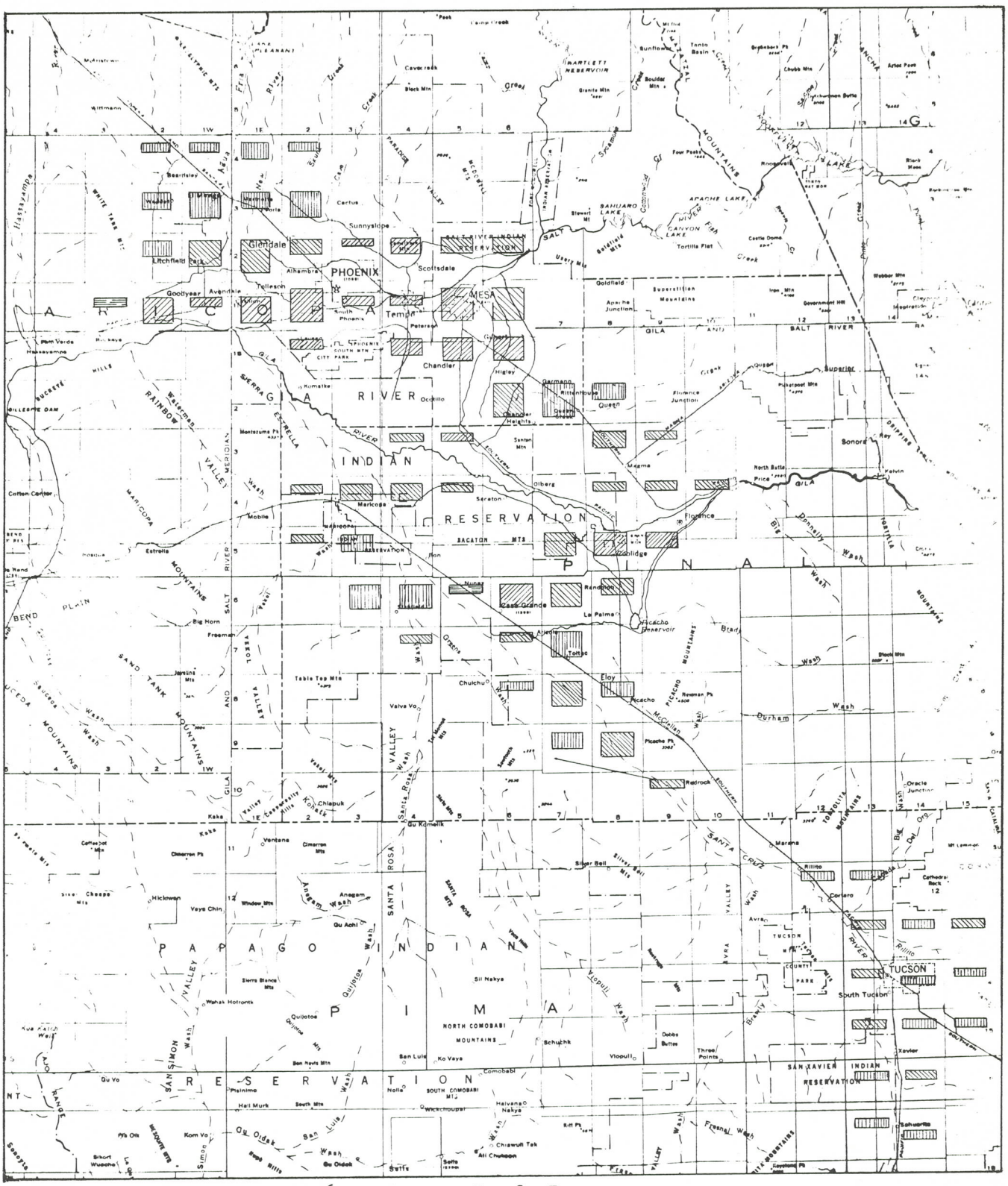

PHOENIX
MESA
Glendale
Scottsdale
Tempe
Chandler
Sunnyslope
Litchfield Park
Goodyear
Avondale
Tolleson
Buckeye
Gila River Indian Reservation
Salt River Indian Reservation
Ak-Chin Indian Reservation
Papago Indian Reservation
San Xavier Indian Reservation
Casa Grande
Coolidge
Florence
Eloy
Maricopa
Sacaton
Superior
Globe
Miami
Tucson
South Tucson
Oracle Junction
Marana
Red Rock
Picacho Reservoir
Apache Lake
Canyon Lake
Bartlett Reservoir
Roosevelt Lake
Gila River
Salt River
Santa Cruz River
Rillito River
Queen Creek
Superstition Mountains
Picacho Mountains
Santa Rosa Mountains
Sierra Estrella Mountains
Maricopa Mountains
Sacaton Mts
Table Top Mts
North Comobabi Mountains
Tortolita Mts
Santa Catalina Mts
Rincon Mts
Dissolved Solids - 1965
3000 ppm
1010-3000 ppm
500-1000 ppm
500 ppm
Average Yearly Pumpage
(In 1,000 acre-feet)
0-20
20-40
40-60
60-120
INDEX OF YEARLY
GROUND-WATER PUMPAGE
(Provided by the
Arizona Water Commission)

Figure 5

TABLE 3
DISSOLVED SALTS CONCENTRATION IN THE
GROUND WATER IN VARIOUS AREAS OF ARIZONA

Area	Date	Quality (ppm-TDS)	Date	Quality (ppm-TDS)
Salt River	1946	1,138	1965	1,120
Eloy	1941	304	1960	229
Casa Grande	1941-48	728	1960	572
Maricopa-Stanfield	1941-48	390	1960	526
Gila River	1941-48	1,070	1960	975
Tucson	--	--	1965	459

the more significant features to be protected would be the surface and air transportation systems below Orme Dam in the Phoenix metropolitan area and the Fred J. Weiler Greenbelt on the Gila River. Storage at Orme Dam will also minimize the need for the alternative of a wide flood channel between Granite Reef Dam and Gillespie Dam. The Paradise Valley Detention Dam to be located above the Granite Reef Aqueduct will help reduce major flooding from along Indian Bend Wash through Paradise Valley north of Phoenix, Scottsdale, and north Tempe. CAP facilities will be coordinated with the two Corps of Engineers projects that have been authorized for the Salt and Gila Rivers and tributaries to the Salt and Gila Rivers in Phoenix and the Phoenix metropolitan area.

6. To more fully control and manage surface and ground waters already available within the central Arizona area and southwestern New Mexico.

7. To provide the central Arizona Indian communities with new economic and social stimulation which will accompany project deliveries of water.

8. To provide sediment control to those water systems diverting from the Salt and Gila Rivers that are now subject to unusually high operating expenses at diversion works, canal systems, and water treatment plants.

9. To alleviate the current geographical imbalance and the anticipated future demand of readily available water-oriented recreational opportunities, and to promote effective fish and wildlife management areas through water exchange.

10. To provide exchange water for water users within Arizona and to Arizona users for additional Gila River depletions in the State of New Mexico to be contracted for under provisions of Section 304(d), (f)(1), and (f)(3), Public Law 90-537. These exchanges will enhance the economic development potential of service areas outside the central service area.

11. To manage project waste water.

12. To improve distribution system efficiency by providing adequate irrigation distribution systems.

D. Legislative History and Requirements 5-11,13

1. Legislative History

At the request of the Colorado River Basin States (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming), Congress passed an Act on August 19, 1921, giving consent to the states to negotiate and enter into a compact for the equitable apportionment of the water supply of the Colorado River. This agreement, known as the Colorado River Compact was signed in Santa Fe, New Mexico, on November 24, 1922. The Compact divides the entire Colorado River Basin into two parts, the Upper Basin and the Lower Basin, separated at a

point on the river in northern Arizona known as Lee Ferry. Article III(a) of the Compact apportions to the Upper Basin and to the Lower Basin in perpetuity the exclusive beneficial consumptive use of 7,500,000 acre-feet each of water per year from the Colorado River system. Article III(b) apportions an additional 1,000,000 acre-feet annually for beneficial use to the Lower Basin.

In 1928, Congress passed the Boulder Canyon Project Act authorizing construction of the Boulder Canyon Project. The Act and its subsequent amendment by the Boulder Canyon Project Adjustment Act directed the Secretary of the Interior to make investigations and publish reports of the feasibility of projects for irrigation, generating electric power, and other purposes in the States of California, Arizona, Nevada, Colorado, New Mexico, Utah, and Wyoming.

In 1944, the Bureau of Reclamation and the State of Arizona entered into a contract for the expenditure of $400,000 for a cooperative investigation of the utilization of Colorado River water in Arizona. This investigation resulted in the Central Arizona Project Report which was submitted to the Secretary of the Interior on December 19, 1947. The Secretary's findings relative to CAP were submitted to Congress in September 1948. Preliminary hearings on the project were actually started in 1947 in the Senate and House of Representatives in advance of submittal of the report. A favorable vote on the project (52-28) was obtained in the Senate, but in 1951 the House Committee on Interior and Insular Affairs postponed action until such time as Arizona's right to the use of Colorado River water was adjudicated or settled by other means.

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 v. California confirmed Arizona's entitlement to 2,800,000 acre-feet annually of the first 7,500,000 acre-feet of Colorado River mainstream flow available to the three Lower Basin States plus 46 percent of flows in excess of 7,500,000 acre-feet.

On June 4, 1963, the day following the Supreme Court opinion, bills to authorize CAP were introduced in both Houses of Congress. From this time through 1968, many additional bills and amendments were introduced proposing different versions of the CAP, and hearings were held yearly.

The most significant bills considered were:

a. S.1658, introduced June 4, 1963.
b. H.R. 4671, introduced February 9, 1965.
c. H.R. 3300, introduced January 23, 1967.
d. S.1004, introduced February 16, 1967.

Different versions of the CAP were passed by the United States Senate (S.1004, August 7, 1967) and the House of Representatives (H.R. 3300, May 16, 1968). S.1004 cleared a conference committee on August 1, 1968, and was approved by both House and Senate. The compromise version became Public Law 90-537 with the approval of President Johnson on September 30, 1968.

During the long legislative history of the CAP, many environmental issues were examined by various Congressional committees. Persons and groups demanding that environmental consequences of the project be considered, presented their views to a responsive Congress. Hualapai (Bridge Canyon) and Marble Canyon Dams on the Colorado River were dropped from the project as a result of opposition from environmental groups. A decision was made by the Congress and the Department of the Interior that a thermal electric generating station was a feasible alternative to provide pumping energy and financial assistance to the project.

In consideration of environmental concerns over effects of the dams on the Grand Canyon area, the Secretary of the Interior directed the Bureau of Reclamation to reevaluate and study all possible power alternatives for the project. Studies led to a recommendation that the Federal Government participate with public and private power utilities in the development of a large coal-fired thermal power unit which later became known as the Navajo Generating Station. It was this revised power development program and recognition of the Mexican Treaty obligation as a National responsibility which provided the final catalyst for quick Congressional approval and authorization of the project.

Agency and Congressional awareness of and response to environmental issues also resulted in language in the authorizing legislation which provides for further study of alternatives for Orme and Hooker Dams.

2. Legislative Requirements

Public Law 90-537, the Colorado River Basin Project Act, authorizes construction of CAP subject to a number of specific requirements and restrictions. Generally, these conditions are imposed in order to assure that existing rights are protected or that operation of the project is consistent with National policies and preferred water management practices. The requirements relevant to this statement are listed below:

a. Protection of Current Rights to Water Affected by the Project

All contracts for project water will be subordinate to all rights to Colorado River water perfected at the time the Boulder Canyon Project Act became effective (June 25, 1929), all rights decreed by the Supreme Court in Arizona v. California, and all contracts made pursuant to the Boulder Canyon Project Act between the Secretary of the Interior

and Arizona, California, and Nevada users existing at the time of authorization. Indian water rights not adjudicated in Arizona v. California will also be protected. Additionally, Buttes Dam and Reservoir shall be operated so that rights of users under the Gila Decree (Globe Equity Numbered 59) are not prejudiced. The operation of Hooker Dam and associated diversions from the Gila River will be subject to the availability of exchange water from the Colorado River and the absence of economic injury to downstream contractors of the Gila River system in Arizona. In times of shortage or reduction of project water, users which have yielded water from other sources for project water will have a first priority to receive the supply available from the project. A further stipulation is made that CAP diversions from the Colorado River shall be limited so that California diversions can be maintained at 4,400,000 acre-feet annually. Nevada is not required to share shortages in any proportion greater than would have been imposed in the absence of the 4,400,000 acre-foot priority to California.

b. Protection of Indian Reservations

Section 302 of Public Law 90-537 delineates the conditions which must be met relative to obtaining Indian lands for project use. The Secretary of the Interior must offer to pay fair market price for all lands and improvements required for project purposes. Authorization to pay relocation expenses is also included. If the Secretary is unable to purchase the land and improvements, they may be obtained through eminent domain proceedings. Owners of land acquired under the provisions of Section 302 retain the right to use or lease the land for purposes not inconsistent with the project. In addition to monetary compensation for the Indian lands obtained from the Fort McDowell Indian Reservation, the Secretary must add to the reservation 2,500 acres of nearby and suitable land so that a reasonable land base will be maintained for the reservation. The affected Indian communities shall have the right, under a plan approved by the Secretary of the Interior, to develop and operate recreational facilities at Orme Reservoir located on or adjacent to their communities.

c. Provisions Regarding Irrigation of Lands and Irrigation Systems

Congress imposed certain operational and contracting requirements upon the project. Public Law 90-537 requires that (1) project water not be made available for irrigation of lands that do not have a recent history of irrigation, except in the case of Indian lands, and fish and wildlife refuges and management areas; (2) controls must be in effect which prohibit the expansion of irrigation from aquifers affected by the project; (3) canals and distribution systems transporting project water must be lined to prevent excessive losses; (4) for a period of 10 years from the date of enactment, no water can be delivered for the production of surplus crops on newly irrigated lands; and (5) no ground water may be exported from the service area unless a surplus of ground water exists and drainage is required.

d. Provision for Development in Western New Mexico

Public Law 90-537 provides that, to the extent it can be accomplished without economic injury to the holders of downstream water rights, New Mexico can increase its consumptive use on the Gila River by an average of 18,000 acre-feet per year above the amount in the decree in Arizona v. California. This increase requires an exchange system in which Arizona users of project water who are also users from the Gila River make their Gila River rights available for use in New Mexico.

E. Description and Function of the Project 7,10,75,173,174

In general, the Gila River Basin with its principal tributaries from above Painted Rock Dam to the upper reaches of the river in southwestern New Mexico will be the area of principal benefit from the project. This area encompasses the metropolitan areas of Phoenix and Tucson and the large agricultural complex located primarily in Maricopa, Pinal, and Pima Counties in central Arizona. It is to these areas in central Arizona that direct delivery of Colorado River water can be made. Communities and agricultural areas located in and adjacent to the upper Gila River watershed primarily in Grant County, New Mexico, may also receive the additional water made available through exchange agreements between the project and central area water users in Arizona. Water will also be delivered to Tucson from the proposed Charleston Dam and Reservoir in Cochise County, Arizona. Agricultural areas in the San Pedro River Basin located below the proposed dam will obtain better regulation and control of riverflows, and may also receive additional water supplies on a usable schedule. In addition, exchange water has been requested which would permit an increase in outdoor recreation and fish and wildlife enhancement through development and operation of upstream lakes on tributaries of the Gila River system.

Approximately 54,000 acres of right-of-way will be required to constructed the project, which will take about 10 years to complete at a total authorized 1968 index cost of $832,180,000, plus or minus such amounts as may be justifed by reason of ordinary fluctuations in construction costs.

Almost all the direct project service area in central Arizona lies between 900 and 2400 feet above mean sea level. The valley floors in the upper Gila River Basin range in elevation from 2500 to 5000 feet and those of the San Pedro from 2500 to 4000 feet. The higher woodland exchange areas in the Salt, Verde, and Gila River watersheds in Arizona generally range from 4000 to over 10,000 feet in elevation.

1. General Project Description

The physical facilities of the project will extend outside the boundaries of the central service area. Primary facilities to convey

Colorado River water into Maricopa, Pinal, and Pima Counties in central and southcentral Arizona will be the proposed Granite Reef, Salt-Gila, and Tucson Aqueducts. From the Lake Havasu diversion facilities in Yuma County, Arizona, this backbone aqueduct system will traverse over 307 miles in a general southeasterly direction through the sonoran desert region of Arizona to a point just north of Tucson. Granite Reef Aqueduct will connect Lake Havasu with Orme Dam and Reservoir northeast of Phoenix at the confluence of the Salt and Verde Rivers. It will also connect with the Salt-Gila Aqueduct which will terminate at the Marana Reservoir near Marana, Arizona, in the southcentral service area northwest of Tucson. The Tucson Aqueduct will then carry water to its terminal point north of Tucson, where it will connect with the existing water system. The elevation along this route will vary from 450 feet above mean sea level at Lake Havasu, to over 2200 feet near the terminal point of the Tucson Aqueduct.

The four project dams - Orme, Buttes, Charleston, and Hooker - will all be located adjacent to or outside the direct water service areas of the project. Secondary canal and pumping systems will be constructed to link the proposed project reservoirs at the Orme, Buttes, and Charleston sites to the project service area. The direct connection of Orme and Buttes Reservoirs to the Colorado River conveyance system will allow deliveries of local water supplies to be coordinated with those of imported Colorado River water. The proposed Hooker Dam and Reservoir will provide a facility to conserve waterflows on the upper Gila River so that exchange agreements with western New Mexico water users can be effectuated.

2. General Project Operation 3,6,9,12,13,115

The Colorado River will be the major source of CAP water. Releases from Glen Canyon Dam will be governed by coordinated long-range operation criteria, as required by Public Law 90-537. Glen Canyon releases and intervening inflow between Glen Canyon Dam and Lake Mead are regulated by Hoover Dam, which is operated under provisions of the Boulder Canyon Project Act and the Boulder Canyon Project Adjustment Act. Releases from Hoover Dam are made to meet contractual commitments to water users in Arizona, California, and Nevada, including water rights as stipulated in the Supreme Court decree in Arizona v. California and the obligations of the Mexican Water Treaty.

The annual Colorado River diversion to central Arizona will range from an estimated minimum of 0.38 million acre-feet during extreme drouth to the designed capacity of about 2.2 million acre-feet during periods of surplus water availability. The project will deliver a long-term average of about 1.2 million acre-feet annually. The Secretary of the Interior, working with state agencies, conservation and irrigation districts, and within the state water law structure, will make specific water allocations and subsequent contracts based on the availability of Colorado River water and the local water-supply conditions and needs.

Through hydrologic coordination and water exchange provisions, vital and essential basin-wide water uses will be possible, including new water resource development in western New Mexico. Final operational criteria will be established for the aqueduct system from coordinated operation studies of the entire Colorado River and Gila River systems during the preparation of the definite plan report, water service contract negotiations, and preparation of standard operating procedures.

3. Description and Function of Key Features in the Project

a. Havasu Intake Channel, Pumping Plant, and Buckskin Mountains Tunnel 70,115,116

As required by Public Law 90-537, water for the Central Arizona Project will be diverted from Lake Havasu on the Colorado River. This will be accomplished by the construction of an intake channel within the Bill Williams arm of Lake Havasu, a landform embankment structure to protect the channel from sediment deposition, a single-lift pumping plant on the shore-line, two discharge lines from the plant, and a tunnel through the Buckskin Mountains to the Granite Reef Aqueduct canal section. Some 200 acres will be involved in construction. The choice of components was made after a study of alternative methods for water diversion into Granite Reef Aqueduct. These alternatives are discussed in Chapter VIII and in the draft environmental statement for this feature. Alternative locations for the delivery system were concurrently studied and are also discussed.

(1) The Intake Channel 101

Water will be drawn from Lake Havasu at a point on the south shoreline of the Bill Williams arm approximately 2-1/2 miles upstream from Parker Dam and about 20 miles northeast of Parker, Arizona. The channel and the pumping plant will be located in Sections 14 and 23, T. 11 N., R. 18 W., GSRB&M. The intake channel will be located within the boundaries of the Havasu National Wildlife Refuge, which was created by Executive Order 8647 on January 22, 1941, and enlarged by Public Land Order No. 559 on February 11, 1949, and embraces lands withdrawn specifically for Bureau of Reclamation purposes on January 31, 1903; September 8, 1903; and June 4, 1930.

The intake channel is necessitated by the heavy sediment flows from the Bill Williams River which would cause excessive wear on

the pumping plant machinery. The intake channel will be formed with a landform embankment structure, constructed by loading and displacing low-density delta deposits by end-dumped fill obtained from the required excavations for the pumping plant, discharge lines, and tunnel. The embankment will be nonuniform in cross section and alinement and is designed to approximate the configurations and colorations of the natural peninsulas that finger out from the Buckskin Mountains into Lake Havasu. The plan will preserve the natural and scenic value of the shoreline area. No excavation will be required across the shoreline finger ridges under this plan. This protection will reduce operation, maintenance, and replacement costs for the pumps.

The site of the intake channel was selected using sediment studies and several alternative location studies, and is placed so that the intake channel will not be adversely affected during the first 100 years by the estimated average annual sediment inflow of 170 acre-feet from the Bill Williams River. Sediment deposition studies for the Bill Williams arm of Lake Havasu were made in 1963, 1964, and 1968. Following completion of Alamo Dam, the studies were further revised during August 1970 to provide final design data for use in locating the Havasu pumping plant intake channel. Estimates indicate that sediment deposits on the south side of the lake will accumulate only to the bottom elevation of the channel by about year 2071. Sediment deposits will not result in the creation of a land bridge to Heron Island.

The intake channel, through which a maximum of 3,000 cfs will be drawn, will have a bottom elevation of about 424 feet. The landform embankment will have a minimum crest elevation of 456 feet, which is about 6 feet above the normal operational water surface elevation of Lake Havasu. Depending upon the amount of material available for the landform embankment, the development plan provides for varying the width and volume of the embankment. The length of the embankment from State Highway 95 may be from about 2,100 feet to about 3,200 feet. The top of the embankment will provide a 30-foot-wide access road, flanked by variable width, freeform expansions and riprap for wave protection. It will be available for maintenance and limited access foot travel for recreational use.

The landform embankment will be constructed by dumping excavated materials from the pumping plant site into the lake and allowing them to settle, displacing the low-density lake sediment now covering the bottom of the lake. This method of construction was selected on the basis of vane shear testing which indicates that the in-place shear strength of the soft silt clay sediment material ranges from about 0.5 psi at a depth of 25 feet below water surface, to 1.0 psi at a depth of 35 feet below water surface. This method of construction was used successfully in the construction of a highway across Candlestick Cove on the west side of San Francisco Bay. The displacement of sediment can be controlled by the shape of the embankment structure and rate of placing fill material.

The circulatory effect of project pumping will result in varying flow velocities within the intake channel. At the beginning of the channel, in the vicinity of the inlet, the flow velocity will approximate 0.5 foot per second. In the main portion of the intake channel between the inlet and the highway crossing, the flow velocity will drop to approximately 0.15 foot per second. Between the highway crossing and the pumping plant intake, the flow velocity will increase to approximately 1.3 feet per second. The above flow-velocity estimates are based on an operating level in Lake Havasu of 447.5 feet with an average channel depth of 23.5 feet, and an average main channel width of 1,000 feet. With lower or higher operating water levels, the flow velocities will increase and decrease respectively, but only to a minor extent.

(2) The Pumping Plant

The Havasu Pumping Plant will be a low profile structure selected for visual esthetic reasons. The top of the main structure will be flush with the surrounding surface area. The only visible parts of the structure will be a visitors' facility, a service building with a crane to handle pumping equipment, and transformers (either 2 three-phase or 4 single-phase units). The pumping plant will house six electric motor-driven 500-cfs pumps with a total capacity of 3,000 cfs. These pumps will raise Colorado River water 800 feet through the discharge lines to the inlet portal of the Buckskin Mountains Tunnel. Besides the basic low profile design of the pumping plant, the two 13-foot-diameter discharge lines running 3,000 linear feet up the hillside to the inlet portal will be buried and the backfill will be contoured to conform as nearly as possible to the original terrain.

Electricity will be furnished via the Parker Switchyard at Parker Dam to a small switchyard 1/2 mile from the pumping plant. The cable conducting electricity from the small switchyard to the pumping plant will be buried. However, the transmission line from the small switchyard to the Parker Substation will be aboveground. Architectural and landscape considerations have been included in the design for the facilities to maintain as nearly as possible the existing visual quality of the area. In addition, the small electrical switchyard will be equipped with improved-appearance pothead supports and takeoff structures. A portion of the existing Parker-Bagdad 69-kv powerline may be removed after construction of the pumping plant.

Adjacent to the pumping plant structure on the west end of the service yard, an energy dissipating structure and channel will be constructed to accommodate and divert floodflows from the drainage ravines coming into the pumping plant area. The disturbed areas above the pumping plant will be restored to their original appearance as nearly as possible. Figure 6 shows the Havasu Intake Channel and Havasu Pumping

Plant sites. Figure 7 shows an artist's conception of the constructed features in place.

The proposed pumping plant site is considered the most suitable site based on a combination of engineering and geological studies, foundation conditions, location studies for the discharge lines and tunnel, environmental considerations, and construction and operating costs. Selection of the present pumping plant site was further influenced by a geological study in the area completed in 1965 which recommended that the pumping plant be located on a foundation entirely of gneiss. Location of the plant on a sandstone foundation north of the gneiss-sandstone contact would be inadvisable due to the suspected low bearing strength and instability of the sandstone when saturated. The proposed site also accommodates a discharge pipeline profile having little, if any, side hill location and provides a shorter discharge line than any of the other locations studied. Site preparation for the pumping plant and power substation to the southeast of Arizona State Highway 95 will require excavation of approximately 750,000 cubic yards of material. Surface exposure of the excavated area will extend approximately 750 feet into the wash and adjacent ridges behind the highway. The maximum width of the general cut area will be about 600 feet. Depending on geological conditions, the cuts will be excavated at about 1:1 side slopes with berms incorporated into the deeper cuts.

Existing Highway 95 will serve as a natural cofferdam during construction of the pumping plant. The portion of the highway crossing the proposed intake channel will be excavated upon completion of the detour to handle traffic flow. This excavated section will be replaced with a precast, prestressed concrete-beam bridge with three spans and two piers. The design of the bridge will be compatible with the design of the pumping plant structure. The material from the excavation will be used as fill around the pumping plant. Additional fill material as needed will be obtained from the excavation for the discharge lines or the tunnel. Access to the pumping plant site will be a paved road east of the bridge and will include a visitor's parking lot. The construction road will be modified to provide this access to the pumping plant after completion of construction.

The Havasu Pumping Plant and the Buckskin Mountains Tunnel will be located within lands under Reclamation application for withdrawal for the CAP, Application Nos. AR 031307, dated February 19, 1962; A 997, dated May 17, 1967; and A 1267, dated August 24, 1967. Both of these structures are outside the existing boundary of the Havasu National Wildlife Refuge.

(3) The Buckskin Mountains Tunnel

The Buckskin Mountains Tunnel will be a 36,000-foot-long, concrete-lined structure with a 20-foot finished diameter and a

Figure 6

Site location of Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel (north portal) on south shore of Bill Williams Arm of Lake Havasu. Photograph No. P344-300-9851.

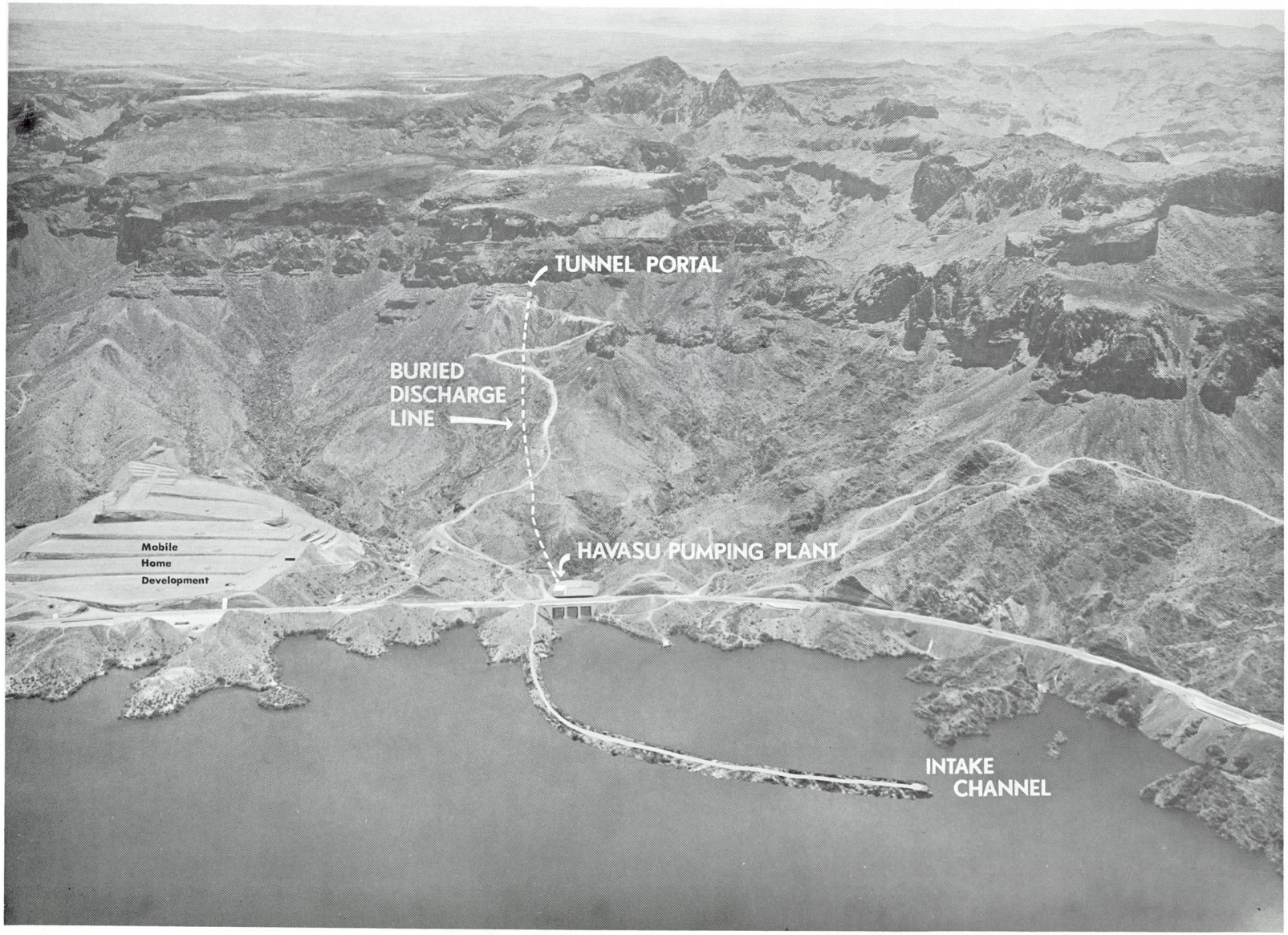


Figure 7

Artist's conception of Havasu Intake Channel, Havasu Pumping Plant and Buckskin Mountains Tunnel (north portal). Photograph No. P344-300-12523.

total slope of 33 feet between the inlet and the outlet portals. The tunnel will convey project water pumped from Lake Havasu for 6.9 miles through the Buckskin Mountains to an outlet portal near Osborne Wash for direct discharge into the Granite Reef Aqueduct canal section. The inlet portal, which will receive water pumped up the hillside in the two discharge lines, will be located approximately 20 miles northeast of Parker, Arizona, in Section 23, T. 11 N., R. 18 W., at approximately Elevation 1235. The outlet portal located near Osborne Wash will be in Section 30, T. 10 N., R. 17 W.

The tunnel inlet portal will be located at the foot of the vertical butte on the hill above the pumping plant. The cut needed for the structure will be kept to a minimum. The portal will consist of a concrete structure with a maximum height of 35 feet. A maintenance road will be constructed to provide access to the inlet portal. An effort will be made to utilize the alinement of existing jeep trails. There will be a small parking space to accommodate maintenance equipment near the mouth of the portal. The outlet of the tunnel will be a typical transition structure for a tunnel-to-canal system. Construction staging areas for the tunnel will be located near the tunnel portals. Temporary powerlines to the tunnel portals will be required to furnish electricity during tunnel construction. When the tunnel is completed, these lines will be removed and their paths obliterated. The tunnel will follow a southeasterly course for approximately 3,590 feet, then curve gently approximately 15 degrees and continue in a southeasterly direction to the outlet portal. All features described above will be located on Federal lands withdrawn by the Bureau of Reclamation.

The transition portion of the tunnel inlet portal and the first 1,000 feet of the tunnel will be excavated by the conventional means of blasting. The area will be dampened to avoid a dust problem. In addition, blasting will be controlled to minimize any adverse effect on the great blue heron colony on Heron Island in Lake Havasu. The spoil will be used as construction material for the intake channel landform embankment, backfill for the pumping plant, or will be spread over the hillside to blend with the natural terrain. The need for stabilization of the spoil to prevent erosion will be considered. Due to the general inaccessibility of the tunnel inlet, the principal driving effort for the remaining 35,000 feet of the tunnel will be from the outlet end via a boring machine or other suitable methods of excavation available at the time of construction.

Construction shaft sites which might be used for conventional tunneling methods will be more applicable for the southern portion of the tunnel route. Adits and shafts, if utilized, will penetrate volcanic rocks that are amenable to conventional excavation and/or standard drilling techniques.

The volume of material to be excavated from the tunnel will approximate 723,000 cubic yards. The spoil material will be deposited in selected areas and shaped to conform with the natural contours of the existing terrain. Stabilization of the spoil from excavation might be required to prevent erosion and subsequent transport to downstream areas. Concrete aggregate for finishing the tunnel will be obtained from commercial sources or Reclamation withdrawn land 10 miles west of the outlet in Osborne Wash. This borrow area will be graded to conform with the surrounding landscape after construction is completed.

b. Granite Reef Aqueduct 7,42,45,56,75,158,166,188,191,193

The Granite Reef Aqueduct canal section will extend from the outlet portal of the Buckskin Mountains Tunnel to Orme Reservoir located at the confluence of the Salt and Verde Rivers. The total length of the aqueduct will be about 190 miles. About 8,900 acres of right-of-way will be required for aqueduct construction. The aqueduct will transport Colorado River water from Lake Havasu to the Salt-Gila Aqueduct and the terminal regulatory facility at Orme Dam at the Salt and Verde Rivers northwest of Phoenix, Arizona. Water delivery turnouts will also be provided along the aqueduct. Northeast of Phoenix near the aqueduct's terminus, the aqueduct's flow will bifurcate for direct delivery to the Salt-Gila Aqueduct or for delivery into Orme Reservoir by means of the McDowell Mountain Tunnel or channel.

The aqueduct will be an open concrete-lined gravity flow structure having a 24-foot bottom width, a 16.43-foot depth, and a top width of about 80 feet with a design capacity of 3,000 cfs. The right-of-way for the aqueduct will vary, depending on topographic relief and structural requirements, from about 180 feet to between 2,000 and 3,000 feet at one point, but will average about 300 feet in width. Total land acquisition required for the aqueduct right-of-way will be about 6,500 acres for the canal and about 2,400 acres additionally for cross drainage and collection systems and pumping plant sites. Design of the aqueduct provides for balanced excavation and embankment sections to reduce the need for off-line borrow areas. Excess excavated material from the construction of the aqueduct and tunnels will be placed within the right-of-way where possible and will be accomplished in a manner which best conforms to the surrounding natural landscape. The spoils will be landformed or revegetated where necessary to stabilize the attained slopes. Plants used for revegetation will be native to the surrounding area.

The architectural design of the pumping plants along the aqueduct system will be sensitive to the surrounding natural landscape. The overall esthetic impact of these structures will be controlled by

the use of line, form, scale, texture, and color to insure compatibility with the surroundings. In addition, special architectural consideration will be given to the visual quality of those structures which are accessible by the general public. Where practical, visitor facilities will be incorporated into the design of the pumping plant structures.

The aqueduct on its route to Orme Reservoir will cross Interstate Route 10 approximately 2 miles north of the Little Harquahala Pumping Plant site, and again at the Centennial Wash siphon. The Granite Reef Aqueduct will also cross I-17 about 23 miles north of Phoenix. Bridges will provide crossings for State Route 72 about 6 miles northwest of Hope, Arizona; U. S. Highway 60 approximately 3 miles west of Hope; and U. S. Highways 60 and 89, 3 miles southeast of Wittmann, Arizona. In addition, 36 farm and 15 county road crossings will be required. The Santa Fe Railroad tracks will be crossed twice; several gas transmission lines and telephone cable lines will also be crossed. The water will be lifted through four pumping plants, and passed through six major siphons and three tunnels. To provide access for operation and maintenance of the aqueduct and to provide crossings for highways and roads, 68 concrete bridges will be constructed across the aqueduct. In connection with the bridge crossings, existing roads and highways will be relocated where necessary to be alined with the bridges.

Figure 8 shows the preliminary plan and profile for a typical reach of the aqueduct from the Cactus Plain (Mile 12.0) through the Bouse Hills (Mile 17.0), across the Cunningham Wash (Mile 22.5), and into the Ranegras Plain (Mile 24.0). This drawing is from a set of 15 preliminary maps, the others of which are on file at the Bureau of Reclamation's Arizona Projects Office in Phoenix, Arizona. Figure 9 shows a portion of the aqueduct route near the Buckskin Mountains.

(1) Route

Beginning at the outlet portal of the Buckskin Mountains Tunnel at Elevation 1221, the aqueduct will follow the eastern side of Osborne Wash south through the Buckskin Mountains for approximately 3 miles, then cross the Cactus Plains in a southeasterly direction to the north side of Bouse Hills to the Bouse Hills Pumping Plant for a lift of 100 feet to Elevation 1314. The Bouse Hills Pumping Plant is located in the SW1/4, unsurveyed Section 10, T. 7 N., R. 16 W., GSRB&M. The aqueduct will continue from Bouse Hills easterly to Cunningham Wash through a siphon 3,550 feet in length, then south through the Ranegras Plain where it will cross State Highway 72 and the Atchison, Topeka & Santa Fe Railroad, 3 miles northwest of Vicksburg.

Continuing through the Ranegras Plain in a southeasterly direction, the aqueduct will cross U. S. Highway 60 and Interstate 10, 3 miles west and 8 miles south of Hope, respectively.

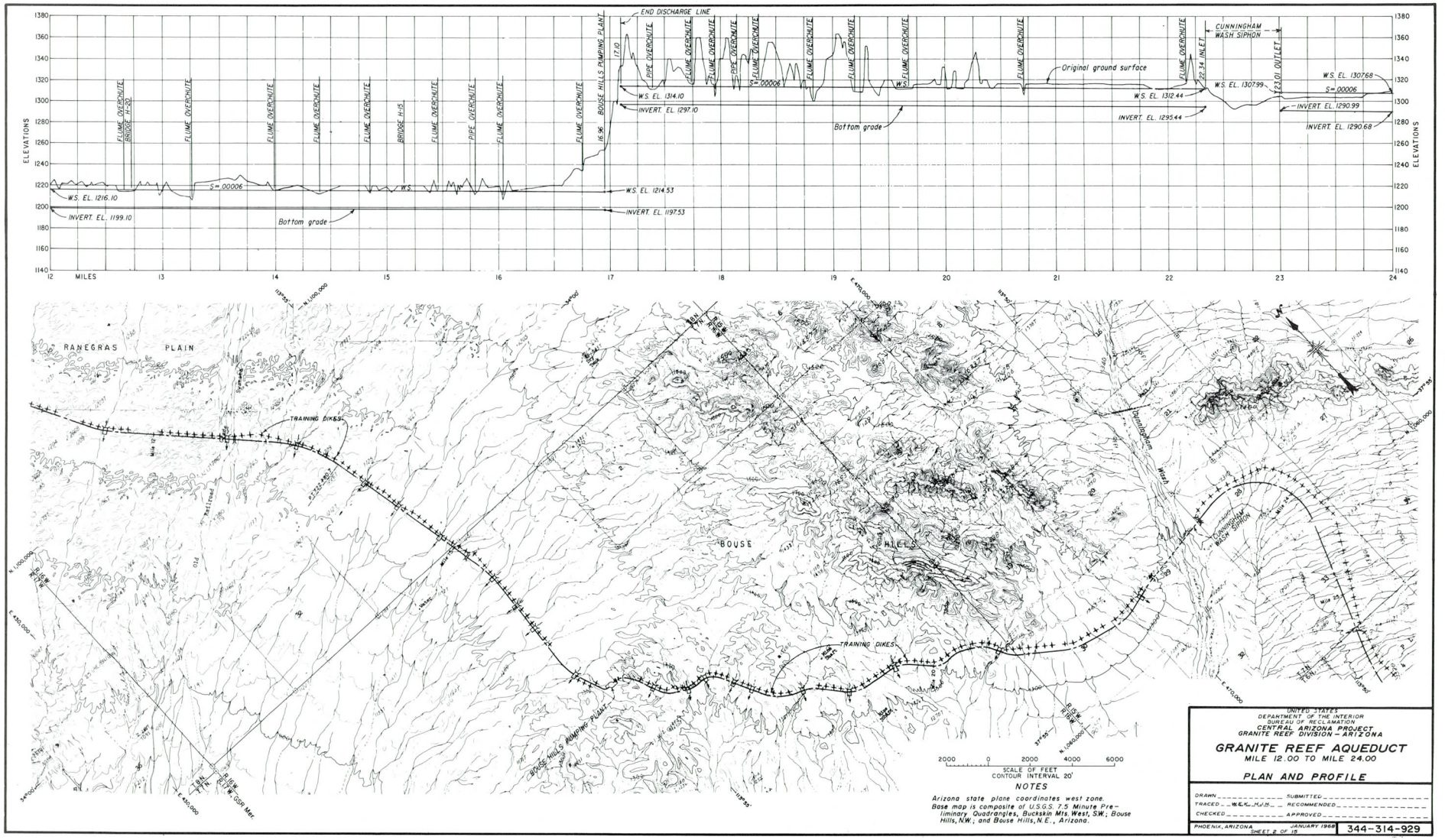
At the southernmost end of the Little Harquahala Mountains, the water will be lifted 100 feet to Elevation 1400 through the Little Harquahala Pumping Plant and directed easterly to the Harquahala Valley south of Interstate Highway 10 and parallel to it for about 4 miles. Little Harquahala Pumping Plant will be located in the SE¼, unsurveyed Section 18, T. 3 N., R. 13 W.

Crossing of I-10 and Centennial Wash will be accomplished through a siphon 5,000 feet in length prior to continuation of the aqueduct through the Harquahala Plain to Burnt Mountain. A tunnel through Burnt Mountain will provide a northeasterly path across the Tonopah Desert to the eastern edge of the Belmont Mountains and the Belmont Mountains Pumping Plant, where a lift of approximately 97 feet to Elevation 1473 will direct the flow northward across the mountains and onto the Hassayampa Plain. The pumping plant site is located in the SW¼, NW¼, Section 13, T. 3 N., R. 6 W., GSRB&M. The Hassayampa Plain will be crossed in a northeasterly direction to a crossing at the Hassayampa River about 20 miles south of Wickenburg and 5 miles northwest of the White Tank Mountains.

The Hassayampa River Siphon, 6,940 feet in length, and the Hassayampa Pumping Plant with a lift of 76 feet, will provide a northeasterly course through a natural saddle between the White Tank Mountains and the Wickenburg Mountains just north of Luke Air Force Auxiliary Field No. 1. The Hassayampa Pumping Plant site is located in the NW¼, SE¼, Section 20, T. 4 N., R. 4 W., GSRB&M.

The aqueduct will cross U.S. Highways 60 and 89 and the Atchison, Topeka & Santa Fe Railroad approximately 3 miles southeast of Wittmann and then continue on a northeasterly course to the southern end of the Hieroglyphic Mountains. The Agua Fria Tunnel, with a length of about 3,900 feet, will provide continuation of the aqueduct in an easterly direction toward the Agua Fria River, crossing the Beardsley Canal on the west bank of the river.

A siphon 9,775 feet in length will cross the Agua Fria River approximately 5 miles south of Waddell Dam. Waddell Dam is the storage reservoir for the Maricopa County Municipal Water Conservation District No. 1. The aqueduct will continue southeasterly, then through a 5,796-foot siphon across New River, turning north of Ludden Mountain and the Deem Hills to a crossing point at Interstate Highway 17, just north of Little Deer Valley, approximately 23 miles north of downtown Phoenix. Just west of I-17, the aqueduct will cross a tributary of Skunk Creek just downstream from an alternative axis of the Corps of Engineers' proposed Adobe Dam. From I-17, the aqueduct will follow a southeasterly course to a crossing at Cave Creek approximately 2½ miles south of Cave Creek Dam and about 1/4 mile downstream from the axis of the Corps of Engineers' proposed Cave Buttes Dam. The aqueduct will enter Paradise Valley approximately 3 miles north of Bell Road and



NOTES

Arizona state plane coordinates west zone.
Base map is composite of U.S.G.S. 7.5 Minute Preliminary Quadrangles, Buckskin Mts. West, S.W.; Bouse Hills, NW.; and Bouse Hills, N.E., Arizona.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION – ARIZONA

GRANITE REEF AQUEDUCT
MILE 12.00 TO MILE 24.00

PLAN AND PROFILE

DRAWN _____ SUBMITTED _____
TRACED W.E.C. H.W.B. RECOMMENDED _____
CHECKED _____ APPROVED _____

PHOENIX, ARIZONA JANUARY 1965 SHEET 2 OF 15

344-314-929

Figure 8

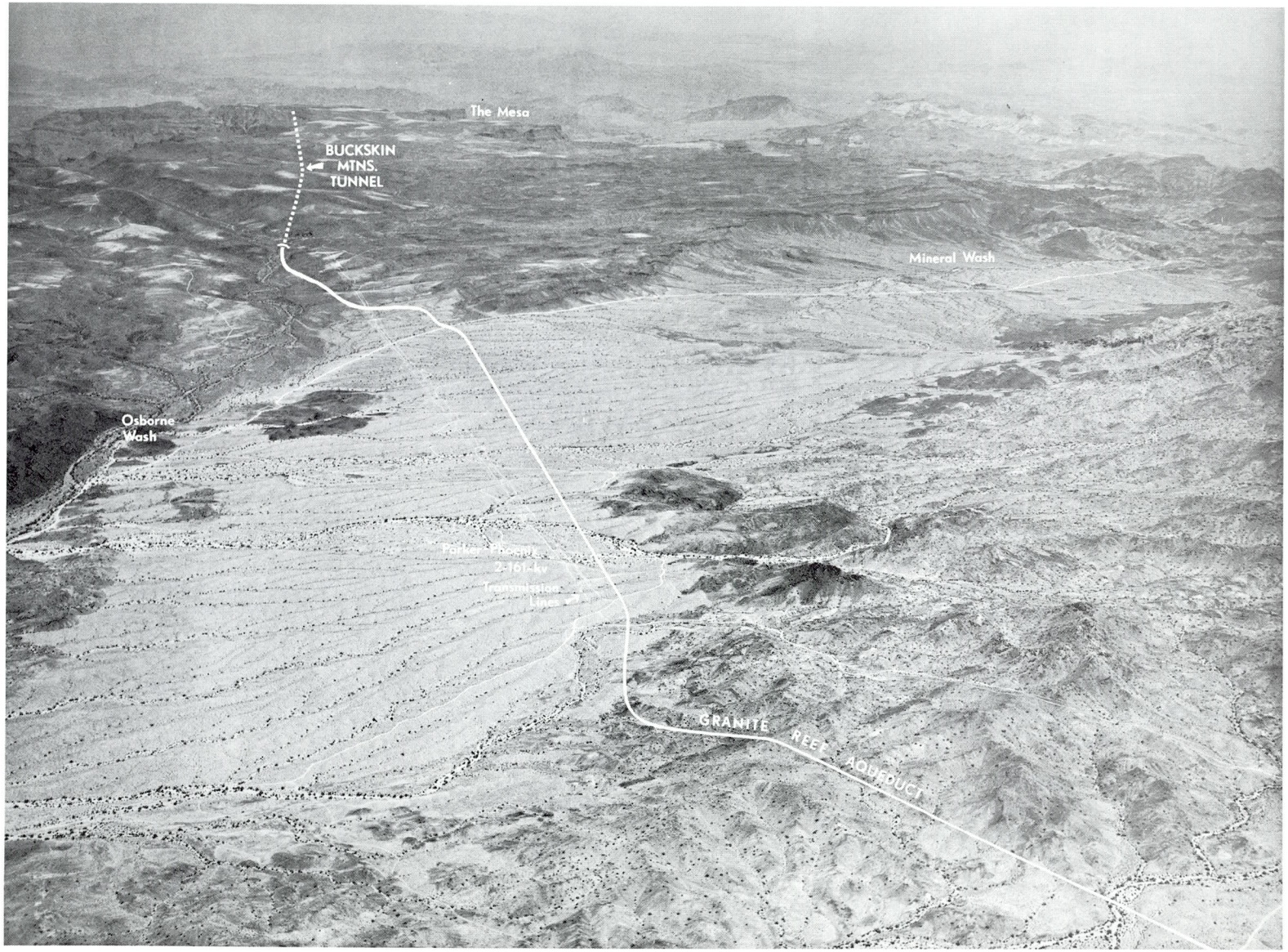


Figure 9

Site location of Buckskin Mountains Tunnel and a portion of the Granite Reef Aqueduct looking northwest across the Buckskin Mountains toward the Bill Williams arm of Lake Havasu. Photograph No. P344-300-12302.

continue just south of the abandoned and uncompleted Verde Canal of the long defunct Verde River Irrigation and Power District and north of most of the present urban development. Scottsdale Road will be crossed just south of its intersection with Bell Road. The aqueduct will pass north of Scottsdale Municipal Airport and continue southeasterly for approximately 3 miles to the McDowell Mountain range, and cross the Salt River Indian Reservation boundary at the northwest corner of Section 36, T. 3 N., R. 5 E., running easterly to a terminal point north of the Beeline Highway (Arizona Highway 87), Section 34, T. 3 N., R. 6 E.

Aqueduct flow into Orme Reservoir will be through the McDowell Mountains via a tunnel or open cut section.

Numerous alternatives to the present alinement have been considered. They are discussed, along with alternative route concepts in general in Chapter VIII of this statement and will be discussed in the individual statement covering this feature.

(2) Design Features [123]

The aqueduct after leaving the Buckskin Mountains Tunnel will include two and possibly three concrete-lined tunnels totaling about 11,400 feet to transport project water through Burnt Mountain, the Hieroglyphic Mountains near the Agua Fria River, and through the McDowell Mountains into Orme Reservoir, unless this last passage utilizes a channel section instead. Six concrete siphons totaling about 31,500 feet will be used to convey water across Cunningham Wash, Centennial Wash, Jackrabbit Wash, the Hassayampa River, the Agua Fria River, and New River. These siphons will be placed under the streambed at a depth of as much as 20 feet to the top of the siphon.

The aqueduct will contain four in-line relift pumping plants. All four pumping plants will be provided with automatic controls to minimize pump cycling and to maintain a constant aqueduct flow. In the event of power outage, the surge wave from the pumping plants will be contained within the canal prism or will be automatically released over weirs near the pumping plant sites. Relift pumping stations will be located at the Bouse Hills, Little Harquahala Mountains, Belmont Mountains, and near the Hassayampa River as described above. Site preparation and plant design will be in accordance with Reclamation Instructions on Environmental Quality - Preservation and Enhancement, Series 350, Part 376, and discussed in the statement for the Havasu Pumping Plant.

In-line check structures will be provided at 7 to 10-mile intervals along the aqueduct to control water surface elevations and to maintain regulating control in the aqueduct system during operations. Automatic gates will be used on the check structures to insure proper delivery of water to the turnout structures during minimum flow conditions,

and also to provide adequate forebay draft for the in-line pumping plants. Electrical control cables as well as the interconnecting lines from the main power source will be placed underground along the aqueduct banks, or within the right-of-way section, to the maximum extent possible.

In the event of an aqueduct breach due to storm flooding or bank failure, pumping plants will shut down and check gates will close to minimize project water loss and flood damage below the aqueduct. In such an event, aqueduct water loss will in most cases be held to the water volume between in-line control structures. For a typical 10-mile reach, the maximum volume of water that may be lost will be about 970 acre-feet at design capacity.

Aqueduct turnouts will be provided at the required locations to furnish water to agricultural and urban areas, primarily in the Phoenix area, and to planned recreation areas and wildlife facilities.

To protect the aqueduct from floodflows, present designs call for nine pipe culverts, four box culverts, nine pipe overchutes, and 168 flume overchutes. In connection with these structures, about 160 miles of low earth dikes will be constructed above the aqueduct to train floodflows to the cross-drainage structures. These training dikes will be shaped and alined to conform with the terrain wherever possible and will require a trench section about 2 feet deep and 4 feet wide.

The aqueduct will also route controlled floodwaters from behind detention dams into Orme Reservoir. The detention dams will be constructed primarily to protect the aqueduct but they will also protect urban and some agricultural service areas. In the Paradise Valley area northeast of Phoenix, a detention dam will be constructed to control and train floodflows into the aqueduct for conveyance into Orme Reservoir. This detention dam will parallel the aqueduct, within the right-of-way, and will be about 11 miles in length. The total width of the right-of-way for both the canal and detention dam will be between 2,000 and 3,000 feet. The maximum height of the dam will be about 36 feet with a top width of 14 feet.

The features authorized by the Flood Control Act of 1965 include the Indian Bend Wash project between the Arizona Canal and the Salt River in Scottsdale and Tempe, Cave Buttes Dam on Cave Creek, Adobe Dam on a tributary of Skunk Creek and Skunk Creek diversion and channelization, New River Dam and channelization, Union Hills diversion channel, Dreamy Draw Dam[123] and the Arizona Canal diversion channel, and Agua Fria River channelization. Except for the Dreamy Draw Dam and the Arizona Canal diversion channel, all of the above facilities would or

could have their structural requirements affected or modified by provisions of the Granite Reef Aqueduct cross-drainage facilities. Some effects would be greater than others. The greatest impact could be on Adobe Dam and appurtenant structures, Union Hills diversion channel, and Indian Bend Wash project.

(3) Operation

The basic operational plan of the aqueduct will be to provide a fairly uniform base flow for delivery and coordination with local surface and ground-water systems. Water will be lifted about 1,000 feet from Lake Havasu to Orme Reservoir. This will require a total dynamic head (TDH) of about 1,200 feet and a total installed pumping plant capacity as shown on Table 4.

Seasonal variations of water demand will continue to be met by ground-water pumping and/or local storage reservoir draft. In a normal water year, when project apportionments are less than the maximum capability of the system, the aqueduct will probably operate for about an 11-month period. A 1-month shutdown period for routine inspection and maintenance will be conducted yearly, or as needed.

In years of maximum project apportionments, when surplus waters are available, diversions to the Granite Reef Aqueduct will probably be at a maximum design capacity for 12 months a year. Project water in excess of seasonal demands will be diverted into Orme Reservoir. In this situation, annual inspection and maintenance of the aqueduct system may be deferred in that water year in favor of the additional water supply. During periods following heavy localized storms in the service area, flows in excess of demands will also be diverted into regulatory storage or delivered to farmlands outside the storm area to allow further reduction of ground-water pumping. Summer storms generally cover relatively small areas, systemwide, and the net water demand will still be greater than the project aqueduct system capacity. Heavy winter storms may result in saturating the service area sufficiently to require a reduction in aqueduct discharge. This will be accomplished by turning off pump units, or diversion into Orme Reservoir for seasonal holdover storage.

c. Orme Dam and Reservoir 7,41,75,95,123,156,162,163,188,190

(1) Location

Orme Dam and Reservoir will be located in Maricopa County about 25 miles northeast of Phoenix, Arizona, at the confluence of the Salt and Verde Rivers in Sections 5 and 6, T. 2 N., R. 7 E., GSRB&M. Alternative locations for and alternatives to this feature have been studied and are discussed in Chapter VIII of this statement. They will also be discussed in the individual statement covering this feature.

During normal operating conditions, the reservoir will extend a maximum of 10 miles upstream on the Verde River and 10 miles on the Salt River to Stewart Mountain Dam, inundating portions of the Salt River Indian Reservation, Fort McDowell Indian Reservation, and Tonto National Forest. Approximately 24,000 acres would be inundated if the reservoir were to reach maximum water surface elevation.

Approximately 5.4 miles of existing Arizona Highway 87 (Beeline Highway) will be relocated with a bridge 2,050 feet in length spanning the Verde River arm of Orme Reservoir at Elevation 1484, in accordance with Section 207(c) of Public Law 87-874. The Bush Highway will be relocated across the crest of Orme Dam from approximately 1.6 miles south of Orme Dam to 0.4 mile north of Orme Dam where the relocated Highway 87 and the relocated Bush Highway will intersect.

Figures 10 and 11 show the Orme Dam site and an artist's conception of Orme Dam and Reservoir, respectively.

(2) Design Features

The dam is planned as an earthfill embankment. Borrow material will be excavated from the reservoir area. The structure will rise 195 feet above the streambed to an elevation of 1,520 feet with a crest length of about 5,700 feet. The dam, with a base width of about 1,300 feet, will taper to a 40-foot roadway at top, providing a freeboard of 6.5 feet above the maximum water-surface elevation of 1,513.5 feet.

The foundation is adequate for either a concrete or earthfill structure. Economics of design indicate that an earthfill dam is preferable to a concrete structure. A structure consisting of earthfill embankment and a center section of concrete with a spillway was considered in 1947.

An estimated sediment deposition of 50,000 acre-feet in a 100-year period originating from the uncontrolled Verde River watershed below Bartlett Dam and the Salt River watershed below Stewart Mountain Dam was used in determining the reservoir capacity.

A saddle dam with a 2,600-foot crest, rising to a maximum height above the cutoff trench of about 60 feet, will be required at the saddle southeast of the dam's left abutment. The elevation of this saddle is 1,450 feet.

Releases from the dam will be made directly into the natural Salt River channel for diversion at the existing Granite Reef Diversion Dam (Salt River Project) or for pumping into the Salt-Gila Aqueduct using the Orme-Granite Reef Pumping Plant. This pumping plant will be a low profile structure, similar to the Havasu Pumping Plant.

TABLE 4
LOCATION, PUMP LIFT, FLOW, AND ENERGY REQUIREMENTS
FOR HAVASU AND FOUR IN-LINE PUMPING PLANTS

	Mile Post	Estimated TDH (ft.)	Q (cfs)	Installed Capacity (mw)
Havasu	0	820	3,000	285
Bouse Hills	17	105	3,000	35
Little Harquahala	50	105	3,000	35
Belmont Mt.	100	97	3,000	33
Hassayampa River	113	81	3,000	26

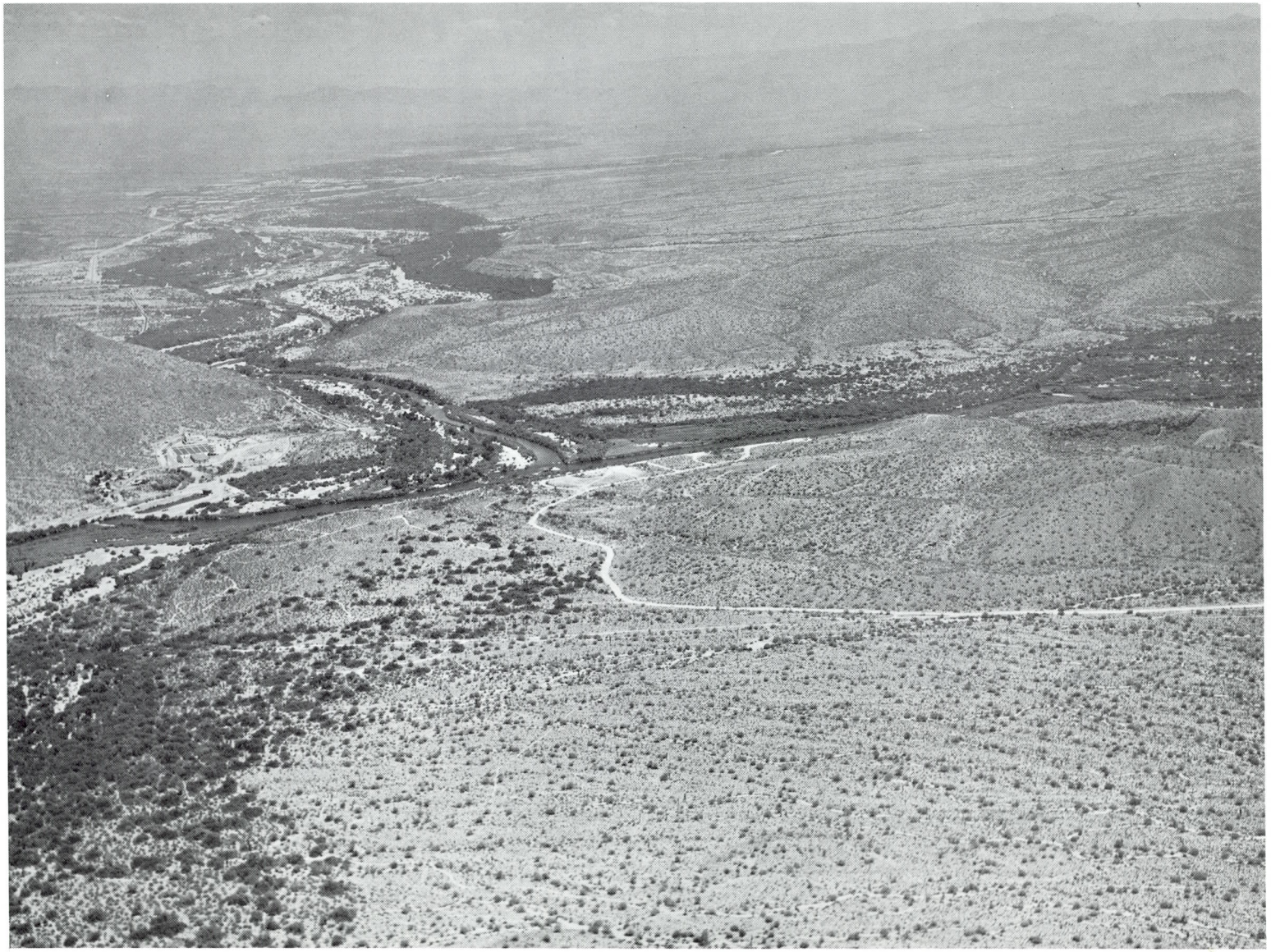


Figure 10

Site location of Orme Dam and Reservoir looking north. Photograph No. P344-300-11947.

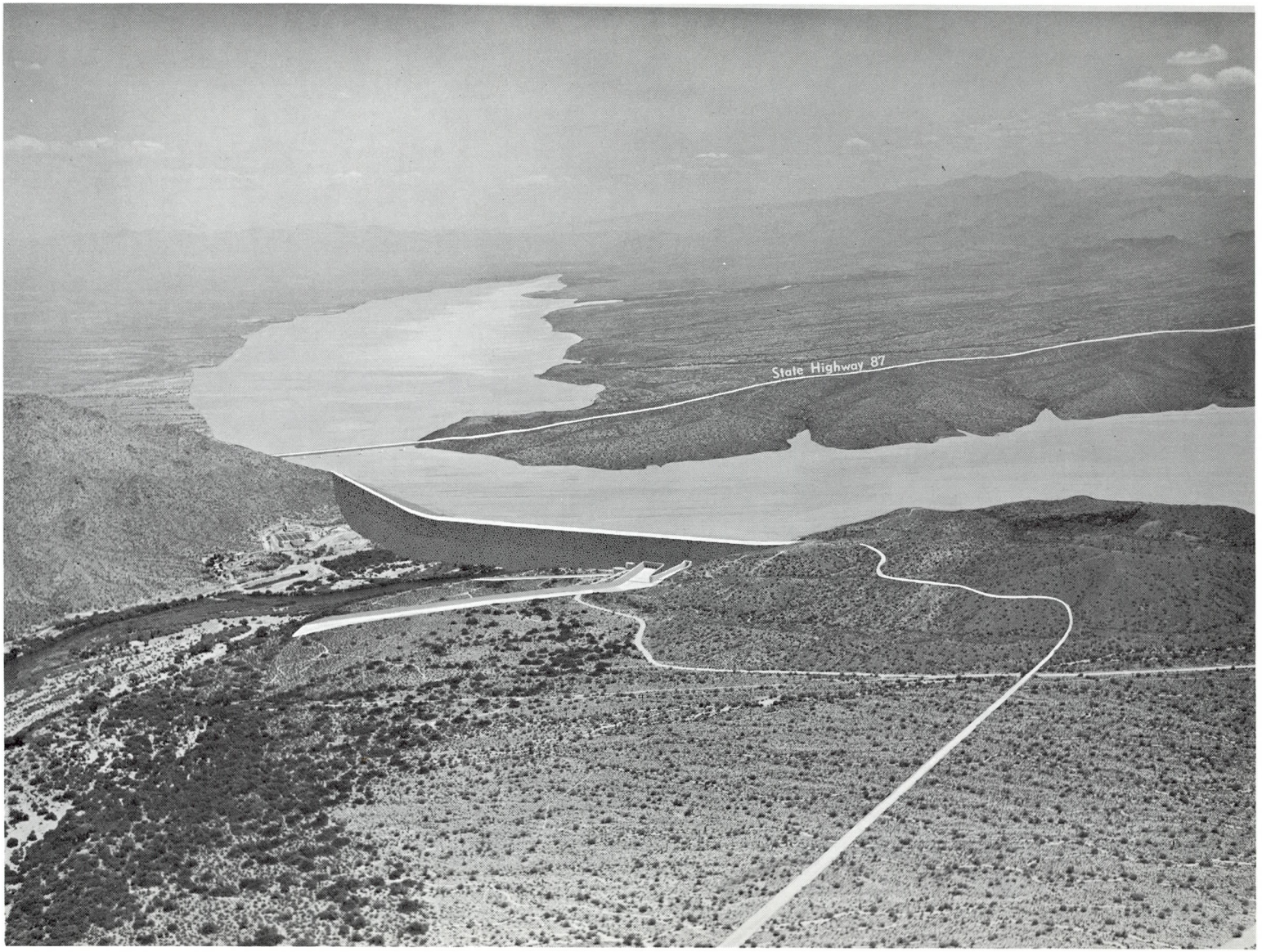


Figure 11

Artist's conception of Orme Dam and Reservoir. Photograph No. P344-300-12303.

The reservoir space will be allocated as shown in Table 5. The land areas to be inundated by the various reservoir levels are listed in Table 6.

(3) Operation

Orme Dam and Reservoir will be operated in coordination with the Salt River Project storage system and diversions from the Colorado River through the Granite Reef Aqueduct. In addition to providing terminal regulatory storage for the Granite Reef Aqueduct, the reservoir will provide flood control for the Phoenix metropolitan area.

Orme Dam and Reservoir will provide operational flexibility to the Granite Reef Aqueduct and will allow the storage of Colorado River diversions during low water demand periods or during aqueduct shutdowns. The reservoir will also facilitate diversions to the Salt-Gila Aqueduct when maintenance is scheduled for the Granite Reef Aqueduct or when emergencies occur. In addition, the reservoir will provide storage capacity for the conservation of flood spills occurring from the Salt River Project storage system. The reservoir will maintain a minimum pool of about 43,000 acre-feet to provide capacity for sediment control and open water for development of recreation and fish and wildlife resources.

Metropolitan flood control plans allied to flood storage in Orme Reservoir call for a flood channel with a capacity of 50,000 cfs to be constructed from Granite Reef Diversion Dam to Indian Bend Wash and 80,000 cfs downstream from Indian Bend Wash through Phoenix. With this anticipated flood protection, the City of Phoenix is planning an airport runway extension which has not been possible due to flooding problems. In addition, the City is endeavoring to optimize safe use of flood-plain lands by supporting the "Rio Salado Project," a proposal for a greenbelt park-utility strip through a metropolitan area now unusable because of periodic flooding.

The channelization of the Salt and Gila River, between Granite Reef Diversion Dam on the Salt River and Gillespie Dam on the Gila River below Buckeye, was authorized by the Flood Control Act of 1960. The levees included in this authorization would have their channel magnitude reduced through Tempe, Phoenix, and the Fred J. Weiler Greenbelt by coordination and control effected by Orme Dam.

A Corps of Engineers' project authorized by the Flood Control Act of July 14, 1960, which included levees along the Salt River in the Phoenix and Tempe areas would be assisted by the control that would be effected by Orme Dam. The Dreamy Draw Dam and other features related to it, authorized by the Flood Control Act of 1965, will not be affected by the construction of Orme Dam.

d. Salt-Gila Aqueduct 7,55,75

(1) Route

The Salt-Gila Aqueduct will begin at the bifurcation structure near the terminus of the Granite Reef Aqueduct in the NE1/4, Section 3, T. 2 N., R. 6 E., GSRB&M, near the Salt River and will continue south across the Gila River to a bifurcation turnout near Picacho Reservoir south of Florence, Arizona. There the aqueduct will turn east through the Picacho Mountains before turning south again to terminate in the SE1/4, Section 8, T. 11 S., R. 11 E., near Marana, Arizona. The total length of the aqueduct will be about 97 miles. About 5,800 acres will be required for right-of-way. Alternative routes have been studied and are discussed in Chapter VIII of this statement. They will also be discussed in the individual statement covering this feature.

The Salt-Gila Aqueduct will transport Colorado River water to designated water contractors within the project service area. Operational characteristics and environmental considerations will be similar to those discussed earlier for the Granite Reef Aqueduct. Water will be available for diversion to the Salt-Gila Aqueduct from either the Granite Reef Aqueduct or Orme Reservoir, and from Buttes Reservoir at times. Project diversion of regulated water released from Orme Reservoir to the Salt-Gila Aqueduct will be made through the Orme-Granite Reef Pumping Plant connected to the aqueduct as mentioned earlier. This pumping plant will have a total pump list of approximately 180 feet and a design capacity of 1,800 cfs.

(2) Design Features

The aqueduct will be an open, concrete-lined canal. The first 63 miles of the aqueduct will have a design capacity of 1,800 cfs, pending possible adjustments for water allocations to users. The remaining 34 miles will have a capacity of 750 cfs. The 1,800-cfs section will be about 15 feet deep and have a top width of approximately 64 feet. The 750-cfs portion will be nearly 10 feet in depth and have a top width of over 40 feet.

The open aqueduct was selected on the basis of comparative cost studies of pipe versus canal made for the Granite Reef Aqueduct which indicated an increase approximately 3 times greater for pipe than for open aqueduct.

Three relift pumping plants similar in design and environmental considerations to the Granite Reef aqueduct in-line pumping plants will be required at various locations along the Salt-Gila Aqueduct. The Salt-Gila Pumping Plant will be located in the NW1/4,

TABLE 5
ALLOCATION OF RESERVOIR SPACE IN ORME RESERVOIR

Function	Capacity (Acre-Feet)	Cumulative Capacity (Acre-Feet)	Water Surface Elevation (Feet)
Dead (sediment)	2,000	2,000	1340
Inactive	41,000	43,000	1374
Conservation	367,000	410,000	1437
Flood Control	950,000	1,360,000	1500
Surcharge	290,000	1,650,000	1513.5

TABLE 6
LAND AREAS INUNDATED BY ORME RESERVOIR AT VARIOUS WATER LEVELS

	Lands Inundated (acres)			
Elevation	Ft. McDowell Reservation	Salt River Reservation	Tonto Natl. Forest	Total
1374	800	600	900	2,300
1437	5,400	900	3,400	9,700
1513.5	14,800	1,300	7,900	24,000

Section 19, T. 2 N., R. 7 E., approximately 4 miles south of the bifurcation structure of the Granite Reef Aqueduct. This pumping plant will be designed to pump 1,800 cfs at a total design head of 84 feet. The Picacho Mountains No. 1 Pumping Plant will be located approximately 65 miles southeast from the beginning of the aqueduct in the NW1/4, Section 27, T. 6 S., R. 9 E., and will have a design head of 146 feet. The Picacho Mountains No. 2 Pumping Plant will be located approximately 66 miles southeast from the beginning of the aqueduct in the SE1/4, Section 26, T. 6 S., R 9 E., and will have a design head of 310 feet. Both plants will be designed for a capacity of 750 cfs. Each plant and appurtenances will occupy approximately 5 acres of foothill and desert land. The Salt-Gila Pumping Plant will be located on Federal land and the Picacho Mountains plant on land that is presently state land. Material excavated for preparation of the pumping plant sites will be used where necessary for backfill and embankment in the plant areas or will be disposed of in approved areas.

Siphons sized to carry the same capacity as the aqueduct will be required at the Salt and Gila Rivers and at 17 major washes. These siphons will be buried at a depth of about 20 feet below the top of the siphon. The average length of the siphons will be about 300 feet with the longest being the Salt and Gila River siphons which will be approximately 9,180 feet and 2,012 feet, respectively. Other siphons will range from about 630 feet at Queen Creek to 175 feet at Mile 91.5. Fifteen of the siphons will be located in Reach 6 of the aqueduct between the Picacho Mountains pumping plants and the Marana Pumping Plant. In addition, 57 flume overchutes, 12 pipe overchutes, 4 box culverts and 4 pipe culverts will be required to prevent floodflows from damaging the aqueduct. Approximately 60 miles of low dikes, 7 miles of channel, and the relocation of approximately 1 mile of the existing Florence Retarding structure (Soil Conservation Service) will be required to divert the floodflows into these cross drainage structures.

Additional flood protection for the Salt-Gila Aqueduct will be provided by the existing Powerline, Vineyard Road, Rittenhouse, Magma, and Florence Flood Retarding structures constructed by the Soil Conservation Service. The Salt-Gila Aqueduct will closely parallel these retarding dams for about 18 miles. The planning and final location of these SCS structures were coordinated with the Bureau of Reclamation's layout of the Salt-Gila Aqueduct to minimize right-of-way requirements and maximize joint flood control protection and benefits for both agencies. The proposed SCS Spookhill Retarding structure would also directly parallel the Salt-Gila Aqueduct and would provide an additional 5 miles of flood protection.

To provide access for operation and maintenance of the aqueduct and to provide crossings for existing roads, highways, and railroads, 61 bridges will be constructed across the aqueduct. There

will be 5 state highway bridges, 34 county road bridges, 21 farm road bridges, and 1 railroad bridge. Existing roads and highways will be relocated where necessary to realine them with the bridges. Present design plans indicate that the bridges will be constructed of precast concrete girders and flat slab decks.

The right-of-way for the 1,800-cfs portion of the aqueduct will be 250 feet wide and 200 feet wide for the 750-cfs section. Approximately 2,700 acres of land will be required for the aqueduct and about 3,100 additional acres for dikes, diversion channels, and pumping plants. Of the total acreage, approximately 2,400 acres are private land, 3,000 acres are state land, 300 acres are Federal land, and 100 acres are Indian land. The aqueduct has been located and designed to use balanced cut-and-fill sections which will minimize the need for borrow. Construction haul roads will be on the aqueduct alinement. The vegetation on the right-of-way is sonoran desert type as discussed in Chapter II of this statement.

(3) Operation

Owing to a wide variation in seasonal water supply and demand and a combined municipal, industrial, and agricultural water requirement, it will be necessary to have a wide range of operational capacity for the Salt-Gila Aqueduct. Utilization of the aqueduct's maximum design capacity will be during peak demand periods in the summer months and in years when surplus project water will be available from the Colorado River or from Orme Reservoir storage.

Heavy winter storms may at times require immediate reduction of project diversion to the Salt-Gila Aqueduct. In this event, reduction in aqueduct discharge will be accomplished by turning off the pumping units and diverting excess flows from the Granite Reef Aqueduct into Orme Reservoir. A similar situation may occur as a result of intense local summer thunderstorms. In most of these summer storm instances, the extent of the area affected will be small.

Operation of the reach of Salt-Gila Aqueduct south of the Gila River will be coordinated with project releases from Buttes Dam and Reservoir for delivery of water to the service areas in Pinal and Pima Counties. It will also be necessary to coordinate operations of both Buttes and Orme Reservoirs with those of an integrated Salt-Gila Aqueduct and San Carlos Project distribution system. Therefore, the Salt-Gila Aqueduct will be designed to tie, by gravity, directly into the existing main conveyance system for the San Carlos Project at the Gila River siphon. At this point, replacement water under an exchange agreement with water users in the upper Gila River basin in New Mexico can be delivered to the San Carlos Project, in addition to its allocation from CAP.

e. Buttes Dam and Reservoir 11,41,48,54,75,77,80-82,150, 151,155,170,172,175

(1) Location

Buttes Dam and Reservoir will be located on the Gila River about 14 miles east of Florence, Arizona, in a narrow gorge about 4 miles upstream from the existing Ashurst-Hayden Diversion Dam. Figures 12 and 13 show Buttes Dam site and an artist's conception of Buttes Dam and Reservoir, respectively. Alternative locations have been studied and are discussed in Chapter VIII of this statement. They will also be discussed in the individual statement covering this feature.

(2) Design Features

The dam will be an earthfill structure rising about 210 feet above the streambed and about 290 feet above the foundation to an elevation of 1,796 feet, with a crest length of about 950 feet. A concrete-lined chute spillway with a maximum capacity of 251,000 cfs will be located in the south abutment. Flood releases will be controlled by six 44x33-foot radial gates. The diverging concrete-lined spillway channel will terminate in a river level stilling basin. Two valve houses and stilling basins will be required. One of these, located at the downstream end or outlet portal of the diversion tunnel, will be used to discharge water directly into the river. The other will be located at the end of a 102-inch pipe. It will be used to regulate irrigation releases to a supply canal which will be constructed along the north side of the river. The concrete-lined supply canal will have a capacity of 1,200 cfs. It will terminate 3-1/2 miles downstream at the existing Ashurst-Hayden Diversion Dam where it will be connected to the San Carlos Project main canal and the proposed Salt-Gila Aqueduct. The Ashurst-Hayden Diversion Dam will be preserved for use during maintenance or emergency periods.

Geologically, the area in the vicinity of the damsite was investigated by the Geological Survey in 1899, the Soil Conservation Service in 1936, the Bureau of Indian Affairs in 1940, the Corps of Engineers, in 1943, and the Bureau of Reclamation in the early part of 1958. On the basis of these investigations, the site was recommended as being geologically suitable for the construction of either a concrete or earth dam.

Sufficient quantities of embankment material are available within the reservoir area. Therefore, it will not be necessary to obtain additional land for borrow areas or construction haul roads. Temporary construction offices will also be located within the reservoir area.

Studies which resulted in establishment of the total capacity of Buttes Reservoir at 366,000 acre-feet considered both the physical characteristics of the site and the storage requirements. The physical characteristics of the site offered no opportunities for significantly improving benefit-cost relationships by raising or lowering the dam within the limitations imposed by sediment and conservation storage requirements.

It has been estimated on the basis of San Carlos Reservoir experience that at the end of a 50-year period, sediment deposition in Buttes Reservoir would be approximately 133,000 acre-feet from a contributing area of 5,300 square miles. On this basis, the estimated useful life of the conservation storage pool is considered to be 100 years. Additional studies now being made, and utilizing streamflow-sediment transport data, indicate that the above value for estimated sedimentation may be too large.

The storage capacity in Buttes Reservoir is presently allocated as shown in Table 7.

The reservoir area will be 6,200 acres at maximum water surface elevation and 5,500 acres at the top of the conservation level. A minimum pool of 2,000 acre-feet with 200 surface acres will be maintained in Buttes Reservoir to provide a minimum water resource for fish and wildlife preservation and recreation.

(3) Operation

The operation of Buttes Dam and Reservoir will provide conservation of water, flood control, sediment control, and enhancement opportunities for recreation and fish and wildlife resources. Floodflows of the San Pedro River uncontrolled by Charleston Dam and Reservoir and other side channel inflows to the Gila River below Coolidge Dam, located on the Gila River 62 miles upstream, will be stored in Buttes Reservoir. This added control will reduce flooding and facilitate project releases. Sediment detention in Buttes Reservoir will reduce the operational and maintenance problems presently existing on the San Carlos Project, including the Ashurst-Hayden Diversion Dam, the canal system, and at Picacho Reservoir.

The reservoir will be operated in coordination with San Carlos Reservoir to provide optimum development of the surface-water resources. Operations of Buttes Reservoir will be in accordance with provisions of the Gila Decree and any modification or amendments thereto.

Figure 12

Site location of Buttes Dam and Reservoir looking east. Photograph No. P344-300-8668.

Figure 13

Artist's conception of Buttes Dam and Reservoir. Photograph No. P344-300-8603.

TABLE 7
ALLOCATION OF STORAGE SPACE IN BUTTES RESERVOIR

Function	Capacity (Acre-Feet)	Cumulative Capacity (Acre-Feet)	Elevation (Feet)
Inactive and Sediment Control	133,000	133,000	1625
Conservation	100,000	233,000	1750
Flood Control	133,000	366,000	1778
Surcharge	54,000	420,000	1787.5

f. Tucson Aqueduct 49,75

(1) Route

The Tucson Aqueduct will originate at the Marana Pumping Plant in Section 9, T. 11 S., R. 11 E., GSRB&M, 2 miles northwest of Marana, Arizona, in Pima County. The aqueduct will proceed in a southeasterly direction from the Marana Pumping Plant for approximately 4 miles to the Marana Regulating Tank. From this point, the aqueduct will continue its southeasterly direction for approximately 16 miles to its terminus in the NE1/4, Section 8, T. 13 S., R. 13 E., GSRB&M, north of Tucson, Arizona. The terminus of the aqueduct will tie to the existing Tucson distribution system through future extensions. The aqueduct alinement was selected as the most economic to deliver water, using the minimum hydrostatic head on the greater portion of the pipeline length. Alternative routes have been considered, as discussed in Chapter VIII, and will be discussed in the individual statement covering this feature.

(2) Design Features

The aqueduct is planned as an underground concrete pipe about 6 feet in diameter with a capacity of 150 cfs. The Marana Pumping Plant, similar in design and environmental considerations to the plants already discussed, will be the only pumping plant in this reach of the aqueduct. The total design head of the pumping plant will be 460 feet with a capacity of 150 cfs. A 1,000-acre-foot regulating reservoir is also planned at the Marana Pumping Plant site. A regulating tank will be constructed on the aqueduct approximately 4 miles northeast of the Marana Pumping Plant.

A right-of-way width of about 99 feet will be required for construction and operation of the Tucson Aqueduct. The total length of the aqueduct right-of-way is 20 miles and will contain 290 acres of land. Of the total acreage in the right-of-way, 140 acres is private land and the remaining 150 acres is state land. Fifty acres of the right-of-way will be required for construction of the Marana Regulating Reservior.

Clearing of native vegetation in the construction area will be minor, with very little restoration required. No replacement of public or private utilities or other improvements will be required in the construction area.

Existing roads will be used for access to the general working area for construction. A service road will be constructed along the aqueduct alinement for maintenance purposes. Since the aqueduct is a closed conduit, borrow areas will not be necessary. Earth materials investigations show that materials excavated for the pipe trench will be suitable for use as compacted embankment and for backfill about the pipe.

(3) Operation

The Tucson Aqueduct will transport Colorado River water to Tucson from the terminus of the Salt-Gila Aqueduct. The aqueduct is currently planned to supply the Tucson area with about 100,000 acre-feet of water annually. Flows in the aqueduct will be regulated in respect to consumptive use requirements in the Tucson area.

g. San Pedro Aqueduct 49,75

The San Pedro Aqueduct, an all-pipeline system, will originate at Charleston Reservoir on the San Pedro River. Water will be released from a controlled outlet through the dam into the pipeline system. The head from the reservoir will provide for the flow to a pumping plant approximately 4 miles downstream on the west bank of the San Pedro River. The pumping plant will raise the water about 320 feet through a 5-1/2-mile-long pipeline westerly to Elevation 4250 in Section 15, T. 20 S., R. 20 E. From this point a gravity pipeline will carry the flow northwesterly and through Mescal Pass and then to the vicinity of Tucson where it will tie into the Tucson muncipal water distribution system.

The aqueduct will be designed to carry a flow of 18 cfs for an annual average of 12,000 acre-feet of water that will be delivered to Tucson to partially supply its needs. Its total length will be approximately 64 miles and will consist of concrete pipe ranging from 21 to 33 inches in diameter. About 750 acres of mostly unimproved land will be required in construction of this feature. The pipeline will be buried to a minimum depth of 3 feet. A 99-foot right-of-way will be required for construction and later for operation and maintenance purposes. The land will be cleared to the extent required for construction and restored as nearly as possible to its original condition. This alinement was selected because of the location of the terminus, and because of the general topographic contour which the pipeline will follow. Alternative routes are discussed in Chapter VIII and will be discussed in the individual statement covering this feature.

h. Charleston Dam and Reservoir 7,14,44,49,54,75,172

(1) Location

The proposed damsite is located on the San Pedro River in Cochise County, Arizona, about midway between Tombstone and Sierra Vista, and about 24 miles upstream from Benson. The dam will be in Section 2, T. 21 S., R. 21 E., GSRB&M. Approximately 6,750 acres will be required in development of this feature. Alternative sites for the dam and reservoir, discussed in Chapter VIII, will be discussed in the individual statement covering this feature. Figures 14 and 15 show the damsite and an artist's conception of the dam and reservoir, respectively.

Figure 14

Site location of Charleston Dam and Reservior looking southwest. Photograph No. P344-300-12289.

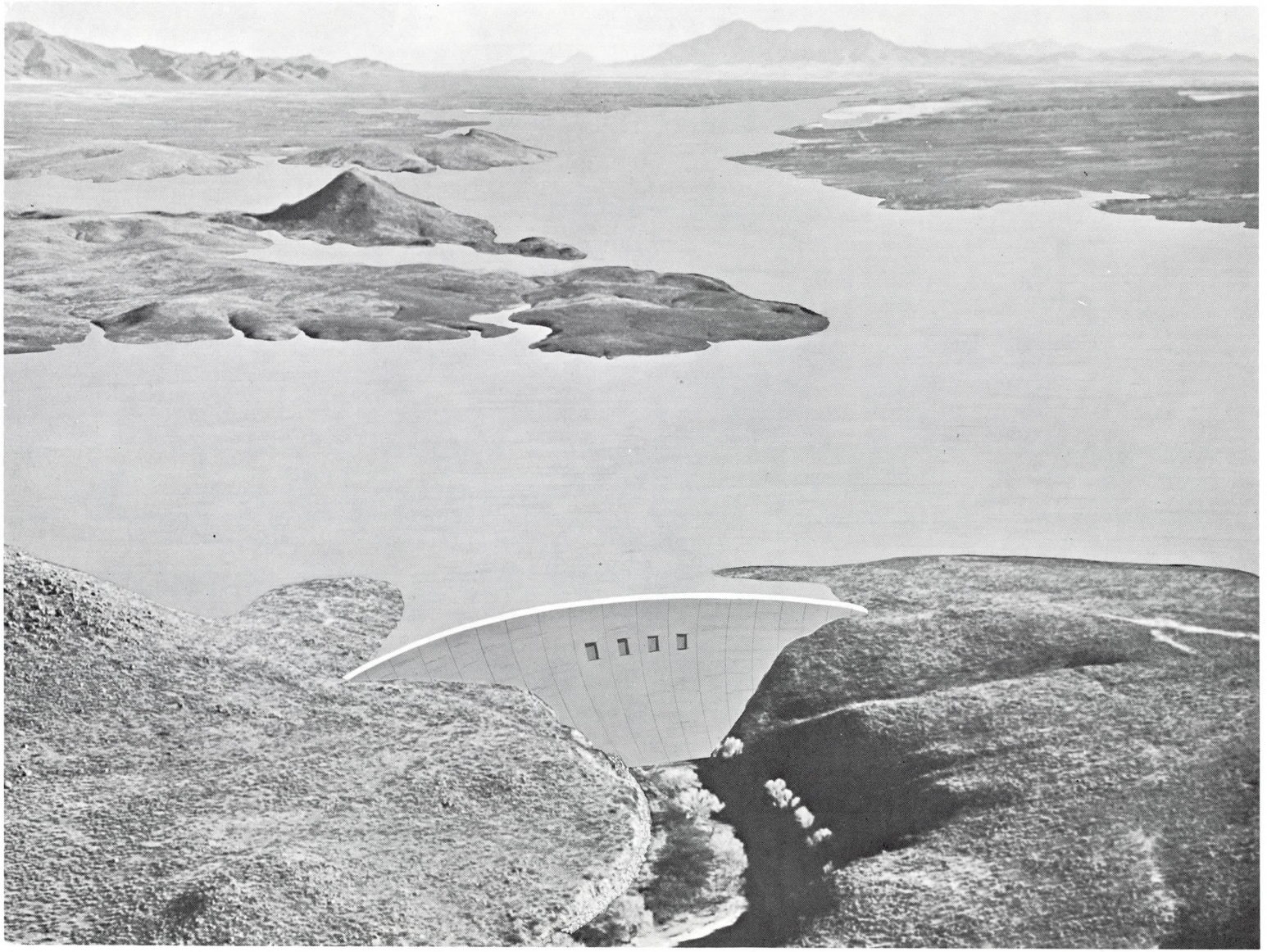


Figure 15

Artist's conception of Charleston Dam and Reservoir. Photograph No. P344-300-12524.

The reservoir when full will extend about 9 miles upstream on the San Pedro River and will inundate about 5,600 acres of land. Ownership of land in the reservoir area is primarily patented land including Spanish Land Grant properties. Some of the land is under Government withdrawal. The reservoir will require some right-of-way from the military reservation at Fort Huachuca.

The reservoir area is crossed by State Highway 90 in the upper reaches and a county road linking Tombstone and Sierra Vista near midreservoir. The Southern Pacific Railroad trackage extends the length of the reservoir on the east side of the river, with a spur extending to Fort Huachuca on the west. The Tombstone water supply line from Miller Canyon crosses about 2 miles of the reservoir area south of Bronco Hill.

(2) Design Features

The dam, as presently designed, will be a double-curvature, thin arch concrete structure rising about 160 feet above streambed to a dam crest elevation of 4090. The dam will have two thrust blocks to spread the load stresses to the foundation. The arch portion of the dam will have a curvature length of 860 feet and a total thrust block length of 570 feet.

In addition to the dam, an earthfill dike will be built in the topographic saddle which extends from about 4,500 to about 8,000 feet west of the river.

The Bureau of Outdoor Recreation has studied the need for land around the reservoir for public recreation use. Based on the Bureau of Outdoor Recreation's recommendation, an additional 1,150 acres of land will be acquired in connection with the acquisition of reservoir land for this purpose.

Major relocations will include portions of the Southern Pacific Railroad, the county road connecting Tombstone and Sierra Vista, and State Highway 90. The Southern Pacific Railroad will be relocated to a higher elevation on the east side of the reservoir, the county road will be relocated downstream of the damsite, and the state highway will be relocated about 1,800 feet upstream from the present bridge. The final determination has not been made concerning the extent of relocation of the Tombstone water supply line.

Construction materials can, for the most part, be obtained from the damsite and the reservoir pool area. Floodplain deposits within the reservoir will be the primary source for both impervious and semipervious earthfill. Channel deposits of the San Pedro River and major tributaries are the readily available sources of sand

and gravel. Riprap can be obtained from required foundation excavation and from sources in the immediate area of the damsite.

About 238,000 acre-feet of capacity is anticipated for the multiple functions of the reservoir. This figure does not include flood surcharge. Initial reservoir allocations are listed in Table 8. The inactive level will be periodically reallocated as sediment buildup occurs. The initial allocation at a low level allows a smaller pool surface which reduces evaporation losses.

(3) Operation

The dam and reservoir will provide conservation of water and control of stormflows of the San Pedro River. Regulation of normal flows, together with retention of stormflows, will benefit downstream users. Downstream water rights will be maintained. The reservoir will provide a minimum pool of 700 acres to facilitate operational control. The minimum pool will also be beneficial in the development of fish and wildlife and recreational resources. The water-holding capability of the reservoir bottom materials indicates that there will be no problems of seepage loss or leakage.

Diversion from the dam will be made under contracts with the Secretary of the Interior for municipal, industrial, and irrigation service.

i. Hooker Dam and Reservoir 7,9,50,51,60,75,159,164,169,172

(1) Location

Hooker Dam site is located on the Gila River entirely within the Gila National Forest in Grant County, New Mexico, about 10 river miles upstream from the communities of Cliff and Gila. The specific site location is at the exit of the Gila River from its gorge incised through the Mogollon Mountains, in the NE1/4, unsurveyed Section 30, T. 14 S., R. 16 W., NMPB&M. The reservoir will inundate about 10 miles of the upper Gila River in southwest New Mexico. About 1,340 acres would be inundated if the reservoir reached maximum water level. Figures 16 and 17 show the damsite and an artist's conception of the dam and reservoir, respectively. Alternative reservoir locations are discussed in Chapter VIII and will be discussed in the individual statement covering this feature.

(2) Design Features

Hooker Dam will be formed by an earthfill embankment. Geologic and topographic evaluation indicates that an earthfill structure is preferable to a concrete structure. Adequate quantities of

TABLE 8
INITIAL ALLOCATION OF RESERVOIR SPACE IN CHARLESTON RESERVOIR

Function	Area Inundated (Acres)	Capacity (Acre-Feet)	Cumulative Capacity (Acre-Feet)	Elevation (Feet)
Dead (sediment)	700	14,000	14,000	4000
Inactive	1,000	8,000	22,000	4010
Conservation	4,000	103,000	125,000	4055
Flood Control	5,600	116,000	238,000	4070

Figure 16

Site location of Hooker Dam and Reservoir looking northeast. Photograph No. P344-300-8636.

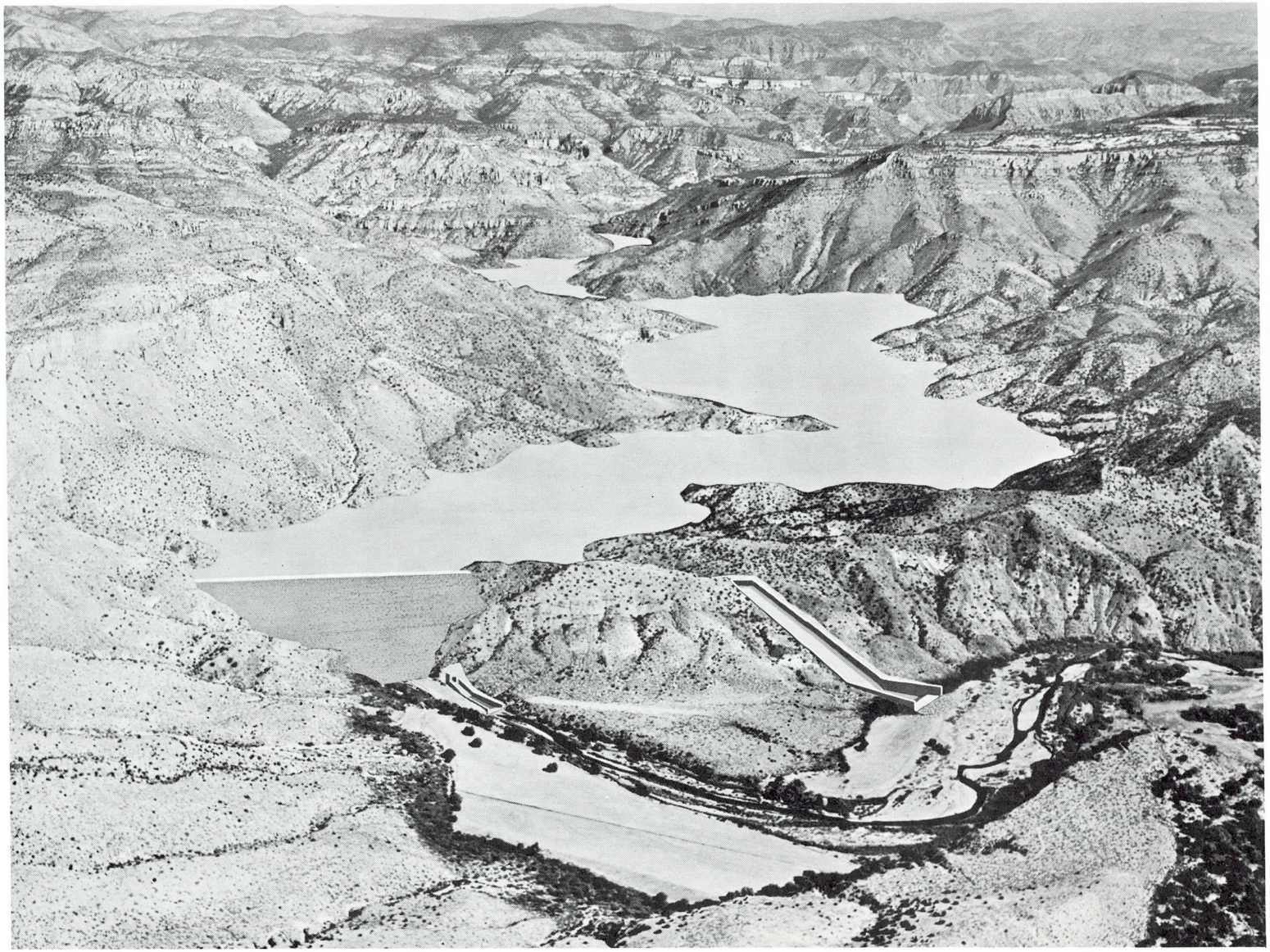


Figure 17

Artist's conception of Hooker Dam and Reservoir. Photograph No. P344-300-8604.

construction materials are readily available in the area. Foundation and water-holding capability of the dam and reservoir appear to be excellent. Present plans call for the structure to rise about 235 feet above the streambed to an elevation of 4,895 feet with a crest length of about 1,500 feet. The structure will taper from a base width of about 1,300 feet to a 40-foot-wide crest.

The dam and reservoir site is in a remote area. Additional road construction will be required to provide accessibility to the site from the existing state, county, and Forest Service roads in the immediate vicinity.

Hooker Dam will provide storage capacity for flood control, sediment control, water conservation, and recreation and fish and wildlife opportunities. The reservoir will have a conservation capacity sufficient to implement the provisions of Subsection (f) of Section 3 04 of Public Law 90-537. The space is tentatively allocated as shown in Table 9. The land areas to be inundated by the various reservoir levels are shown in Table 10.

The dam will be a permanent structure. The reservoir created will provide for sediment deposition for a minimum period of at least 100 years.

(3) Operation

Hooker Dam and Reservoir will allow water users in New Mexico to increase their consumptive use from the Gila River and its tributaries by project water exchange agreements with downstream water users in Arizona. The downstream water users who are affected will obtain replacement water from the CAP aqueduct system. This is in accordance with the provisions of Subsections 304(d) and (f)(1) of Public Law 90-537. It is anticipated that the water developed by Hooker Dam will be used primarily for municipal purposes and for mining-oriented industry. Diversions for M&I uses will be made available at the dam for delivery by the contractor's system. Potential conveyance systems from the reservoir are not a part of CAP plans or cost estimates.

Hooker Reservoir will be operated to insure that there will be no economic injury to downstream contractors within the Gila River system in Arizona. Diversions and depletions in New Mexico will be such that the annual consumptive use will not exceed an average of 18,000 acre-feet per year in any period of 10 consecutive years, over and above those consumptive uses allowed New Mexico under the Arizona v. California Decree. Additional diversions will be permitted in the future when the Colorado River is augmented and works for further exchanges are constructed.

j. Power and Transmission Requirements 68,69,103,167,199

For the purpose of supplying the power requirements of the CAP and augmenting the Lower Colorado River Basin Development Fund, the Secretary of the Interior was authorized and directed by Section 303 of the project Act to determine and recommend a plan to Congress within 1 year of the effective date of the project Act. The Secretary filed his report with Congress on September 30, 1969, concluding that taking into account manufacturers' warranties, motor efficiencies, power transformers, station auxiliary losses, and transmission losses, the electric capacity required at the powerplant to serve the CAP operating at full hydraulic capacity of 3,000 cfs would be 561 megawatts. The Secretary's report recommended that the Federal Government participate in a thermal-generating powerplant as the most suitable alternative for supplying the power requirement of the CAP. On December 12, 1969, the Secretary signed contracts providing for participation by the United States in the Navajo Project which consists of a thermal powerplant near Page, Arizona, and associated transmission facilities.

The power requirement was determined prior to final water allocations to the potential water contractors, resolution of alternative conveyance methods to be employed in the Phoenix metropolitan area, more specific determination of the design value of energy, and the concomitant hydraulic design gradient of the aqueduct system.

The following items were included to cover contingencies to the CAP power requirement:

Item	Increase
1. An additional 14-1/2 miles of cut-and-cover section	10 mw
2. An additional 100,000 acre-feet of water to the City of Tucson	9 mw
3. An increase in the canal slope	7 mw

With these items, the total power requirement was 560 megawatts for the 3,000-cfs Granite Reef Aqueduct. This rounded figure was subsequently refined to 561 megawatts.

TABLE 9
TENTATIVE SPACE ALLOCATION FOR HOOKER RESERVOIR

Function	Capacity (Acre-feet)	Cumulative Capacity (Acre-feet)	Elevation Feet
Sediment 100 yrs.	10,000	10,000	---
Inactive	20,000	30,000	4780
Conservation	70,000	100,000	4863
Flood Control		(under reevaluation)	
Surcharge		(under reevaluation)	4890

TABLE 10
LANDS INUNDATED AT VARIOUS WATER LEVELS
IN THE PROPOSED HOOKER RESERVOIR

Elevation Feet	Lands Inundated (Acres) Gila National Forest			
	Forest	Primitive	Wilderness	Total
4780	580	---	---	580
4863	900[1/]	80	140	1,120
4890	1,070[1/]	90	180	1,340

1/ The 900 and 1,070 acres include some patented lands within the Gila National Forest.

Prior to a heightened awareness of the multifaceted capabilities of the Paradise Valley Reach of the Granite Reef Aqueduct to provide a greenbelt area and flood protection for the Indian Bend Wash area of Phoenix, Paradise Valley, Scottsdale, and north Tempe by means of the Paradise Valley Detention Dam, consideration was included for an additional 7-mw pumping plant at Cave Creek to overcome the additional friction loss for 10-1/2 miles of closed concrete conduit through this area. By using a canal section through Paradise Valley and eliminating the Cave Creek Pumping Plant, the effect of increased friction slope has been offset.

The 10-mw allowance for additional cut-and-cover section does not presently appear to be required. The final water allocation to the Tucson metropolitan area and the upper Santa Cruz River basin with its overdraft for agriculture, mining, and municipal purposes will remain in the contingency stage until after water service contract negotiations are completed.

Table 11 lists presently anticipated power requirements in horsepower and megawatts at the high voltage side of the bus at each CAP pumping plant. Data are included for the project with Granite Reef Aqueduct capacity of 3,000 cfs.

The total megawatt demand at the high voltage side of the bus was multiplied by 1.09 to allow for transmission system losses. For the 3,000-cfs aqueduct the 483-megawatt demand at the high voltage side of the bus at the pumping plant requires a 527-megawatt output at the power source.

Another pumping plant, not listed in Table 11, called the Orme-Granite Reef Pumping Plant, will be required. This plant is designed to pump releases from Orme Reservoir to the Salt-Gila Aqueduct when the aqueduct is not carrying Colorado River water to full capacity. It would, therefore, not be used when the aqueduct system was operating at maximum capacity and would not add to the maximum power demand.

To cover the estimated CAP load, the Secretary of the Interior contracted for an entitlement of 24.3 percent of the then 2,310-megawatt capacity of the Navajo Generating, or 561 megawatts. Subsequent to this contract, however, the generating plant station service load requirements have increased to operate wetscrubbers and other items of equipment for environmental protection. The present plant rating is 2,250 megawatts and the 24.3 percent entitlement of this capacity is 546.75 megawatts.

Accordingly, the contract capacity now available from the Navajo plant is still adequate to meet the pumping requirement during years when less than 2.2 maf are diverted. When the full hydraulic capacity of the aqueduct system is utilized throughout the entire year, it may be necessary to acquire additional capacity and energy from sources other than the 24.3 percent of the Navajo plant.

(1) Design/Operation Criteria

The Navajo Project points of power delivery to the CAP are at the McCullough Switching Station and the Westwing Substation sites. McCullough Switching Station site is located near Boulder City, Nevada. The Westwing Substation site is situated near Phoenix, Arizona.

In order to determine the transmission system requirements between these two substations and the CAP pumping plants using Navajo Project power, various power-flow studies have been made. Three basic transmission plans were investigated: (1) Liberty to Buckskin 230-kv line with intermediate substations at Harcuvar and Hassayampa and Mead-Buckskin 230-kv line with possible interconnections at Davis and Parker Dams; (2) Liberty-Buckskin 230-kv line with intermediate substations at Harcuvar and Hassayampa and Burro Creek-Buckskin 345-kv line tapping the existing Mead-Liberty 345-kv line near Burro Creek; and (3) Liberty-Buckskin 230-kv line with intermediate substations at Harcuvar and Hassayampa and Burro Creek-Buckskin 230-kv line tapping existing Mead-Liberty 345-kv line near Burro Creek.

The alternatives to the base plans studied included six alternate base power-flow cases with a variety of different line outage cases. The variations to the base cases were made by changing the voltage of the lines, by different schemes of interconnecting to existing facilities and by altering line routes.

In selecting a suitable transmission plan, many factors were considered, the most significant being: (1) environment, (2) an integrated lower Colorado region system to serve all Federal needs, and (3) proper accounting of costs among the projects. An integrated transmission system approach was used to develop the basic transmission plan which would serve all project loads in the area in the most economical and reliable manner, and provide flexibility of operation and maintenance. Figure 17E illustrates by a schematic sketch the proposed CAP transmission system and is not intended to show the exact line, substation, and pumping plant locations.

A 230-kv backbone transmission system was selected from the various plans studied to interconnect the CAP pumps with the Navajo Project delivery points. The backbone transmission system consists of the Davis-Mead 230-kv Transmission Line No. 2, the Davis-Parker 230-kv Transmission Line No. 2, the Liberty-Parker 230-kv transmission line with intermediate substations at Harcuvar and Hassayampa, the Westwing interconnection with Liberty-Pinnacle Peak 230-kv circuit, and the McCullough-Mead interconnections.

An interconnection of the existing Liberty-Pinnacle Peak 230-kv transmission line into the Navajo Project Westwing Substation will provide a path for power flow between the Navajo Project and the CAP transmission system. This interconnection will consist of about 1-1/2 miles of double circuit line. It is anticipated that a similar arrangement for interconnecting

TABLE 11
POWER REQUIREMENTS FOR THE CENTRAL ARIZONA PROJECT

Pumping Plant	Estimated Design Pumping Efficiency (Percent)	Location (Miles)	Total Head (Feet)	Q (cfs)	Horse-power	MW Demand at High Voltage Side of Bus **
Granite Reef Aqueduct						
Havasu	85.6	*	820	3,000	326,400	285
Bouse Hills	87.7	18.4	105	3,000	40,800	35
Little Harquahala	87.7	51.5	105	3,000	40,800	35
Belmont Mountains	88.2	101.9	97	3,000	37,500	33
Hassayampa	92.0	114.3	81	3,000	30,000	26
Salt-Gila Aqueduct						
Salt-Gila	84.6	4.4	84	1,800	20,300	18
Picacho Mtns. #1	81.3	64.6	146	750	15,300	13
Picacho Mtns. #2	83.1	66.4	310	750	31,800	28
Tucson Aqueduct (Colorado Source)						
Marana	74.7	0.3	460	150	10,500	9
Tucson Aqueduct (San Pedro Source)						
San Pedro	75.0	4.0	330	18	900	1
				Total	554,300	483

* Havasu Pumping Plant is located on the Bill Williams arm of Lake Havasu. Stationing on the Granite Reef Aqueduct starts at Buckskin Mountains Tunnel outlet portal.

** The demand at the high voltage side of the bus was obtained by converting horsepower to megawatts - then dividing by 0.90 to allow for pump manufacturer's overbuilding to meet warranties, extra capacity to cover wear, etc. This answer is again divided by 0.95 to allow for motor efficiency and power transformer and station auxiliary losses.

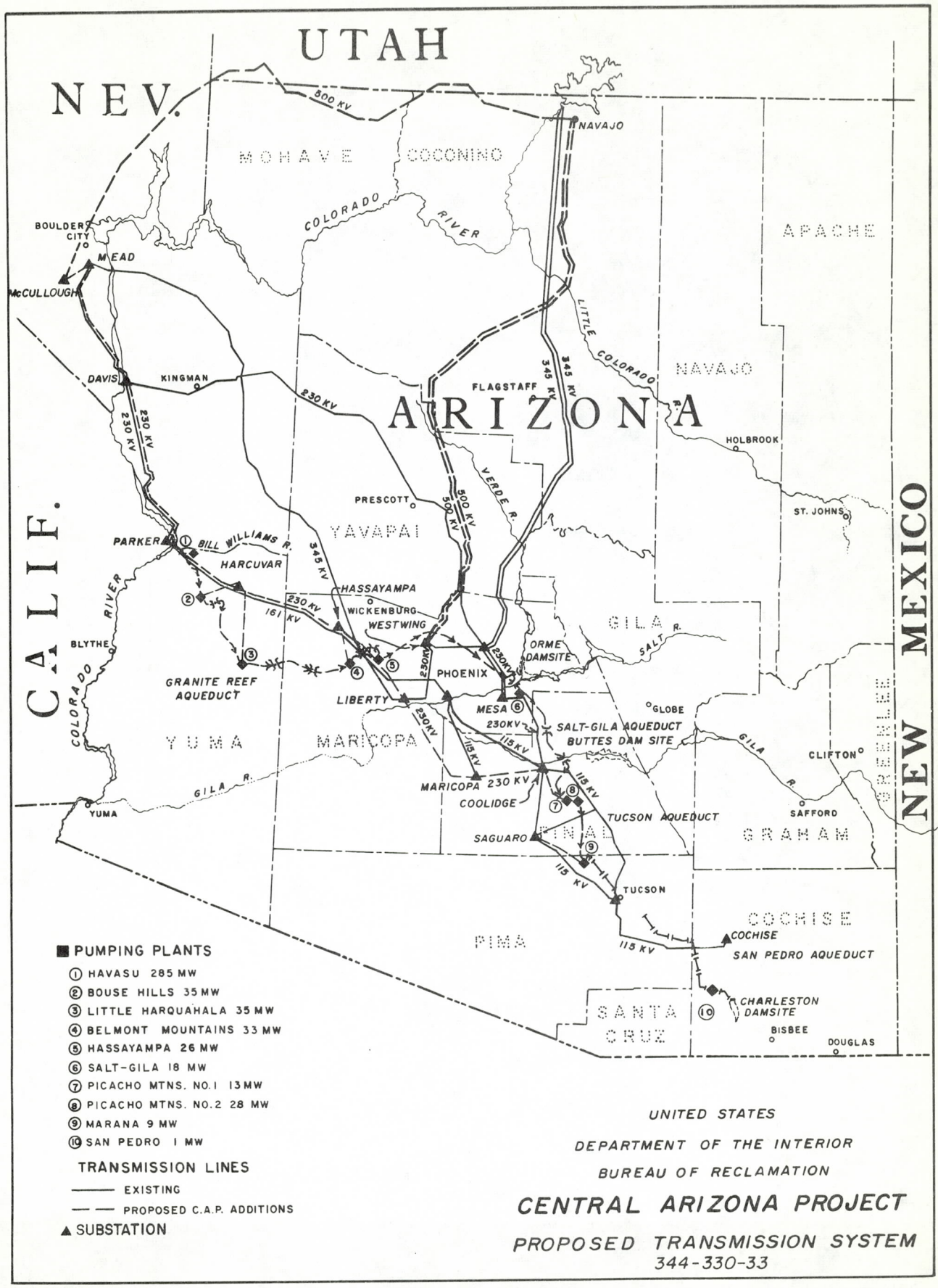

UTAH
NEV.
CALIF.
NEW MEXICO
ARIZONA
MOHAVE
COCONINO
APACHE
NAVAJO
YAVAPAI
YUMA
MARICOPA
PIMA
GILA
GRAHAM
COCHISE
SANTA CRUZ
GREENLEE
TINAJA
NAVAJO
500 KV
COLORADO RIVER
LITTLE COLORADO
VERDE R.
SALT R.
GILA R.
BILL WILLIAMS R.
BOULDER CITY
MEAD
McCULLOUGH
DAVIS
KINGMAN
PARKER
HARCUVAR
HASSAYAMPA
WICKENBURG
WESTWING
BLYTHE
GRANITE REEF AQUEDUCT
LIBERTY
PHOENIX
ORME DAMSITE
MESA
SALT-GILA AQUEDUCT
BUTTES DAM SITE
COOLIDGE
MARICOPA 230 KV
SAGUARO
TUCSON AQUEDUCT
TUCSON
YUMA
PRESCOTT
FLAGSTAFF
HOLBROOK
ST. JOHNS
GLOBE
CLIFTON
SAFFORD
COCHISE
SAN PEDRO AQUEDUCT
CHARLESTON DAMSITE
BISBEE
DOUGLAS
345 KV
230 KV
161 KV
115 KV
PUMPING PLANTS
① HAVASU 285 MW
② BOUSE HILLS 35 MW
③ LITTLE HARQUAHALA 35 MW
④ BELMONT MOUNTAINS 33 MW
⑤ HASSAYAMPA 26 MW
⑥ SALT-GILA 18 MW
⑦ PICACHO MTNS. NO.1 13 MW
⑧ PICACHO MTNS. NO.2 28 MW
⑨ MARANA 9 MW
⑩ SAN PEDRO 1 MW
TRANSMISSION LINES
EXISTING
PROPOSED C.A.P. ADDITIONS
SUBSTATION
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
PROPOSED TRANSMISSION SYSTEM
344-330-33

Figure 17E

Mead Substation to McCullough Switching Station will be accomplished by a short tieline, or by contractual arrangements over existing facilities.

The backbone transmission system will deliver power and energy for the Havasu Pumping Plant. Power and energy will also be delivered through these facilities to the Bouse Hills, Little Harquahala, Belmont Mountains, and Hassayampa Pumping Plants and regulating structures on the Granite Reef Aqueduct.

To serve CAP pumping loads on the Salt-Gila, Tucson, and San Pedro Aqueducts, additional transmission system capacity will be required. Planning studies have shown that the 115-kv system south and east of Phoenix could have problems delivering power sometime after 1972. To provide the additional system capacity, construction of a new transmission line into the area will be required. The studies indicate the best solution to this problem would be the joint construction by CAP and Parker-Davis Project of Liberty-Maricopa and Maricopa-Coolidge 230-kv transmission lines with direct allocations of costs and usage to these projects. Construction of these 230-kv lines would provide a system to deliver power to CAP pumps, allow removal of the existing Phoenix Substation and the 115-kv and 161-kv lines emanating from it. The capability of the Bureau of Reclamation's 115-kv system south of Phoenix would also be increased by construction of additional 230-kv transmission lines into the area. Power for pumping plants on the Salt-Gila, Tucson, and San Pedro Aqueducts will be supplied from existing substations as far as practical. Some modifications will be made at the existing substation yards.

The high voltage transmission line design will probably utilize steel, single circuit, free-standing towers with each tower supporting the conductors in a horizontal plane and two overhead ground wires. Design and location of the transmission lines will conform with the "Environmental Criteria for Electric Transmission Systems," as published by the U. S. Departments of the Interior and Agriculture. Other appropriate environmental design criteria, such as the Western Systems Coordinating Council's "Environmental Guidelines," will also be used. The high voltage transmission line between the Phoenix and Parker areas will not be restricted to the location on or adjacent to the aqueduct since the line's location will not be limited to the grade of the aqueduct. The lines will generally parallel existing transmission lines or be constructed on existing right-of-way. In areas where existing right-of-way is not of sufficient width or the environmental protection criteria dictate that the line should be located elsewhere, additional right-of-way will be required. Since the new lines will parallel existing facilities as nearly as possible, additional access roads for construction and maintenance will be minimal.

Two new intermediate substations, Harcuvar and Hassayampa, will be constructed along the high voltage transmission

line between Parker and Liberty Substations. These substations will provide power for the four in-line pumping plants located on the Granite Reef Aqueduct. The substation design will include modern, low-profile structures to minimize visual impact on the area.

The original transmission system plan indicated that it would be desirable from a reliability standpoint to interconnect the Havasu Pumping Plant with the Parker Switchyard. Three transmission lines would then terminate in the Havasu Pumping Plant area, one each to the north, east, and the Parker Switchyard. To avoid a large substation at the pumping plant site, the substation would be located at a remote site and the pumping plant supplied by means of a single line thereby reducing the environmental impact by minimizing the facilities needed at the pumping plant site. Three possible sites for the substation were considered. The Aubrey site was located approximately 2 miles north of the pumping plant across the Bill Williams River. The Monkeys Head site was situated approximately 1.5 miles southwest of the pumping plant. The third site, Buckskin, was located about 4 miles east of the pumping plant. Buckskin Substation was determined to be the best alternate from an environmental standpoint. This plan would eliminate construction of a substation on the north side of the Bill Williams River or adjacent to U. S. Highway 95 and the Colorado River. Other impacts in the substation area, such as esthetics and construction activities, would be the same at all of the sites.

Further review of the environmental and economic factors of constructing a separate Buckskin Substation has indicated that use of existing facilities at Parker Switchyard is a more acceptable alternative. Four 230-kv breaker bays are available in the Parker Switchyard for use by CAP. To handle the additional load, it will be necessary to uprate the capacity of the 230-kv bus and the interrupting rating of the existing 230-kv breakers. A tie to Havasu Pumping Plant would then require about 1-1/2 miles of transmission line which would terminate in a 230-kv terminal structure and continue underground approximately 1/2 mile to the pumping plant. Also at the pumping plant, the existing 69-kv Parker-Bagdad line will be placed in cable and fed from the pumping plant transformers through an underground cable. This may permit eventual removal of the existing 69-kv wood pole line from the Havasu Pumping Plant area to the Parker Switchyard and removal of a small substation serving it.

Radial transmission lines will be required from the high voltage transmission lines to provide the necessary power and energy to all of the CAP pumping plants. The distribution lines will have voltage capabilities ranging from 69-kv to 115-kv depending on the load requirements of each individual pumping plant. Radial transmission lines for the Bouse Hills, Little Harquahala, Belmont Mountains, and Hassayampa Pumping Plants will originate from two substations - Harcuvar and

Hassayampa - on the proposed high voltage transmission line between Parker Dam and Phoenix, Arizona. The Granite Reef, Salt-Gila, Picacho Mountains Nos. 1 and 2, Marana, and San Pedro Pumping Plants radial transmission lines will originate from existing Parker-Davis transmission facilities or will utilize these facilities as much as possible. All of the new radial transmission lines will require acquisition of right-of-way for construction and maintenance. Single circuit wood pole construction is expected to be used for the radial transmission lines. Choice of size, shape, color, and location for the structures will be analyzed to minimize contrast with the environment. Feeder lines which will provide electrical service to the check structures along the aqueducts will be located underground to the extent practicable.

The undergrounding of transmission lines has been considered. In areas of high population where a right-of-way is not available, high voltage lines are being placed in underground conduit. This, of course, is possible only where cost considerations become secondary. The Westinghouse Electric Corporation, for instance, has estimated that to underground a 345,000-volt transmission line for some 300 or 400 miles, it would require an expenditure of at least 26 times the cost of placing the transmission line overhead on conventional towers and using a conventional type of construction. For this reason the undergrounding of transmission lines is generally not considered feasible. The major economic factor in undergrounding high voltage transmission lines lies in the cost of the continuously insulated electrical cable and in the facilities needed to maintain this insulation. Also required are a considerable number of expensive reactor stations which are necessary to offset the inherent capacitive effect of the cable.

In situations where the voltage level is considerably less, such as for radial transmission lines in city urban construction where voltages are, perhaps, on the order of 15,000 volts, undergrounding costs are only about twice those of normal construction.

In urban areas where distribution voltages are used, the numerous local loads located periodically along the cable hold this voltage to acceptable levels. This is not true in transmission cables.

Although there are many modern innovations in high voltage transmission in cable-type conductors, such as superconducting cable and various other exotic methods, all are presently too expensive to consider for long distances.

Additional information on the transmission lines and related facilities will be provided in the individual statements on the major features.

(2) Location of Proposed Transmission Lines

Reconnaissance surveys were conducted in May 1972 to determine the best possible routes for the backbone transmission system between Mead Substation located near Boulder City, Nevada, and Liberty Substation located near Phoenix, Arizona. The transmission system routes will be described in three parts, the Mead-Davis 230-kv Transmission Line No. 2, the Davis-Parker Transmission Line No. 2, and the Liberty-Parker 230-kv Transmission Line.

The Mead-Davis 230-kv Transmission Line No. 2 will originate at the Bureau of Reclamation's Mead Substation located in Section 28, T. 23 S., R. 64 E., MDB&M, and will be approximately 70 miles long. The line parallels at 150 feet the existing No. 1 Mead-Davis 230-kv line which travels from Mead Substation in a southerly direction across the Eldorado Valley, in an area that is presently traversed by several transmission lines and numerous dirt roads. The transmission line will be located between the Eldorado Mountains and U. S. Highway 95, to a point west of Copper Mountain where it will traverse Cottonwood Valley between the Eldorado Mountains and the Newberry Mountains. The transmission line will enter the Lake Mead National Recreation Area (LMNRA) near Bill Gay's Butte and will continue in a southeasterly direction traversing the Newberry Mountains near Lake Mohave. The line will cross the Colorado River approximately 1,500 feet downstream from Davis Dam and will enter the Davis Dam Switchyard. Approximately 20 miles of transmission line will be located within the LMNRA. However, the visual impact of the line in the recreation area will be minimal since it will follow an established line corridor and will not be the first such encroachment on the area.

The Davis Switchyard has enough area to accommodate the new equipment required for the Mead-Davis No. 2 line. No additional grading will be necessary in this area. It will be necessary to extend the present fences. All other associated work will then be performed within the fenced switchyard area.

After leaving the Davis Switchyard, the 70-mile Davis-Parker 230-kv No. 2 transmission line will continue to parallel the existing No. 1 transmission line to a point north of Lake Havasu City, Arizona, where the line will diverge and follow a route which is behind a range of high rocky ridges. This section of the alinement is very rough, with high rocky ridges and boulder strewn canyons which restrict travel in the area. This portion of the transmission line and access road will be hidden from Lake Havasu City and Lake Havasu. After leaving this area, the terrain changes to large wide washes and steep narrow ridges with rocky outcrops, which will permit the access roads to be hidden from view by utilizing washes. A small portion of the line may

be visible in this area from Lake Havasu. After leaving the Lake Havasu City area, the line again parallels the existing line and will utilize the present access roads. Approximately 4 miles north of Parker Dam, the alinement crosses an area that is presently being developed for subdivision purposes. This portion of the alinement will also be visible from U. S. Highway 95. It will be necessary for the transmission line to traverse a small portion of the Havasu National Wildlife Refuge to the shores of Lake Havasu. From this point, the line will cross the lake into California and continue on to the Parker Dam 230-kv switchyard. The crossing span will be approximately 2,730 feet long. This span will be adjacent to the Parker-Davis 230-kv Transmission Line No. 1 and the Citizen's Utility Company's Lake Havasu City transmission line in an established transmission line river crossing corridor. As previously stated in this statement, existing bays in the Parker Switchyard will be used for terminating the transmission line. The length of this section of the line is approximately 69 miles and crosses typical desert terrain with sparse vegetation.

The 120-mile Liberty-Parker 230-kv transmission line will utilize the right-of-way now being occupied by the Parker-Phoenix 161-kv No. 1 line. The existing transmission line will be removed and a new 230-kv transmission line constructed in its place. The line will be duplex conductor to have sufficient capacity to serve the CAP loads and the maximum capacity of the existing 161-kv line. The uprating of the existing line will keep the environmental impact to a minimum by: (1) utilizing an established right-of-way, (2) using one line in lieu of two, (3) replacing a line that has been in service for many years and requires a great amount of maintenance, and (4) utilizing existing access roads for construction and maintenance.

Liberty Substation is located in Section 19, T. 1 N., R. 2 W., GSRB&M. From this point, the line proceeds in a northwesterly direction across the Hassayampa Plain and McMullen Valley. The line traverses the Harcuvar Mountains through Cunningham Pass and continues across Butler Valley and Cactus Plain to Osborne Wash where it traverses the Buckskin Mountains through Giers Wash. After leaving the Buckskin Mountains, the line runs approximately parallel to Highway 95 and the Colorado River to a point opposite the Parker Dam powerplant where it will cross the river into California and enter the Parker Switchyard.

k. Communication System

A communication system will be necessary to provide status monitoring of the various pumping plants and aqueduct checks associated with the CAP. Microwave channels to provide communication circuits and telemetering circuits from the Navajo Generating Station are being provided and developed by the Project Manager (Arizona Public Service Company) for the Navajo Southern Transmission System. As a result, it

will only be necessary to add additional channels to the equipment presently being installed. In general, the communication and microwave systems required by the CAP will utilize already existing and developed sites on the Parker-Davis system. It will probably not be necessary to make new entries in remote areas. The only additions required will be microwave antennas to provide microwave channels from the pumping plants to the base stations for existing microwave sites as necessary. Data acquisition and control from the various canal check structures will be provided by buried cable from the pumping plant sites in either direction. The minimum excavation required for burying the cable will be accomplished in conjunction with aqueduct and pumping plant construction.

1. Irrigation Distribution System 7,75,173,174

Within the Central Arizona Water Conservation District there are 26 organized irrigation entities that have submitted expressions of interest in contracting for CAP water. Eleven of these entities have surface distribution systems of varying conveyance and operating efficiency, capable of operating on a unified and coordinated district basis. Of these 11 entities, 8 entities receive varying portions of their supply as surface water by direct river diversion, by transfer from another district, or near a district boundary line. The remaining 15 entities have no semblance of a coordinated system. Only two of the 26 districts have internal conveyance and distribution laterals that are lined to the individual farm turnout.

Concurrent efforts are being made in the area of contract negotiation for project repayment, subsidiary water service contracts, and to formulate plans for distribution and administration of the imported water supply. Water-using agencies in the area have expressed a willingness and desire to contract for water service and are negotiating contract terms. The water will be distributed to the contractors at aqueduct-side measuring turnouts along the main aqueducts. These aqueducts will either be underground pipe systems or lined canals. Contracting agencies will be responsible for distributing water supplies from the main aqueduct to the point of use. The conservation of water by the increased efficiency of operation and curbing of the nonbeneficial consumptive uses has been considered in the analysis of water supply under future project conditions.

In all areas, an improvement in conveyance and distribution system efficiencies is essential to obtain optimum water development and use. Widely varying capabilities and conditions exist among and between the various organized districts and unorganized areas. Lining of presently unlined and future conveyance and distribution systems would be provided by, and would be the responsibility of, existing or to-be-formed districts, that contract for project water. This is a legislative requirement found in Section 304 of the authorizing act and is particularly applicable in Maricopa, Pima, and Pinal counties and in the Upper Gila River areas. Several water user organizations have lining programs in progress and others are planning such work in the near future.

All new distribution systems constructed to deliver water to areas now dependent solely upon private pumps will be built with modern impervious linings or pipe systems. Existing unlined systems will be rehabilitated by the water users to provide lined or pipe systems throughout the project area.

Present planning contemplates that distribution systems authorized under Sections 301 and 309 of the project act to deliver project water to lands served would be constructed and financed by local water-using entities, or by the Bureau of Reclamation under separate repayment contracts.

The existing facilities of the Salt River and San Carlos Projects, the Maricopa County Municipal Water Conservation District, and several other districts, are based on integrated surface- and groundwater supplies. Rehabilitation and lining of conveyance and distribution works in progress by these districts to improve their system efficiencies would be completed under project conditions.

Costs of distribution systems for concrete-lined or underground pipe systems have been estimated on the basis of cost values per acre of area under system service. An adjustment may be needed after water allocations to subcontractors are established. A total area of about 500,000 acres has been considered to require distribution facilities.

These quantites are used for establishing facility design requirements and for alternative design analyses. Subsequent modifications may be expected after later determinations are made on distribution to various areas of need and negotiated contracts.

m. Drainage and Reuse Facilities 75,173,174

The control, use, and disposal of the return and effluent flows in the project area will require physical facilities and contractual provisions governing the control and recycling of return flows. The regimen change from agricultural to urban uses will alter the hydrologic cycle. Flows which formerly reached the ground-water reservoir by deep percolation of applied water will, in the future, become increasingly available at treatment plant outfalls. The magnitude of these import and local supply return flows may approach 650,000 acre-feet annually under full project conditions. In the Phoenix metropolitan area the uncontrolled or unmanaged release of return flows of this magnitude could exceed the capability of downstream Gila River diverters to utilize those flows without the creation of a drainage problem. Flows from this source would be of a quality generally adequate for irrigation of crops that are not directly ingested. These flows would probably be of sufficient magnitude to supply certain industrial demands and agricultural lands within economical transport distance. This water, utilized as a surface supply, would leach through the soil and carry excessive dissolved solids through and below the root zone. Drainage of the lands upstream from the barrier at Gillespie Dam may require as part of the project works

a system of open drains and drainage wells. The magnitude of future drainage water discharge over Gillespie Dam will, to a large measure, be determined by the recycling of metropolitan waste water effluent by water contracting entities upstream, and the extent of contractor efficiency exercised in controlling the return flows at the boundary of the contracting district. In the event the contractor does not put the return flow to beneficial use, the Secretary reserves the right to recapture the water for project use.

CHAPTER II

DESCRIPTION OF THE ENVIRONMENT

II. DESCRIPTION OF THE ENVIRONMENT

This chapter describes the present and projected future environment of the project area within the Gila River watershed and areas contiguous to the aqueducts. Section A deals with the general environment of the CAP project area. Section B makes projections about the future environment of the area without the project, and Section C deals with the specific environments of various project facilities. The discussion in Section C will be expanded in the individual environmental statements which will be prepared covering the major features of the project. Certain drawings from the Framework Study are included in this chapter primarily for illustrative purposes. It should be pointed out that these drawings are only as accurate as the mapping standards set up for the study. Therefore, some differences between these drawings and the more refined data presented in this statement, or subsequent individual environmental statements, will occur. Two of the differences will be noted later in this chapter.

A. The Present Environment of the Project Area

1. Topography[131,134,135]

The project area lies within the Gila River watershed upstream of Gila Bend in the Basin and Range physiographic province of the Southwest. Elevations range from around 500 feet above mean sea level near the Painted Rock Reservoir to Mt. Graham's 10,713 feet near Safford, Arizona.

The Basin and Range province is characterized by mountain chains and alluviated valleys. (See Figure 17A) That part of this province which borders the Colorado Plateau is mountainous with some small valleys, but in the southwestern part containing the prime service area of the CAP, the buttes and ranges are of generally small area, protruding above wide alluvial plains and valleys. The valleys consist of a series of interconnected basins partly filled with alluvium. The basin rims are formed by mountain ranges consisting of many types of rock, which usually have been subjected to faulting, and are strongly deformed. Differential erosion has given the ranges an irregular appearance. (See Figure 17B, and Table 11A)

The aqueduct system and the direct service area of the CAP lie within the sonoran desert and Mexican highland sections of the Basin and Range physiographic province. The area is composed primarily of the historic flood plains of the Gila and Salt Rivers and their tributaries, intersected by alluvial fans of many ephemeral side drainages. Numerous isolated mountain ranges separate the broad, gently sloping alluvial floored basins. These alternating mountains and basins were produced by large-scale faulting in which mountain blocks were uplifted and basin areas were depressed. Subsequent to and during faulting, the valleys were filled with alluvial material eroded from the mountain masses which are composed chiefly of granite, gneiss, schist, and various volcanic and sedimentary rocks.

Most of the project service area in central Arizona lies between elevations of 900 and 2,400 feet above mean sea level. Mountain blocks range up to 10,713 feet in elevation but usually have heights of between 500 and 2,000 feet above surrounding valley floors. The valley floors in the upper Gila River basin range in elevation from 2,500 to 5,000 feet.

Drainage in the mountain ranges consists of numerous short canyons or simple systems of branching canyons and gullies. Trunk canyons enter the basin areas at the apexes of alluvial fans. The larger channels commonly retain their identity down the fans and across the basin floors, but other canyons distribute their intermittent flows into a separate system of branching transient gullies. The basin floors are drained by a myriad of shallow subparallel washes running directly downslope. The washes and gullies eventually flow into a central wash or braided channel along the axis of the basin. Larger desert washes and intermittent rivers collect the drainage from a number of separate basins. None of the basins in the project area contains a closed drainage system.

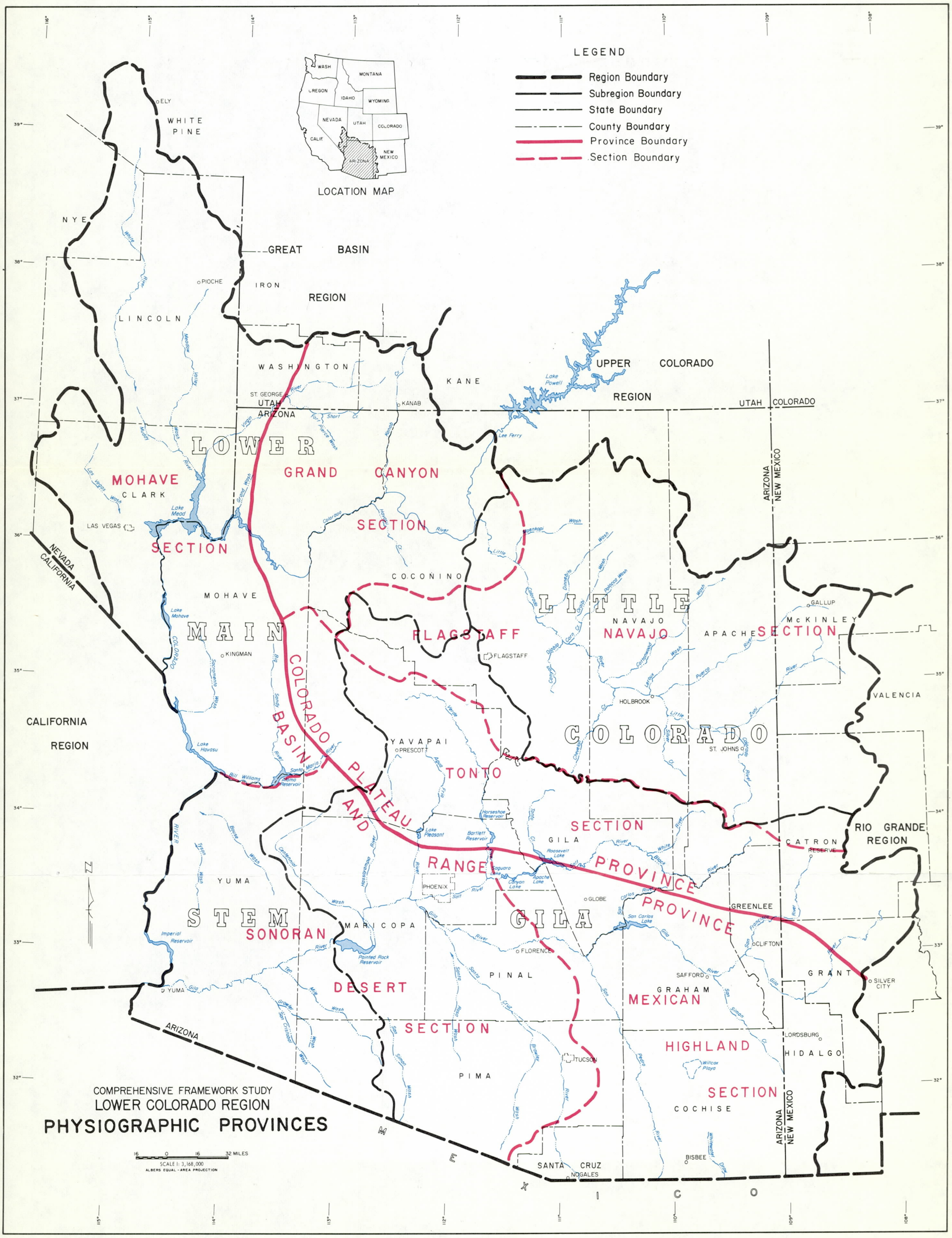
The perennial and intermittent rivers of the sonoran desert section originate in the mountains areas to the north, east, and south which receive relatively larger amounts of precipitation than the desert. The project area contains the Hassayampa, Agua Fria, Verde, Salt, Gila, San Pedro, and Santa Cruz Rivers, and several smaller streams. These streams flow along the interconnected basin areas between ranges, except locally where they cut through low ranges. The river channels and flood plains are entrenched below the general level of the basin floors and some are flanked by river terraces.

2. Soils and Geology[131,135,136]

The project area contains numerous small isolated fault-block mountain ranges separated or surrounded by alluvium filled basins. The mountains are composed of granite, metamorphic rocks, volcanic rocks, and minor amounts of older basin deposits. The basins, which are commonly thousands of feet deep are largely filled with uncemented and cemented mixtures of gravel, sand, and clay washed down from the adjacent ranges. In some areas the deposits include volcanic rocks, and some basins contain subsurface beds of salt or other evaporites precipitated from ancient saline lakes. The basins generally contain ground water below depths of a few hundred feet.

The soils of the CAP area are inherent to the parent materials of the Basin and Range physiographic province. Most of the soils have developed on alluvial materials derived from the igneous and sedimentary rocks that comprise the mountain ranges typical of the province. (See Figure 17B and Table 11A)

The Basin and Range province is characterized by steep, sparsely vegetated, northwest-southeast trending mountains and broad alluvium filled valleys. Most of the soils in the basins and valleys of this



COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
PHYSIOGRAPHIC PROVINCES

Figure 17A

TABLE 11A

LOWER COLORADO REGION

GENERAL LAND CHARACTERISTICS AND SUITABILITY FOR USE

MAP SYMBOL	GENERAL LAND CHARACTERISTICS								GENERAL SUITABILITY FOR USE 1/					
	Topographic Position	Elev. in Ft.	Soil Parent Material	Soil Depth	Mean Ann. Precip. in Inches	Mean Ann. Temp. F°	Ave. Frost-Free Period in Days	Dominant Native Vegetation	Livestock Grazing	Native Timber Production	Cropland (irrigated unless other noted)	Native Wildlife Habitat 2/	Outdoor Recreation	Surface Water Yield
1	Gentle Slopes, Escarpments, Ledges & Breaks	5,000 to 7,500	Sandstone & some Shale	Very shallow to shallow, locally deep	6 to 16	49 to 53	100 to 170	Grass, Shrubs & Pinon-Juniper Woods	F to G		P to F-deep soils	G to E Mule Deer, Antelope & Turkey	F to G (cool summer)	P to F
2	Mountainous	8,000 to 12,000	Basalt, Limestone, Sandstone & Alluvium	Very shallow to shallow, locally stony	20 to 35+	32 to 40	30 to 70	Mixed Conifer Forest & Alpine	P to F	G to E	P	G to E Most species Big Game	G to E (cool summer & wintersports)	E
3	Rolling, Sloping Hills, Escarpments, Ridges & Canyons	6,500 to 7,500	Sandstone & Shale	Very shallow to shallow, locally deep	10 to 16	47 to 52	100 to 160	Wooded, Shrubs, Grass & Conifer Forest	F to G	F to G	P to G-deep soils	F to G Mule Deer, Antelope & Upland Game	F to G (cool summer)	F to G
4	Flood Plains, Rolling Hills, & Local Sand Dunes	4,000 to 5,500	Alluvium & Aeolian	Deep to Mod. Deep (medium texture)	6 to 13	50 to 55	110 to 200	Shrubs & Grass	F to G		G to E	F to G Upland Game & Mule Deer F to E Upland Game	P to G (cool summer)	P
5	Uplands & Rolling Plains	5,500 to 6,700	Basalt & Cinders with Alluvium	Mod. Deep to Deep	8 to 11	48 to 54	110 to 200	Grass & Shrubs	P to G		F to G	P to G Mule Deer & Upland Game	P to G (cool summer)	P to F
6	Uplands Rolling Hills, & Local Sand Dunes	5,500 to 6,000	Old Alluvium & Sandstone	Mod. Deep to Deep (sandy)	8 to 11	48 to 54	110 to 180	Wooded, Shrubs & Grass	F to G		F to G	F to E W.T. Deer & Upland Game G to E Antelope	F to G (cool summer)	P to F
7	Gentle Slopes & Valleys	4,000 to 6,500	Alluvium	Mod. Deep to Deep	6 to 16	56 to 62	190 to 228	Wooded, Shrubs, Grass & Conifer Forest on cool, moist sites	P to F	P - warm dry sites to G - cool moist sites	P to G	F to E Upland Game & Mule Deer	G to E (cool summer)	P to F
8	Plains, Rolling Hills, Some Breaks & Escarpments	4,500 to 5,500	Interbedded Sandstone & Shale	Very Shallow to Mod. Deep, some Deep (generally clayey)	6 to 16	50 to 55	110 to 200	Wooded & Grass	P to F		P to G	P to G Deer, Turkey & Bear F to E Antelope	P to F (cool summer)	P
9	Mountain Slopes, Breaks & Canyons	5,000 to 8,000	Shale & Sandstone	Very Shallow to Mod. Deep (stony)	16 to 30	39 to 50	70 to 130	Wooded, Grass, Shrubs & Conifer Forest	P to G	P - warm dry sites to G - cool moist sites G to E for Ponderosa Pine	P to G-deeper soils Irr. & non-irr.	G Deer, Bear, Turkey, Elk & Javelina - lower elev.	G to E (cool summer)	G to E
10	Gentle, Sloping Hills with Narrow Canyons	4,500 to 7,000	Limestone	Very Shallow to Shallow	8 to 30	47 to 55	60 to 150	Wooded, Grass, Shrubs & some Conifer Forest in areas above 18" ppt.	P to G	P - warm dry sites to G - cool moist sites	P (except small local areas)	E Deer, Elk, Antelope, Turkey & Bear	G to E (cool summer)	P to G
11	Rolling Plains, Canyons, Rock Ledges, & Mountain Slopes	5,000 to 8,000	Basalt, Cinders & Tuff	Shallow to generally Deep (stony & clayey)	12 to 30	39 to 50	70 to 130	Wooded, Grass, Shrubs & Conifer Forest in areas above 18" ppt.	P to F	P - warm dry sites to G - cool moist sites	P to G irr. & non-irr.	G to E Deer, Elk, Antelope & Turkey	G to E (cool summer)	F to E
12	Mountain Slopes with Deep Canyons & Escarpments	2,500 to 5,000	Canyon-lands, Rocklands & Alluvium	Very Shallow to Shallow (Rocky)	8 to 12	50 to 56	130 to 250	Bare rock to Wooded & Grass	P to F		P	F to E Deer, Turkey & Bighorn Sheep	P to E (Grand Canyon)	P to F
13	Mountain Slopes	3,000 to 5,500	Mixed Granite, Rhyolite, & Gnesis	Very Shallow to Deep (stony)	14 to 30	48 to 56	60 to 160	Shrubs, Grass, Pinon-Juniper Woods & Conifer Forests in areas above 18" ppt.	P to G	P - warm dry sites to G - cool moist sites	P-shallow soil to G-deep soil	G to E Deer, Bear, Javelina, Antelope, Turkey, Quail & Non-game Species	P to G	F to E
14	Gentle Slopes & Valley Floors	3,500 to 5,000	Recent & Old Alluvium	Mod. Deep to Deep	8 to 16	58 to 62	175 to 210	Grass, Shrubs & Woods	G to E		G to E	F to E Mule Deer Javelina & Quail F to E Rare Species	F to G (mild winter)	P to F
15	Valley Floors & Closed Basin	4,100 to 4,200	Alluvium	Deep & Dense (Saline)	Near 10	58 to 62	175 to 210	Barren & Grass	P		P	E Waterfowl & Non-game Species	P to G	P
16	Gentle Slopes & Valley Floors	125 to 3,500	Alluvium	Deep to Very Deep	3 to 10	62 to 72	220 to Yearlong	Cacti, Annual Grass & Shrubs	P to F		G to E	F to E Mule Deer, Sonoran Antelope, E For all wildlife in riparian areas	P to E (near water all year)	P
17	Desert Mountains & Slopes	500 to 4,000	Granite, Schist, Rhyolite & Basalt	Shallow to Mod. Deep	4 to 14	55 to 65	190 to Near Yearlong	Cacti, Annual Grass to Perennial Grass & Shrubs	P to F		P	F to E Desert Bighorn Sheep, Mule Deer & Javelina at higher elev.	(warm winters) P-summertime to E-wintertime	P to F

1/ General Rating P - Poor
F - Fair
G - Good
E - Excellent

2/ This habitat supports many bird, reptile and other forms of wildlife but are too numerous to list.

COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

GENERAL LAND CHARACTERISTICS

Figure 17B

province are deep, level to nearly level and have textures favorable both to water entrance and soil workability. The soils on the mountains of the province are very shallow to moderately deep, are on steep to very steep slopes, and generally have loamy to clayey textures. In places these soils are stony or rocky. Sources of sediment in this province include the valley of the San Pedro River and along the Gila River between San Carlos Lake and the Arizona-New Mexico boundary. This province is considered as three sections because of physiographic and climatic differences.

The Mexican highland section occupies the southeast corner of the province and reflects the transition zone between the desert valleys of southwestern Arizona and the semidesert grassland areas extending to the Continental Divide in New Mexico. This section is somewhat higher in elevation than the western valleys and has slightly more rainfall. The soils in this section are usually deep and are medium or moderately fine in texture.

The sonoran desert section of this province is representative of the physiographic characteristics of the southwestern desert portions of Arizona. It contains most of the presently irrigated land of the CAP. Yearlong growing seasons are common and all crops are grown under irrigation. The mountainous areas of this section are steep and have little vegetal cover. The soils in the gently sloping alluvium filled valleys are deep, quite heterogenous in texture and have smooth to gently undulating topography. The soils are quite low in organic material and have not been leached of soil nutrients.

The third section of this province is the Mohave section. This section consists largely of the lower canyon of the Colorado River and minor tributaries south to the Bill Williams River and is not included in the CAP area.

The soils in the project area are commonly affected by the precipitation of salts produced by weathering of rock-forming minerals and brought in by surface runoff. Since the seepage from rainfall is usually not sufficient to carry the salts down to the water table, they accumulate in the soil as the water evaporates. The effects are most noticeable near mountains of calcium-bearing rocks, where alluvial deposits are commonly cemented by calcium carbonate to a concrete-like material called caliche. Further down the basin slopes, calcium carbonate content decreases, but soluble alkali salts detrimental to agriculture are still present.

a. Subsidence[15,16,17,18,19]

Land subsidence is a topographic phenomenon which is usually caused by the rapid extraction of fluid substances, oil or water, from

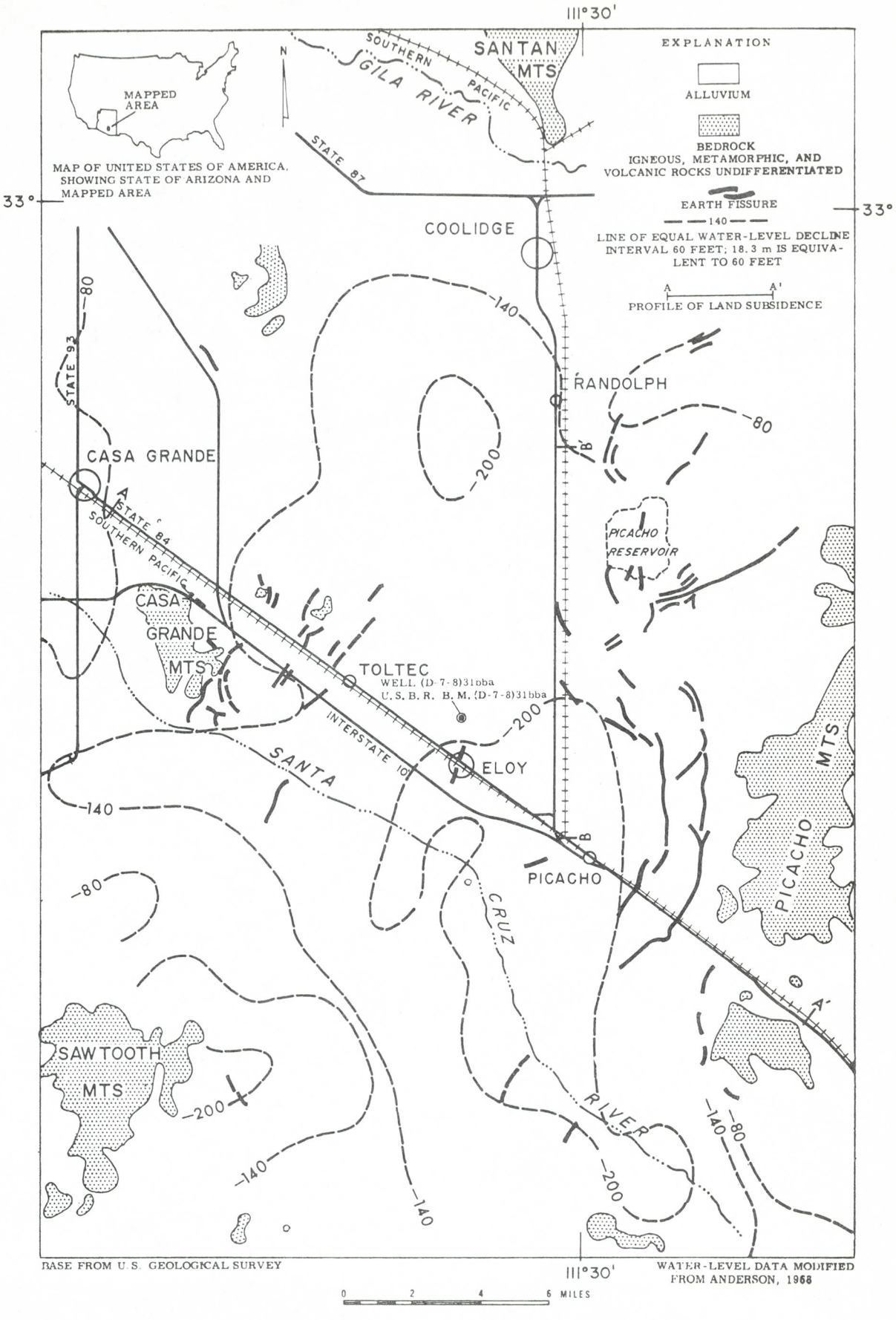
beneath the earth's surface. The spaces left by this extraction are filled by compaction of subsurface materials, causing a settling of the surface. The maximum amount of subsidence will occur in the heavily pumped areas of a basin, creating differential in subsidence between these areas and the peripheral basin areas. This creates the cracks, or earth fissures, which are commonly associated with subsidence, that occur primarily in the peripheral areas.

Land subsidence and earth fissures in central Arizona are related to water level declines caused by large-scale ground-water pumpage for irrigation and municipal uses. Pumpage in excess of recharge has caused steady declines in ground-water levels throughout the project area. For the period 1923 to 1964, maximum ground-water level declines of over 300 feet were recorded near Stanfield and Mesa. Near Eloy, a decline of 200 feet was noted. The point of maximum documented subsidence in the project area occurs to the northwest of Eloy, where the land subsided 7.5 feet during the period 1948 to 1967. (See Figures 17C and 17D) Data from the cooperative U. S. Geological Survey - Bureau of Reclamation subsidence program recorded subsidence amounts of 1.0 feet, 0.4 feet, and 2.2. feet from the spring of 1965 to December 1971 in the Eloy, Chandler Heights, and Luke Air Force Base areas, respectively.

Earth fissures and associated differential subsidence have damaged irrigation systems, interstate highways, and railroads. Earth fissures have damaged Picacho Reservoir, while differential settlement across Interstate Highway 10, near Picacho, necessitates continued maintenance. Figures 18 and 19 show typical earth fissures caused by subsidence.

b. Earthquake Potential 152-159

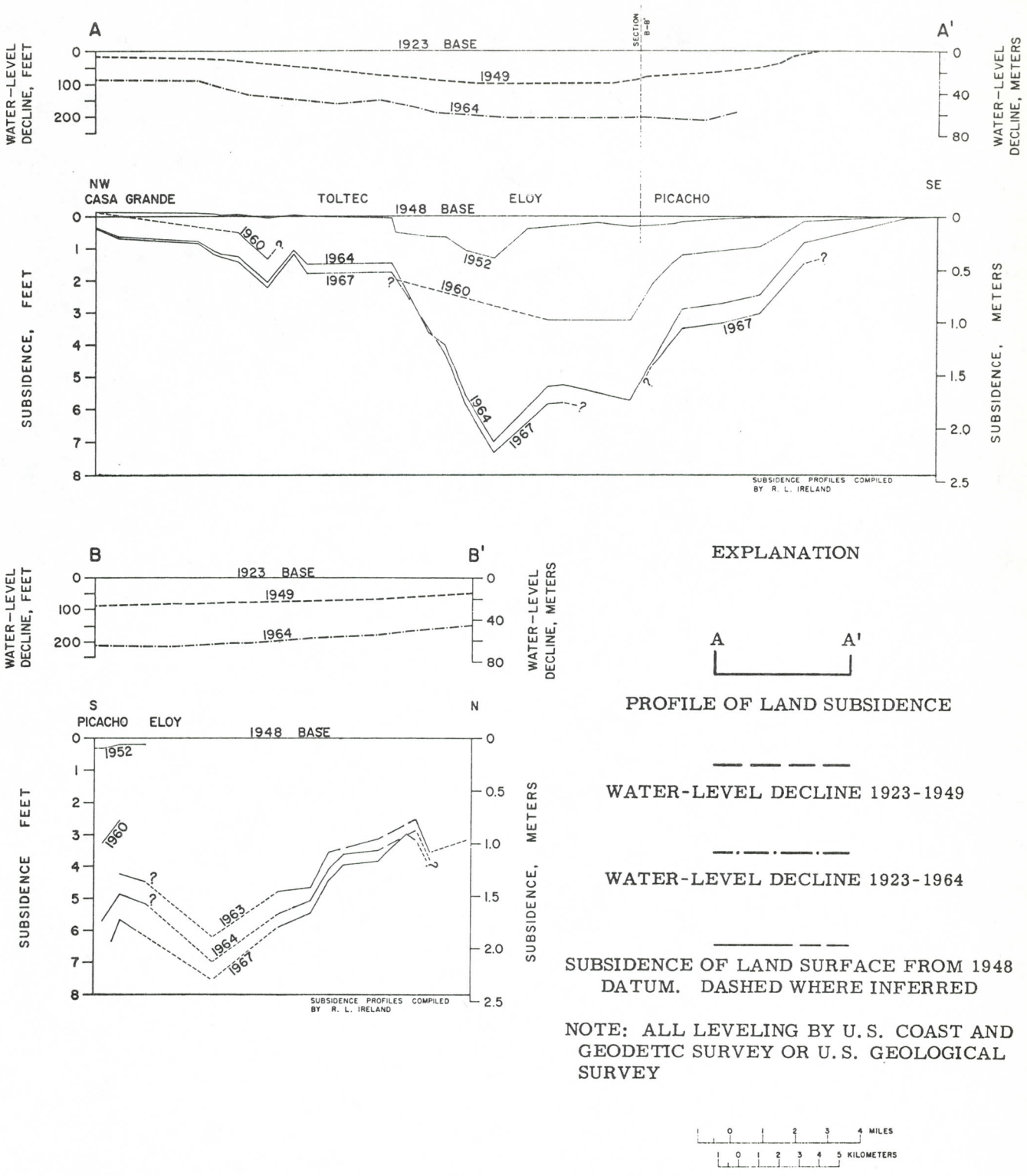
The potential earthquake hazard to project facilities is not considered to be serious. Severe earthquakes in California and Mexico have been widely felt throughout southern Arizona, but few earthquakes have centered within the southern part of Arizona during the 122 years of recorded earthquake history. During that period, earthquake damage in southern Arizona has been minor. Various authorities disagree on what the earthquake hazard potential is in Arizona. But based on feasibility level geologic studies, the probable maximum earthquake intensity expected along the aqueduct system, including the San Pedro Aqueduct, is V to VI on the Modified Mercalli Scale which ranges from I (weak) to XII (very strong). The probable maximum earthquake intensity expected in the Orme and Buttes Dam sites is VI to VII, and in the Hooker and Charleston Dam sites is VIII to IX on the Modified



202

Location of earth fissures, 1969, and water-level declines, 1923-64, in western Pinal County.

Figure 17C



Profiles of land subsidence, 1948-67, and water-level declines, 1923-64, in western Pinal County.

Figure 17D

Figure 18

Earth fissure near a suburban housing development east of Mesa, Arizona. Photograph No. P25-300-7527.

Typical earth fissure near Chandler Heights, Arizona. Photograph No. P344-300-8675.

Figure 19

Mercalli Scale. Because of the potentially greater hazard involved, seismic risk for the dams was evaluated from a more conservative viewpoint than for the aqueduct system facilities. Also, Hooker and Charleston Dams are closer to centers of greater earthquake activity than are other project facilities. There are no known active faults within the project area.

More detailed investigations to be conducted for final design may result in minor revision to the expected earthquake intensities outlined above.

3. Climate[131,135]

The CAP area is primarily located in the arid sonoran desert portion of the southwestern United States. The climate of this area is characterized by long, hot summers and short, mild winters; low annual rainfall; low relative humidity; high evaporation, and a high percentage of days of possible sunshine.

There are two distinct moisture sources. Winter precipitation is associated with moisture moving into the area from the Pacific Ocean while the Gulf of Mexico supplies moist air for most of the region's summer rains. Winter rains, sometimes lasting for several days, usually occur as gentle showers over a large area. Local summer thunderstorms which usually cover only small areas are usually of high intensity and of short duration and produce many of the destructive flash floods well-known in the Southwest.

The mean annual precipitation varies from less than 6 inches along the western boundary to 11 inches at Tucson, 12 inches in the upper Gila River Basin, and to more than 30 inches in the higher mountain ranges. Over the project service area, the annual precipitation averages about 8 inches. (See Figure 19A)

The type of precipitation occurring in the project area depends on elevation and time of year. In the desert portions of the project area, snow is a rarity. When it does fall, it melts rapidly. In the higher elevations, generally above 7,000 feet, precipitation occurs as rain between spring and fall and as snow in the winter. Rainstorms may occur throughout the year in the desert and foothill sections, but are more frequent during July through September and again during December through March.

Temperatures show some variability over the area, depending mostly on elevation, with the summer season beginning about mid-May and ending in October. Maximum readings in excess of 100°F. are the rule during much of this period. Winter temperatures in the low desert typically reach daily maximums in the mid-sixties to low seventies.

Sunshine and clear skies are dominant with possible sunshine occurring about 85 percent of the daylight hours. The predominantly clear skies and characteristically dry atmosphere permit intense surface heating during the day and active radiational cooling at night, producing large diurnal temperature variations averaging 30°F., and sometimes exceeding 40°F. Mean annual temperatures typical of the area are 72°F. at Gila Bend, 69°F. at Phoenix, and 68°F. at Tucson. Frost-free periods vary from about 240 to in excess of 300 days.

The combination of high temperature and low humidity causes high rates of evaporation and transpiration. The gross annual evaporation rate averages about 70 inches in central Arizona.

4. Vegetation and Wildlife

a. Vegetation [1,20-25,37,47,51,52,75,113,131,135]

The CAP watershed area has a wide variation in vegetative cover types. (See Figure 19B.) These classifications were taken from the Comprehensive Framework Study for the lower Colorado River Region and are described in more detail in the study volumes. The forest types include the coniferous forest zones of spruce-fir, Ponderosa pine and the pinyon-juniper woodlands, and the chaparral types, all of which occur above 4,000 feet elevation. The rangeland type extends from the forest type through the northern desert shrub, perennial and ephemeral southern desert shrub types, and the northern and southern grasslands. Scattered throughout the area are patches of cultivated land including irrigated pasture and urban areas. It should be noted that Figure 19B does not reflect much of the riparian vegetation shown after page 56 (Table 12, which was provided by the Arizona Game and Fish Department). This is one example where the Framework Study mapping standards did not require this type of refinement.

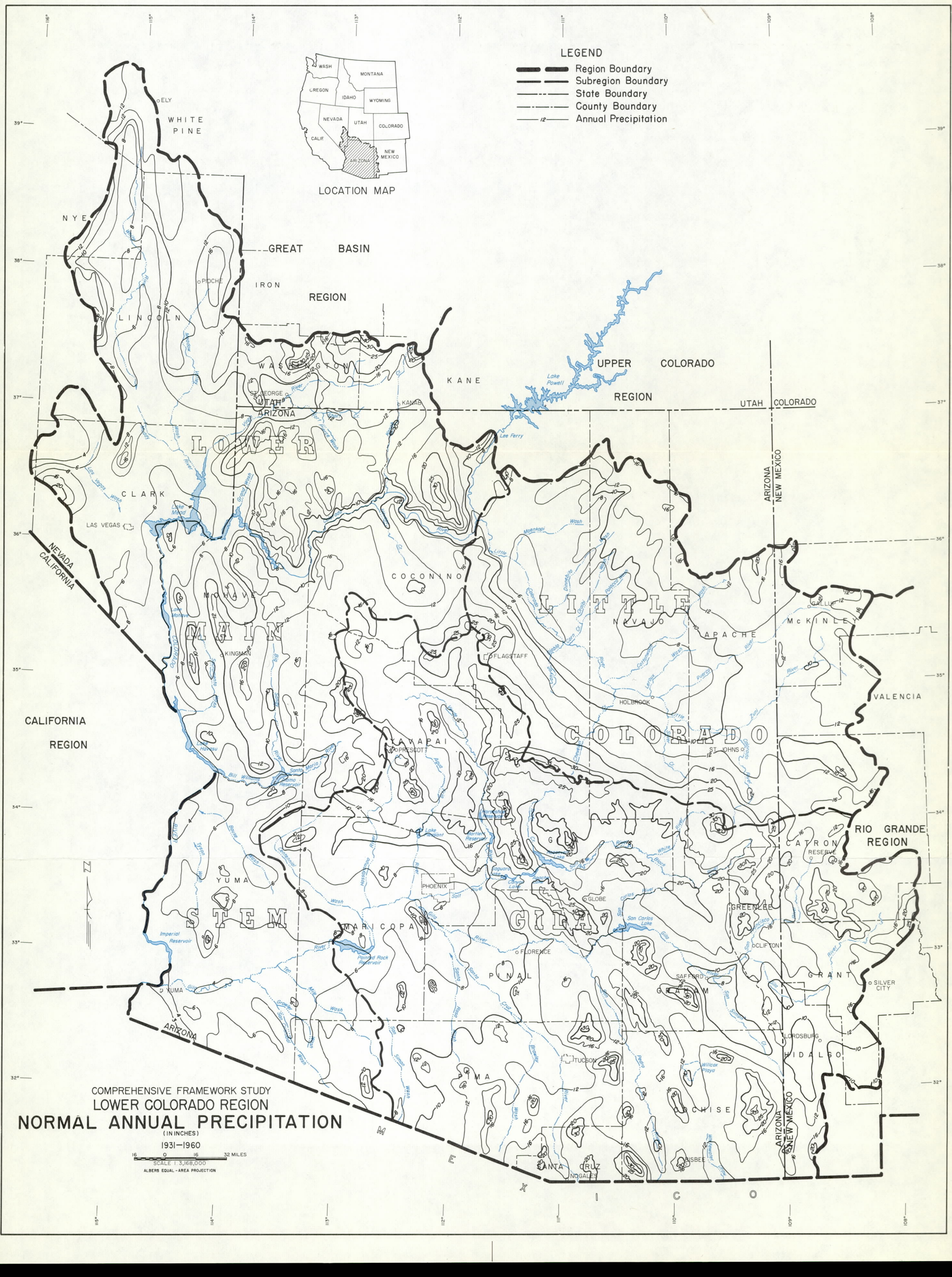
(1) Coniferous Forest

The coniferous forest extends from about 4,700 feet elevation to about 10,000 feet. The spruce-fir timber type extends from about 8,500 feet to the timberline. The dominant tree species in this type include Englemann spruce, white fir, and cork bark fir. Interspersed throughout this spruce-fir type are numerous subalpine and wet mountain meadows and grasslands.

The Ponderosa pine timber type provides most of the commercial forest lands within the area. This type extends from an elevation of about 5,500 feet to 9,500 feet, with Douglas fir providing an important component of the timber type between the elevations of 8,000 and 9,500 feet. Other woody plants include mountain maple, alder, alligator and prostrate juniper, Gambel oak, and Arizona locust.

(2) Woodland

Forest types classified as woodlands include the pinyon-juniper type which usually occurs at elevations over 4,500 feet



COMPREHENSIVE FRAMEWORK STUDY

LOWER COLORADO REGION

NORMAL ANNUAL PRECIPITATION

(IN INCHES)

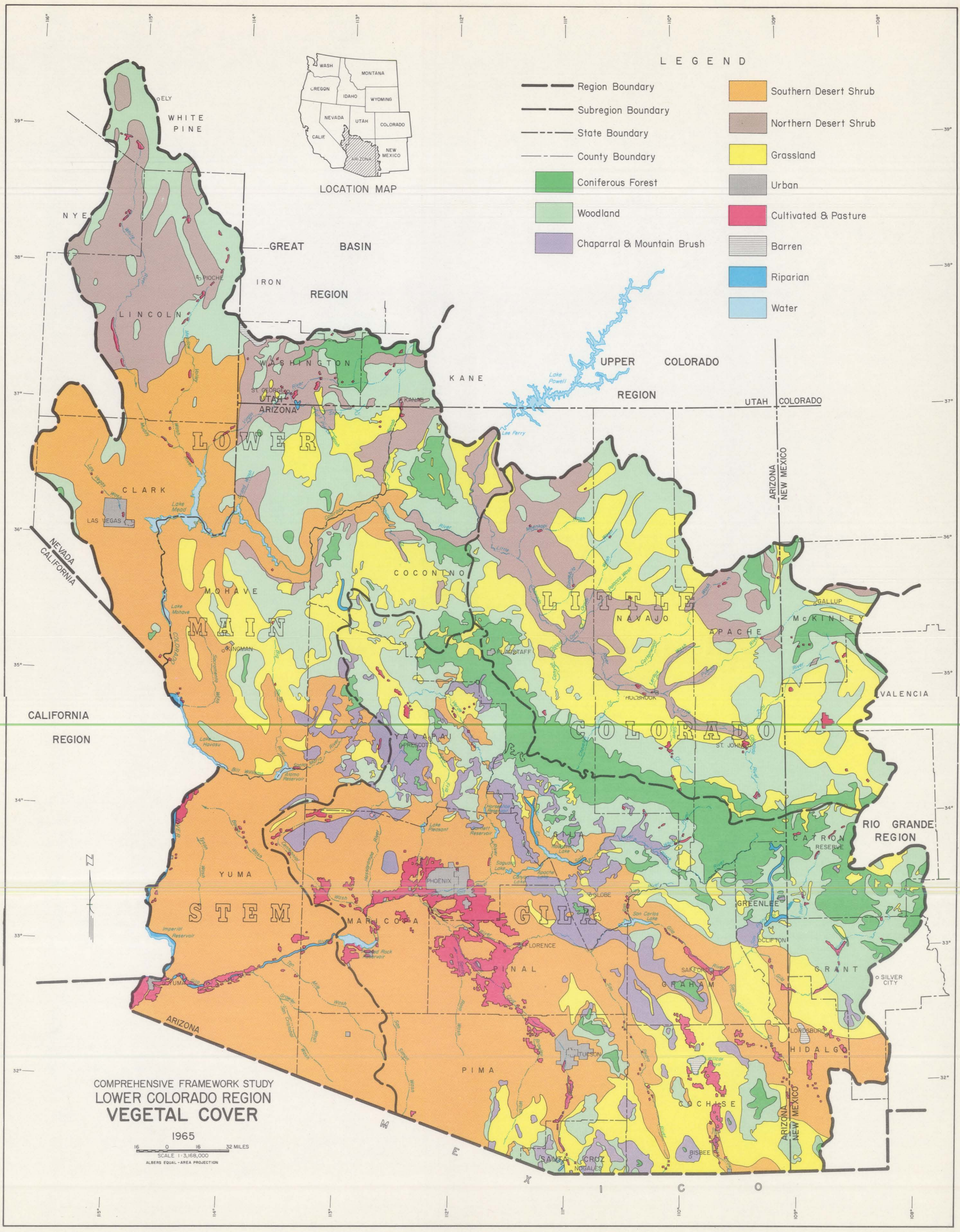
1931–1960

16 0 16 32 MILES

SCALE 1:3,168,000

ALBERS EQUAL-AREA PROJECTION

Figure 19A



COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
VEGETAL COVER
1965
16 0 16 32 MILES
SCALE 1:3,168,000
ALBERS EQUAL-AREA PROJECTION

Figure 19B

and generally occupies an area immediately below the Ponderosa pine. The principal species in this community include one-seeded juniper, Utah juniper, alligator juniper, and pinyon pine, with an understory of Emory and Gambel oak, ceanothus, bitterbrush, and cliff rose. There is some big sagebrush in the northern half of the region.

The oak woodland type occupies the foothills and mountains in the southeastern part of the area between the elevations of 4,500 and 6,000 feet. The principal species include the Emory oak, Mexican blue oak, and Arizona white oak.

(3) Chaparral or Mountain Brush

The most extensive areas of the chaparral vegetative type in the region lie south of the main Ponderosa pine forest in central Arizona between the elevations of 4,000 and 5,500 feet. The dominant plants are generally tough-leaved evergreen shrubs. Scrub liveoak, mountain mahogany, manzanita, desert ceanothus, laurel, and hollyleaf buckthorn are the dominant plants of this association, with individual junipers, pinyon pines, and scrub yellow pine sometimes forming a scattered overstory.

Other conspicuous and common shrubs in the Arizona chaparral include sugar sumac, scarlet sumac, poison oak, squawbush, buck-brush, deer-brush, silk tassel, Apache plume, brickell bush, red mohonia, wait-a-minute bush, mountain balm, cliff rose, and haplopappus.

(4) Streamside - Including Riparian and Marsh

The riparian type is scattered along the drainages throughout the watershed area in narrow strips and in large blocks along the Hassayampa, Verde, Salt, Gila, and San Pedro Rivers. The dominant plants in this type are deciduous, including sycamore, cottonwood, baccharis, and willow in the lower elevations, with alder, maple, ash, walnut, and locust occurring along the streams in the elevations above 5,000 feet. Mesquite and saltcedar occur at lower elevations along with arrowweed, bermuda, and saltgrass. Saltcedar has also invaded in areas to 6,000 feet. In the higher mountains, shrubby willows and alder are the principal understory occurring along the streams and wet spots.

The true riparian community lies beyond the edge of streams and usually occurs on slightly raised terraces. The vegetation may be quite stable and represented by woody plants or, following an extremely destructive flood, it may also be in a successional state. Moisture stress in this community is greater than along the river, especially when the river is temporarily dry or running extremely low.

The climax plants of the riparian community can withstand certain amounts of inundation but generally they require well aerated soil that is not continually saturated, thus the development on slightly raised terraces.

If the topography around the river is relatively flat, additional terraces above the one adjacent to the river may occur. These terraces may be 20 feet above the river but this does not limit the plants growing on them from developing deep root systems through the soil down to the water table. Typically in the Southwest this community is characterized by healthy and old mesquite trees.

Beyond and above the lower terraces and streamside communities the topography generally becomes more rugged and quite variable. If mountains occur at some distance from the river, the broad terraces give way to outwash bajadas from the mountains. These vary in soil texture from coarse soil near the mountains to finer soils near the river. The change in soil influences the moisture availability and the vegetational composition. If the river has cut through the mountains, the terrain usually becomes quite steep immediately beyond the riparian communities. On these steeper slopes exposure plays an important role. The more southerly exposures have extreme moisture stress and either support very xerophytic plants or less dense vegetation. As the aspect changes from south to north, the vegetation usually becomes more dense, contains more mesophytic plants and fewer xerophytes, or both. Thus, within any one valley there may be a great variety of vegetational communities.

One other community that is often associated with rivers that have broad flood plains is marsh vegetation. These communities develop only when there is standing water for most of the growing season. Plants such as sedges, reeds, and cattails which do well with roots and lower stems in standing water are characteristic of this vegetation.

The history of the valleys and streams of the Southwest has been one of change with time. Without disturbances, the rivers would flow periodically, establishing new channels and new sand bars and alluvial terraces that caused changes in the vegetational patterns but did little to alter the basic composition of vegetation in the valleys. Some valleys had broad areas flooded due to beaver activity or new erosion patterns and supported wet marshlands; others were continually being swept clean and rechanneled never permitting marshland establishment. With the development of manmade dams and decline in beaver populations, the river patterns changed. The dams controlled the flow of the river cutting deeper channels with essentially no broad flooding and new channelization. The rivers began to entrench deeper and terraces became more stable. The reduction of beaver dams

eliminated local flooding and marshland establishment. Thus the wetland vegetational types were lost except for a few local depressions in the broader river valleys.

There are three major vegetative riparian types in central Arizona. The first is the riparian forest or woodland, which is made up of large trees such as sycamore and cottonwood. It is associated with streams having a perennial surface flow. The second is the mesquite-shrub land. Mesquite is often found in areas which have occasional surface flow. It is a native to this area, and with other associated species, provides excellent forage and habitat for wildlife. The third is the saltcedar (Tamarix sp.). It is found in areas similar to those which were dominated by the mesquite but saltcedar has a much higher tolerance for high soil salinity and has replaced the mesquite in many locations.

The rapid drop in ground-water tables in the past 50 years has had serious effects on some of the riparian communities. Some large mesquite bosques have deteriorated and been lost. A recent article ("The Lethal Decline of Mesquite on the Casa Grande National Monument")[113] points out that in the early years of this century there were large, healthy stands of mesquite at the monument. Between 1902 and 1923, the water table dropped 34 feet in this area, and between 1931 and 1949, the water table dropped another 60 feet. Virtually all of the mesquite found on the monument died during the second period. The article suggests that most of the trees could not keep their root growth in pace with the water table's decline, and became weakened. This allowed various parasites and insects to attack the trees and finally kill them.

Estimates of riparian vegetation sufficient to be classified as good dove habitat have been made by the Arizona Game and Fish Department for most major riparian areas in the project area in Arizona. These data were gathered from studies performed on dove nesting habitat by the Arizona Game and Fish Department under a Federal grant (FW78R). Acreages were counted in minimum areas of approximately 5 acres, with 25 to 100 percent crown cover. The Arizona Game and Fish Department estimated that an additional 10 to 15 percent should be added to these acreages to include smaller stands and those which have less than 25 percent crown coverage. This would bring the total amount to around 46,700 acres, of which 20,800 would be saltcedar, 24,700 mesquite, and 1,200 mixed stands. It should be recognized that the definition of "riparian" is not a uniform term.

Excluding the phreatophyte areas along the Gila River below Painted Rock Dam and the Colorado River main stem, a total of 41,200

acres of riparian vegetation in stands of 5 or more acres was mapped. Of this amount, 18,150 acres were predominantly saltcedar (Tamarix pentandra), 21,950 acres were predominantly mesquite (Prosopis juliflora) and the remaining 1,100 were a mixture of the two along with other common riparian species. The riparian stands contain some baccharis, catclaw, ironwood, cottonwood and willow, but the amounts of these other species have not been determined. Table 12 shows these acreages.

(5) Southern Desert Shrub

The perennial southern shrub type occurs between 3,000 and 4,500 feet in elevation. The type is characterized by cacti, including the saguaro, cholla, and pricklypear. Creosote bush, paloverde, catclaw, rabbit bush, mesquite, coffeeberry, star bush, ocotillo, and bur-sage are the important woody plants in this type.

(6) Ephemeral Desert Shrub

The sonoran or ephemeral southern desert shrub type occurs along the western part of the area, traversed by the Granite Reef Aqueduct, usually at elevations of less than 3,000 feet and in places with less than 8 inches of annual rainfall. Vegetation in this type is relatively sparse. This type is dominated by creosote bush with some bur-sage growing in open stands with little to no perennial ground cover. Numerous annual forbs and grasses may occur during favorable periods of moisture. On the bajadas and mountain slopes adjoining the ephemeral desert shrub community at this altitude and range are saguaro, paloverde, cholla, barrel cactus, ironwood, mesquite, and ocotillo.

(7) Southern Grassland

The southern grassland type occurs generally below 4,000 feet in elevation. Black and blue grama, sideoats, tobosa, sand dropseed, and Arizona cottontop are the dominant grass species. Scattered individual oak trees may occur forming a thin overstory in some areas. Four-wing salt bush, mesquite, and cacti occur in limited quantities throughout these areas.

(8) Cultivated and Irrigated Areas

Nearly all of the cultivated and irrigated pasture is located along the mainstems of the Colorado, Gila, Salt, Verde, San Pedro, and Santa Cruz Rivers. The western and central valleys are suitable for most cultivated crops. The cool climate crops are grown during the fall, winter, and spring seasons, while crops adapted to the warmer temperatures are grown during the summer. Winter vegetables and citrus are limited to this lower, warmer section of the project area.

TABLE 12

ACRES OF RIPARIAN VEGETATION
CLASSIFIED AS GOOD DOVE HABITAT

Area	Streamflow Characteristics	Habitat Acreages Saltcedar	Mesquite	Mixed
Bill Williams River Delta				
Planet Ranch to Mouth	Intermittent			1,100
Gila River				
Safford to Bylas	Intermittent	1,600	130	
Marijilda and Stockton Washes	Intermittent		550	
Goodwin Wash	Intermittent		340	
Winkleman to Kearney	Perennial	1,035	510	
Maricopa Road to Salt-Gila River Meridian	Intermittent	5,030	2,080	
Salt-Gila River Meridian to Miller Road	Perennial Intermittent	1,110	110	
Miller Road to Gillespie Dam	Intermittent	5,380		
Gillespie Dam to Painted Rock Dam	Intermittent	3,170	470	
San Pedro River				
Fairbank to Winkleman	Intermittent		6,820	
Picacho Lake		820	70	
Santa Cruz River				
San Xavier and Komatke Thickets	Intermittent		6,860	
Salt River				
Stewart Mountain Dam to Granite Reef Dam	Perennial		1,010	
Verde River				
Camp Verde to Salt River	Perennial		3,000	
	TOTALS	18,150	21,950	1,100

Small grains, domesticated and native grasses, and alfalfa make up the typical improved pasture in the higher elevations.

b. Fish and Wildlife [1,26-39,47,52,53,55,56,66,71,77-81, 108,122,142,176,179,180,184]

There are many species which are numerous, prolific, and capable of competing with other species in order to establish and occupy a niche. These include those species managed as a renewable resource for game purposes. Other species which are limited in numbers and which are believed to be declining in population have been classified and designated as rare, endangered, peripheral, or status undetermined by the Bureau of Sport Fisheries and Wildlife in the publication, Rare and Endangered Fish and Wildlife of the United States (1968).[66] These four designations are defined as follows:

Endangered: An endangered species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy. Its peril may result from one or many causes, loss of habitat, or change in habitat, over-exploitation, predation, competition, disease. An endangered species must have help or extinction will probably follow.

Rare: A rare species or subspecies is one that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens. Close watch of its status is necessary.

Peripheral: A species or subspecies whose occurrence in this country is at the margin of its natural range. Special attention may be needed to retain them in the United States.

Status Undetermined: A species or subspecies which has been suggested for rare or endangered classification, but about which further information is needed to clarify its status.

Species which are managed for game purposes and species which are included in the rare and endangered species list are discussed in the sections on fish, amphibians and reptiles, birds, mammals, and in the specific reservoir site fish and wildlife discussions. Only species which are endangered are listed by the Bureau of Sport Fisheries and Wildlife in Appendix D, 50 CFR 17.[176] This official list is periodically revised with the current list being dated October 13, 1970.

(1) Invertebrates [33]

Lists of the known or probably present species of invertebrates found at the reservoir sites were prepared by Cazier. Single copies of these lists may be obtained upon request from the Bureau of Reclamation Office in Boulder City, Nevada. The insects especially have successfully invaded, exploited, and established themselves in environmental "niches" at all four reservoir sites.

"There are aquatic and terrestrial groups; subterranean and arboreal species; aquatic forms living as climbers on vegetation,

sprawlers on the bottom, burrowers in the bottom, free-ranging, close-clinging and vegetation inhabitating forms; there are plant and animal parasites; parasites on parasites; scavengers; carnivores; predators; copriphags; saprophags; phytophags on all the species of plants, and on all the parts of the plants, roots, trunks, stems, leaves, flowers and seeds; there are ground and plant nesting species; symbiotic relationships between plant and insect, animal and insect; oligolectic and polylectic pollinators; poisonous and non-poisonous forms and a few whose relationship to the whole is nebulous. No other group of animals so completely dominates the environment! Nor do the invertebrates find an equal when it becomes necessary to adapt and survive under changing conditions."[33]

(2) Fish

About 56 species of fish are found in waters in the project area. Seventeen species are indigenous to the Gila River basin. The endangered Gila trout is endemic to the headwaters of the Gila River, Gila National Forest, New Mexico. The endangered Apache trout is found in Ord Creek and East Fork of White River, Fort Apache Indian Reservation, Arizona. Introduced cold water game species of fish include several species of trout, walleye, and northern pike. Introduced warm-water species include striped bass, white bass, channel catfish, flathead catfish, yellow perch, and tilapia. The threadfin shad has been introduced into reservoirs below 4,500 feet as forage for game fish.

(a) Native Fishes

During the decade of 1950-1960, striking changes took place in the aquatic habitats and in the fishes of Arizona, and this change of natural conditions is continuing. Reduced surface flows of some streams and the stocking of exotic fish species are two factors restricting distribution of native fish. In the New Mexico portion of the watershed area, the native fish fauna has been influenced greatly by the introduction of exotic species.

Seventeen species of fishes (18 kinds if one named subspecies is included) were indigenous to the Gila River basin, and of these two are monotypic genera known from no other river system - Tiaroga cobitis and Meda fulgida (see Table 1 in Appended Material). At the specific level, five species are endemic to the Gila (moving from there into the extreme lower Colorado River), including the two species just mentioned, and 10 of the species doubtless arose in the Gila River system, to disperse into the Little Colorado, Bill Williams, and Yaqui River systems. The remaining seven species range (or ranged) widely throughout the Colorado River drainage net. Of the 17 species, only one, the speckled dace, ranges outside the Colorado River basin (the Gila topminnow has a closely related subspecies in the Yaqui system), further stressing the uniqueness of the fauna.

Fishes of the Gila system may be broken into three, broadly-overlapping categories on the bases of their collective ecologies: 1) big-river fishes capable of living not only in the lower Colorado and Gila Rivers, but also of penetrating into the canyons of the larger streams to relatively high elevations - these are generally the seven species that are (or were) distributed widely in the Colorado system; 2) a group generally living in smaller, lower elevation waters, such as desert creeks and cienegas; and 3) a montane element that ranged from the native trouts at the highest available waters, to certain minnows and suckers that moved to relatively low elevations so long as suitably turbulent, solid-bottomed habitats were available. The ecological relations of this (or these) fauna and the ecological features of the Orme, Buttes, Charleston, and Hooker Reservoir sites are summarized in Tables 2 and 3 of the Appended Material. These tables reflect contrasting estimated conditions prior to 1850 with those of the present.

(b) Non-Native Fishes

Known and hypothetically present non-native fish species for each of the four reservoir sites are listed in Table 4 of the Appended Material.

Rainbow and brown trout are found commonly in the streams and impoundments from 5,500 to 10,000 feet. Cutthroat and brook trout are found above 8,500 feet.

Largemouth bass is one of the major game fishes found in most reservoirs of the drainages of the Colorado, Gila, Salt, and Verde Rivers. Smallmouth and yellow bass are found in the Salt and Verde Rivers. Warmouth and striped bass occur in Lake Havasu. Bluegill and green sunfish are widespread throughout the streams of the area. The warmouth and redear sunfish are found in the Salt River reservoirs in Arizona. White and black crappie are most common in the larger reservoirs. Some crappies are in smaller lakes up to 7,000 feet in elevation. Rockbass are caught occasionally in lower Oak Creek in the Verde River drainage. Yellow perch are established in a few of Arizona's lakes at relatively high elevations and help to support ice fishing. Walleye or pike perch are found in the waters of the lower Salt River and could be an important fish in colder, deeper lakes in the future. White bass are found in Lake Carl Pleasant, a reservoir on the Agua Fria River. Yellow bass are found in the Salt River reservoirs below Roosevelt Lake.

Catfishes are found throughout the watershed area. Channel catfish are the most prized catfish and are found in most of the large reservoirs. Irrigation canals and many stock ponds throughout the region, notably those on Indian reservations, have been stocked

with channel catfish. Flathead catfish are found in the San Carlos Reservoir on the Gila River. Black bullhead are found in small, muddy streams, lakes, and canals at lower elevations. Yellow bullhead are found in some of the small, relatively clear mountain streams. Tilapia are found in the warmer irrigation canals near Gila Bend and Buckeye, Arizona.

Populations of forage fishes such as carp, buffalofishes, quillback, and various suckers are found in the larger reservoirs. Mosquitofish are common in still water. Important species of bait fish such as the redshiner, fathead minnow, golden shiner, speckled dace, redside shiner, and threadfin shad are found in most streams and lakes of central Arizona.

(c) Rare and Endangered Species 66,176

Of the native fishes listed in Table 1 of the Appended Material, five species are extinct in the Gila River basin: bonytail chub, Colorado River squawfish, woundfin, humpback sucker, and the desert pupfish. The trouts are endangered in their natural environs, but are (or are soon to be in the case of S. gilae) placed under semi-domestication and stocked to maintain their populations. Three species are depleted, and appear to be approaching the "endangered" level. These are the Gila chub, Gila spikedace, and loach minnow. The loach minnow and the Gila spikedace, both essentially extirpated from Arizona waters (substantial populations exist only in the Aravaipa Canyon, Graham and Pinal Counties), are locally abundant in the upper Gila River in New Mexico. The humpback sucker and Colorado River squawfish once were abundant at such localities as the San Pedro River at Charleston and the Salt River at the Tempe Bridge, but are now extinct at these sites. They are now found mostly in the upper Colorado River basin. The Colorado River squawfish is currently listed as endangered in the 1968 edition of the Bureau of Sport Fisheries and Wildlife's Rare and Endangered Fish and Wildlife of the United States[66] The Gila topminnow, once abundant in marshes of the southern part of the Gila River Basin, is now found in only a few scattered localities near Safford, Arizona. It is also listed as endangered in the 1968 edition referenced above. Both of these are on the endangered list.[176] The desert pupfish once was common in the lower Gila River basin, including the San Pedro River. It is now extinct in the Gila River basin. It is found in Arizona in two isolated springs of the southern part of the state. The woundfin, which before 1900 lived in the lower Gila River, is now found only outside the area in the Virgin River above Lake Mead. The loach minnow, Gila spikedace, and Gila chub are now found only in the remote and isolated perennial flow sections of Aravaipa Creek and the upper Gila River in New Mexico. The speckled dace usually occurs in streams located at elevations of at least 3,500 feet.

In the Gila River basin the endangered Gila trout occurs only in Diamond, McKenna, and Spruce Creeks in the Gila National Forest. The endangered Apache trout is managed under semi-domestication and stocked to maintain its population. It is almost entirely restricted to streams of the Fort Apache Indian Reservation.

(3) Terrestrial Vertebrates

More than 750 species and subspecies of terrestrial vertebrates occur in the lower Colorado region. Over 40 of these species of wildlife provide hunting ranging from highly prized big-game to nongame species. Many other species, mostly small mammals and birds, provide enjoyment for the nonhunting outdoorsman for nature study and photography.

(a) Amphibians and Reptiles [26,37,38,39]

The herpetofauna has not changed radically in the watershed area due to man's activities. According to Lowe and Zimmerman, there are 116 species of reptiles and amphibians (22 amphibians and 94 reptiles) in the project area. Species of amphibians include one salamander and 21 frogs and toads. Reptilians include 5 turtles, 41 lizards, and 48 snakes. Three species have been introduced, the bullfrog and two turtles. Minckley states that there are 102 species of reptiles and amphibians at the four reservoir sites, with one salamander, 15 frogs and toads, 6 turtles and tortoises, 35 lizards and 45 snakes. Minckley cites evidence of two introduced turtles in the area, the soft-shelled turtle and the common snapping turtle. Roughly 10 to 15 percent of the species at each reservoir site are not found at any other of the reservoir sites with the exception of the Buttes Reservoir site where all of the species are common to other proposed project facility locations.

None of the species of reptiles or amphibians is considered rare or endangered by the Bureau of Sport Fisheries and Wildlife. The reticulate Gila monster (Heloderma suspectum suspectum) and the desert tortoise (Gopherus agassizi) are listed as status undetermined species in the 1968 edition of the Rare and Endangered Fish and Wildlife of the United States.[66] Detailed lists of all of the species in the project area, and specifically at the reservoir sites may be found in the material of Lowe, Zimmerman, and Minckley.

(b) Birds

In general, the species of birds found in an area depends on the type of vegetation. As is true in other forms of life found in the project area, the bird fauna is very diverse. This is due to the great diversity of habitats. By referring to the description of

the vegetation which was presented earlier, it may be seen that even within a small area there are many different habitats. Of greatest concern in the project area is the riparian community, which provides habitats for the most abundant and diverse bird fauna of the project area. By listing a few of the many varied habitats within the riparian community, the diversity becomes apparent. There are open water marsh areas, shore areas, weedy marsh areas, thickets, tall trees, shrubs, and tall grass areas.

Table 7 in the Appended Material lists the birds at the four reservoir sites and critical life history data.

Mourning doves are found throughout most of the watershed area. The white-winged dove is more restricted in distribution, occurring in the lower desert regions of western Arizona. The band-tail pigeon occupies high mountain ranges. Even more limited in distribution are the blue grouse and chukar. Three species of quail, Gambel's, Mearn's and scaled, are present in the area. The Gambel's quail occupies the desert and lower mountain elevations, while Mearn's and scaled quail normally occur in the grasslands at higher elevations. The Afghan white-winged pheasant recently has been stocked in agricultural areas in the desert.

There are five rare or endangered species found within the project area. The Mexican duck (E) is found during the summer in the San Simon Creek basin in the southeast portion of the Gila River basin. It has occasionally been sighted in the Upper Gila River Valley below the Hooker Dam site. The Special Area No. 15 map hexagon symbol (Figure 19E and Table 13, after page 68) shows the area considered to be the primary habitat breeding area for the Mexican duck in the United States. This area is specifically managed by the Bureau of Land Management for this purpose. The Yuma clapper rail (E) is a summer resident in some alkaline cattail marshes along the lower Colorado River north to the Bill Williams River delta which is at the southeast end of Lake Havasu and in the Topock swamp near Needles. None of the habitat of the Yuma clapper rail will be affected by the CAP. The peregrine falcon (E) and the prairie falcon (R) are rare seasonal or transient inhabitants of the project area and are included on several reservoir site avian lists. Two and possibly three pairs of bald eagles (E) nest in the general area of the proposed Orme Reservoir.

(c) Mammals

Big-game mammals in the region are distributed widely. Deer are the most abundant and widespread of the big-game species, with the desert mule deer occupying a greater part of the desert shrub and most of the forested habitat of the Gila River basin. White-tailed deer occupy habitat ranging from southern desert shrub

to the Ponderosa pine forests. Elk occupy higher mountain forest and meadow areas during the summer, moving down into the woodland and open grass country in the more severe winter months. The pronghorn antelope are more numerous than the elk, and are found in the rolling grassland both north and south of the Mogollon Rim in Arizona. Desert bighorn sheep occur in several of the lower desert mountain ranges.

The black bear, also considered as big game, are found throughout much of the coniferous forests, pinyon-juniper, and oak-woodland country along the Mogollon Rim. The javelina or collared peccary is found at lower elevations.

Several species of predatory mammals and nongame mammals are well distributed throughout the area and include coyote, bobcat, mountain lions, badger, skunk, jackrabbits, prairie dogs, and various ground squirrels.

The Sonoran prong-horned antelope is endangered, and was formerly distributed widely in grassland areas throughout the region but recent reports indicate that it is not now present in the project area. The spotted bat, a naturally occurring rare mammal, has a reported range of Oregon, California, Idaho, Montana, Wyoming, Colorado, New Mexico, Arizona, and Nevada. The spotted bat has been reported only four times prior to 1967 in Yuma and Maricopa Counties in Arizona. In light of the range and infrequency of observation, it is not anticipated that the project will have adverse impact on this species.

The coatimundi, jaguar, and ocelot are designated as peripheral species. These three species are occasionally seen on some of the reservoir sites and adjoining range lands and mountains.

Species of bats may be seen in the early evening around the rivers. Shrews use the thick grass and thickets along the water's edge. Muskrat and beaver live along the rivers and in marshy areas. Small native rats, mice, squirrels, and rabbits are found in the cottonwood-sycamore woodlands.

Table 8 in the Appended Material lists the mammals found in and adjacent to the four reservoir sites. These reservoir sites are not the exclusive habitat areas of these species.

5. Ecological Interrelationships [47]

Desert ecological communities in general are considered relatively tolerant to extreme natural stresses. In order for the desert biota to survive in the extreme temperature and low-moisture conditions, they have modified their life-form and adapted successfully into the hardy forms found in the desert environment. Erosion rates of desert soils are

variable from low to high depending on soil structure, particle size, cohesiveness, plant cover, and other factors. Erosion results from strong winds or intense rainfall and storm runoff. Soils are sometimes low in quality. The sparse desert vegetation, resulting from the climatic and geologic regimen, has limited the diversity and forms of animal life. Species known to exist historically are now extinct. Long periods of isolation in the severe desert environment have caused evolutionary changes in some species. Species that could not evolve became extinct.

Grassland, chaparral, and woodland communities are progressively more stable ecological systems. Each provides more cover, forage, and water storage, and thus is able to support larger populations of animals. To some extent, large stands of vegetation modify climatic conditions within them due to increased humidity from plant transpiration.

Natural successional changes have occurred in many ecological communities, especially the riparian community. In addition, changes due to change in climate, man's activities, and other factors have made visible differences in several of the ecological communities in the project area.

Natural changes are discussed at length by Minckley. His theory is that around 1870, climatic changes caused the incision of river and stream channels. This dried up extensive wetlands which were associated with these channels and created the now familiar mesquite and cottonwood-sycamore-baccharis riparian communities. In the second third of this century, the introduced saltcedar made heavy inroads on the mesquite bosques, and formed a third type of riparian habitat.

Man and his activities have resulted in a significant impact on some desert areas. Relatively small areas of the desert have been modified by introducing water and transforming desert land to agricultural and urban land uses. Dropping of the water table due to ground-water overdraft has also resulted in replacement of marsh and riparian areas with desert shrub. Man has affected, to some degree, the desert's ecology by constructing highways, canals, and other improvements, and conducting military training operations. Roads across desert lands often change the drainage patterns in the area, and it can be many years before vegetation is reestablished in the disturbed areas.

Woodland and grassland communities have been affected due to changes in the hydrology of the watershed area. Many of these areas have also been overgrazed, and due to the desert environment are slow in recovering their normal vigor.

6. Cultural Factors and Land Use 1,63,75,131,135-137,139,182

a. Land Use Pattern

The project area is generally located within the 50,900-square-mile drainage area of the Gila River and its principal tributaries from above Painted Rock Dam in Arizona, to the upper reaches of the Gila River in southwestern New Mexico. Approximately 54,000 acres of land will be directly involved by the construction of the project. For the most part, the watershed area is undeveloped. For example, the irrigated agricultural and urban and industrial area complexes within the Gila River Basin cover an area of 1,260,000 acres, or 3.4 percent of the total land resource of 36,790,000 acres. The CAP facilities will occupy in part some of these existing complexes. The remaining facilities will occupy land that is presently used for grazing, rangeland, forests, military, transportation, and recreation.

The pattern of development and land use varies widely from place to place within the project area, depending on topography, soil types, water supply, mineral deposits, and transportation routes. The three basic categories of land use are: 1) relatively undeveloped land, 2) irrigated farmland, and 3) urban areas.

For much of its length, the Granite Reef Aqueduct passes through alluvial desert plains surrounded by rugged and desolate mountains. The area provides only meager forage for livestock grazing and consequently ranch development has not been intensive. The terrain and climate in the area of the Tucson and San Pedro Aqueducts are not quite so severe as they are adjacent to the Granite Reef Aqueduct, and grazing is somewhat more intensive in these areas. There is some scattered mining activity in the immediate area of project facilities, but this activity is generally limited to small sites with no large areas being devoted to mineral production. The human inhabitants live largely in small communities and towns along the major roads or on isolated ranches.

The Indians began agricultural development in the area in prehistoric time by diverting water from larger streams onto flood plains and adjacent basin floors. Beginning in the Territorial period, white settlers adopted and expanded surface-water irrigation along the Hassayampa, Agua Fria, Verde, Salt, Gila, San Pedro, and Santa Cruz Rivers. Ground-water pumping on a large scale was started in the early 1900's in shallow water-table areas along the major streams to supplement the surface-water supply, or because of drainage problems. Improved pumping technology, wartime fiber requirements, and high farm prices in the late 1940's and 1950's resulted in a rapid expansion of ground-water irrigation into basin areas far from the major streams. At the present time, irrigation is highly developed in the vicinities of the Salt, Gila, and Santa Cruz Rivers, and significant areas are farmed in several other neighboring basins. The total irrigated area was about 700,000 acres in 1970.

Project aqueducts and reservoirs lie immediately adjacent to much of the agricultural area. (See Figure 19C)

The major urban areas directly under project influence are the Phoenix and Tucson metropolitan areas located in the Salt River and Santa Cruz River Valleys, respectively. These areas involve about 300 square miles of land. Both undeveloped and agricultural lands are being urbanized daily and both classifications will be involved in future shifts in land use.

The smaller cities of Florence, Casa Grande, and Coolidge are in the area irrigated in part from the Gila River. Other small cities and towns including Eloy, Picacho, and Maricopa, are in areas irrigated entirely with ground water.

b. Land Ownership[63,135]

The required right-of-way for the CAP facilities falls within a variety of ownerships, including Federal, Indian, state, and private. A larger portion of the aqueduct system will be on public domain land under Reclamation withdrawal, especially between the Colorado and Hassayampa Rivers. A small area of National Forest land will be crossed near the Salt River. The State of Arizona owns a large portion of the land along the route south of the Salt River. These state and Federal lands are largely undeveloped, and are leased for grazing. Several miles of the Granite Reef Aqueduct cross undeveloped land of the Salt River Indian Reservation near Phoenix. Some privately owned land will be crossed in the vicinity of the urban and agricultural development between the Hassayampa River and the west boundary of the Salt River Indian Reservation.

The following tabulation shows the approximate percentage of aqueduct right-of-way ownership in each category:

Federal	40%
State	27%
Indian	3%
Private	30%

The Orme Dam and Reservoir site is on land of Tonto National Forest, Salt River Indian Reservation, and Fort McDowell Indian Reservation. Approximately 9,700 acres will be needed for the conservation storage area. Of the 24,000 acres below maximum water surface elevation at flood stage, the right-of-way requirements are:

Forest Service	7,900 acres
Indian lands	16,100 acres

Buttes Dam and Reservoir site is located on the Gila River, on public domain and private lands. Approximately 4,000 acres are involved for conservation storage. The area below the maximum flood control storage elevation will be about 5,500 acres.

Charleston Dam and Reservoir site, on the San Pedro River, is mostly on private land. There is also a small amount of land owned by the state as well as part of the Fort Huachuca Military Reservation. Approximately 5,600 acres may be involved at the maximum flood storage elevation, of which 4,000 acres will be inundated by the conservation storage.

Approximately 1,120 acres and 1,340 acres of National Forest land are required for the conservation level and flood stage level, respectively, for the Hooker Dam and Reservoir site, on the Gila River in New Mexico. These figures include portions of the Gila Primitive and Gila Wilderness Areas, and patented private land.

Figure 19D is a landownership map for the Lower Colorado Region.

c. Archeological and Historical Sites 41-46,60,73,141,177,178, 182,184

Four major cultural subareas may be distinguished in the Southwest: the Hohokam of the desert of central and southern Arizona, the Mogollon of the mountainous areas of eastern Arizona and western New Mexico, the Anasazi of the high plateau region known as the Four Corners, and the Patayan, which centered in the Colorado River Valley in a desert environment. There was considerable cultural interchange among the major subareas in prehistoric times. The prehistoric cultures of the Southwest are ancestral to historic and modern Indian cultures of the area. For example, the Hopi of northern Arizona and the Zuni of west-central New Mexico still live on or near the townsites of their prehistoric ancestors.

Another continuity between prehistoric and historic people is seen in the desert region of southern Arizona where the relationships of the present day Pima and Papago farmers to the prehistoric Hohokam are well established. Present evidence suggests that some of the Mogollon people may have joined the Anasazi to the north, while others may have joined the Hohokam.

In the central Arizona area, historic landmarks are generally connected with three major influences in the area's history: the Indian supremacy, the Spanish settlement, and the American period. The first European to visit the basin was Fray Marcos de Niza, a Franciscan who, in 1539, traveled from Mexico in search of the rumored Seven Cities of Cibola. It was not until the 19th Century that American hunters and trappers began drifting into the region.

The National Park Service, Southwest Archeological Center, has conducted surveys of aqueduct routes and reservoir sites to appraise the archeological and historical sites and structures. These initial surveys identify about 15 sites along the aqueduct routes. There are 12 known archeological sites that have been located on the Verde River above its confluence with the Salt River in the area of the proposed Orme Dam and Reservoir. Six sites have been located in the Buttes Reservoir. In the Charleston Reservoir area and vicinity, 113 new sites were located bringing the total to 133 known archeological sites. A contract is being negotiated with the National Park Service for archeological surveys on the proposed Hooker Dam site and reservoir area and for additional surveys on all of the project features. Two such studies covering the Havasu feature and the Granite Reef Aqueduct have been completed. A known major archeological site, Woodrow Ruin, is located on the west bank of the Gila River, approximately $2\frac{1}{2}$ miles downstream from the Hooker Dam site. Woodrow Ruin is an extensive Mogollon site covering approximately 10 acres and is recorded on the National Register of Historic Sites and the New Mexico State Register of Cultural Properties. In addition to the Woodrow Ruin there are nine unlisted sites or areas of historical interest in close proximity to the Hooker Dam and Reservoir site that may be affected by the project development.

Current listings of the National Register for Historic Places and Designated National Historic Landmarks in the Federal Register reveal three sites that will be in the same counties as project features - see Figure 19E and Table 13. (Archeological Sites 3 through 6 are misplotted, none of which will be influenced by the project.) The Casa Grande National Monument will be 7 miles northwest of the Salt-Gila Aqueduct, the Lehner Mammoth-Kill National Historic Landmark is 8 miles south of the proposed Charleston Reservoir and the Hohokam-Pima Irrigation Sites, and other potential nominations including the Park of the Four Waters in Phoenix are all located at distances varying from 4 to 20 miles downstream from the aqueducts and siphons crossing the Salt and Gila Rivers.

Prehistoric and historical habitation was closely tied to the surface waters of the area. Numerous sites occur along the terraces of the larger streams. In general, the prehistoric sites consist of sherd areas, trash mounds, playing fields, and small masonry or adobe ruins. The historic sites are quite varied.

Specific archeological and historical sites which may be affected by project facilities are discussed later in this chapter and in Chapter III. The information obtained in future surveys will be reflected in the individual environmental statements covering the major feature of the project.

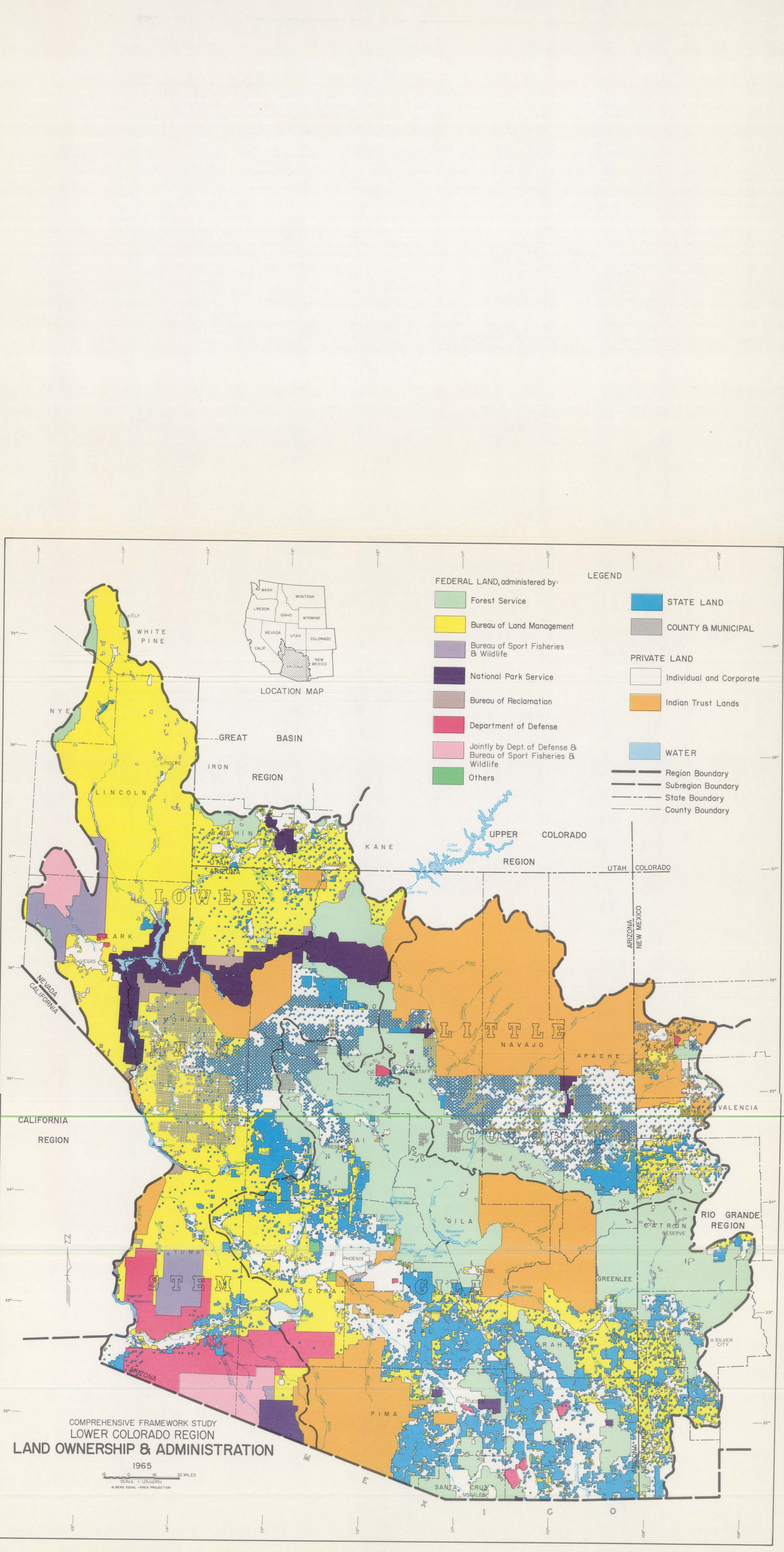

LEGEND
FEDERAL LAND, administered by:
Forest Service
Bureau of Land Management
Bureau of Sport Fisheries & Wildlife
National Park Service
Bureau of Reclamation
Department of Defense
Jointly by Dept. of Defense & Bureau of Sport Fisheries & Wildlife
Others
STATE LAND
COUNTY & MUNICIPAL
PRIVATE LAND
Individual and Corporate
Indian Trust Lands
WATER
Region Boundary
Subregion Boundary
State Boundary
County Boundary
LOCATION MAP
WASH
MONTANA
OREGON
IDAHO
WYOMING
NEVADA
UTAH
COLORADO
CALIF
ARIZONA
NEW MEXICO
GREAT BASIN REGION
UPPER COLORADO REGION
CALIFORNIA REGION
LOWER COLORADO REGION
RIO GRANDE REGION
WHITE PINE
NYE
LINCOLN
IRON
KANE
UTAH
ARIZONA
COLORADO
NEW MEXICO
NAVAJO
APACHE
MCKINLEY
SAN JUAN
VALENCIA
YUMA
MARICOPA
GILA
GRAHAM
GREENLEE
CATRON
SANTA CRUZ
PIMA
YAVAPAI
MOHAVE
LA PAZ
RIVERSIDE
SAN BERNARDINO
IMPERIAL
Lake Powell
Lee Ferry
Roosevelt Lake
Horseshoe Reservoir
Bartlett Reservoir
Apache Lake
Canyon Lake
San Carlos Lake
Imperial Reservoir
Painted Rock Reservoir
Lake Mead
Lake Havasu
Parker Dam
Davis Dam
ELY
PIOCHE
KINGMAN
FLAGSTAFF
PHOENIX
GLOBE
TUCSON
NOGALES
SILVER CITY
LAS VEGAS
NEVADA
CALIFORNIA
MEXICO
COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
LAND OWNERSHIP & ADMINISTRATION
1965
16 0 16 32 MILES
SCALE 1:1,000,000
ALBERS EQUAL-AREA PROJECTION

Figure 19D

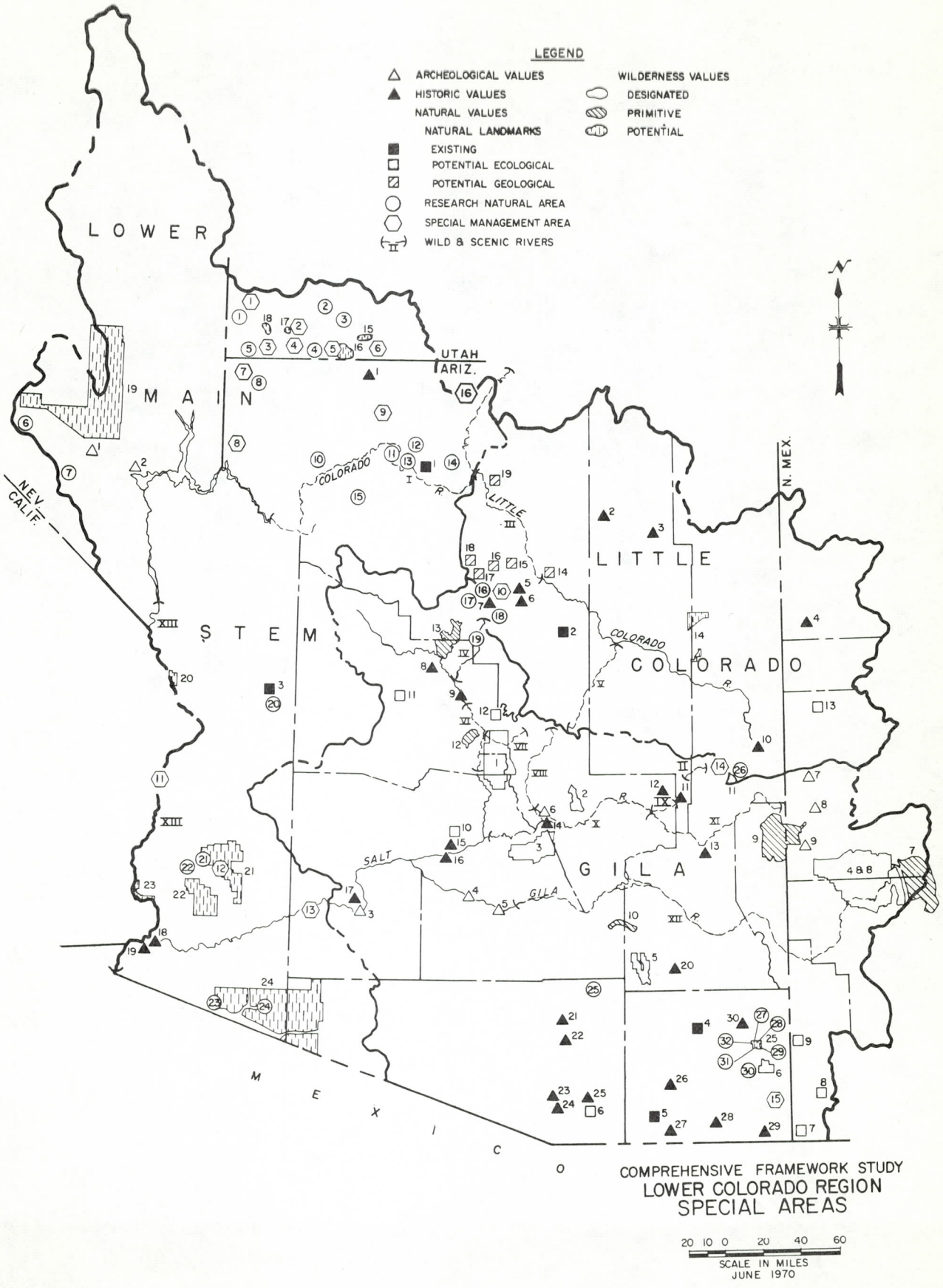

LEGEND
ARCHEOLOGICAL VALUES
HISTORIC VALUES
NATURAL VALUES
NATURAL LANDMARKS
EXISTING
POTENTIAL ECOLOGICAL
POTENTIAL GEOLOGICAL
RESEARCH NATURAL AREA
SPECIAL MANAGEMENT AREA
WILD & SCENIC RIVERS
WILDERNESS VALUES
DESIGNATED
PRIMITIVE
POTENTIAL
LOWER
MAIN
STEM
LITTLE
COLORADO
GILA
UTAH
ARIZ.
NEV.
CALIF.
N. MEX.
COLORADO R.
LITTLE R.
SALT
GILA
MEXICO
COMPREHENSIVE FRAMEWORK STUDY
LOWER COLORADO REGION
SPECIAL AREAS
20 10 0 20 40 60
SCALE IN MILES
JUNE 1970

Figure 19E

TABLE 13

SPECIAL AREAS - LOWER COLORADO REGION

Symbols and numbers refer to Figure 19E

Archeological Sites of Major Significance

1	Tule Springs	
2	Gypsum Cave	
3	Snaketown	
4	Grewe Site	
5	Casa Grande	
6	Roosevelt	
7	Tularosa Cave	
8	Cordova Cave	
9	Mogollon Village Site	

Significant Historic Sites

1	Pipe Springs N. Mon.	
2	Old Oraibi	
3	Awatovi	
4	Zuni	
5	Merriam (C. Hart) Base Camp	
6	Winona Site	
7	Lowell Observatory	
8	Jerome	
9	Camp Verde	
10	Casa Malpais	
11	Fort Apache	
12	Kinishba Ruins	
13	Point of Pines	
14	Roosevelt Dam	
15	Pueblo Grande Ruin	
16	Park of the 4 Waters	
17	Gatlin Site	
18	Yuma Territorial Prison	
19	Yuma Crossing	
20	Sierra Bonita Ranch	
21	Tucson	
22	San Xavier del Bac	
23	Presidio at Tubac	
24	Tumacacori N. Mon.	
25	Fort Buchanan	
26	Tombstone	
27	Lehner-Mammoth-Kill Site	
28	Double Adobe	
29	San Bernardino Ranch	
30	Fort Bowie N. Mon.	

Special Management Areas

	Names	Acres	Administering Agency
UTAH			
1	Ripple Arch	762	Bureau of Land Management
2	Cottonwood Canyon	80	Bureau of Land Management
3	Joshua Tree	1,000	Bureau of Land Management
4	Sand Mountain	1,600	Bureau of Land Management
5	Red Mountain	6,320	Bureau of Land Management
6	Coral Pink Sand Dunes	1,200	State of Utah
ARIZONA			
7	Sullivan and Virgin River	50,000	Bureau of Land Management
8	Grand Wash Cliffs	35,000	Bureau of Land Management
9	Kanab Creek Canyons	70,000	Bureau of Land Management
10	C. Hart Merriam Scenic Area	275	Forest Service
11	Lower Colorado River	350,000	Bureau of Land Management
12	Kofa Game Range	660,000	Bureau of Sport Fisheries & Wildlife
13	Gila River Greenbelt	62,735	Bureau of Land Management
14	Phelps Botanical Area	100	Forest Service
15	Mexican Duck Habitat	1,000	Bureau of Land Management
16	Vermillion Cliffs	50,136	Bureau of Land Management

Research Natural Areas

UTAH			
1	Blackbrush	400	Bureau of Land Management
2	Kolob Mesas	75	National Park Service
3	West Rim Phantom Valley	15,360	National Park Service
4	Desert San Dunes	1,200	Bureau of Land Management
5	Desert	1,000	Bureau of Land Management
NEVADA			
6	Wood Canyon	2,880	Bureau of Land Management
7	Pine Creek Canyon	240	Bureau of Land Management
ARIZONA			
8	Black Rock Mountain	154	Bureau of Land Management
10	Mt. Emma	1,154	National Park Service
11	Great Thumb	960	National Park Service
12	Swamp Point	1,120	National Park Service
13	Powell Plateau	5,120	National Park Service
14	Neal Springs	15	National Park Service
15	Wayside	480	National Park Service
16	San Francisco Peaks	1,024	Forest Service
17	G. A. Pearsons	154	Forest Service
18	Walnut Canyon	260	National Park Service
19	Oak Creek Canyon	940	Forest Service
20	Joshua Tree	160	Bureau of Land Management
21	Palm Canyon	840	Bureau of Land Management
22	Fishtail Canyon	160	Bureau of Land Management
23	Antelope Flat	57	Bureau of Sport Fisheries & Wildlife
24	Sierra Pinta	5,120	Bureau of Sport Fisheries & Wildlife
25	Butterfly Peak	1,000	Forest Service
26	Phelps Botanical Area	100	Forest Service
27	Far West Picket Park	90	National Park Service
28	East Picket Park	50	National Park Service
29	South Shake Springs	25	National Park Service
30	Pole Bridge Canyon	320	Forest Service
31	Jesse James	45	National Park Service
32	West Picket Park	40	National Park Service

The present Research Natural Areas include examples of:

1. Typical or unusual faunistic and/or floristic types, associations or other biotic phenomena.
2. Characteristic or outstanding geologic features and processes.

Natural Landmarks (Existing)

1	Kaibab Squirrel Habitat	Arizona
2	Barringer Meteor Crater	Arizona
3	Hualapai Valley Joshua Trees	Arizona
4	Willcox Playa	Arizona
5	Ramsey Canyon	Arizona

Ecological Areas (Potential Additions)

6	Sonoita Creek	Arizona
7	Guadalupe Canyon	New Mexico
8	Animas Canyon	New Mexico
9	San Simon Cieniga	New Mexico
10	Camelback Mountain	Arizona
11	Granite Dells	Arizona
12	Fossil Creek	Arizona
13	Zuni Salt Lake	New Mexico

Geological Areas (Potential Additions)

14	Grand Falls, Little Colorado River	Arizona
15	Doney Craters to Black Monocline	Arizona
16	S P Crater	Arizona
17	Government Cave	Arizona
18	Red Mountain	Arizona
19	Lower Gorge, Little Colorado River	Arizona

Primitive

	Name	Subregion	Acres
7	Black Range**	Gila	169,984
8	Gila (both) (designated and primitive)**	Gila	132,788
9	Blue Range***	Gila	211,470
10	Aravaipa Canyon*	Gila	5,667
11	Mt. Baldy****	Little Colorado	7,400
12	Pine Mountain***	Gila	16,399
13	Sycamore Canyon***	Gila	49,590
14	Petrified Forest National Park (portions)	Little Colorado	50,260
15	Virgin River Area	Lower Main Stem	5,500
16	Canaan Area	Lower Main Stem	8,000
17	Cottonwood Canyon Area	Lower Main Stem	9,800
18	Red Mountain Area	Lower Main Stem	12,440
19	Desert Wildlife Range	Lower Main Stem	665,000
20	Lake Havasu National Wildlife Refuge	Lower Main Stem	17,000
21	Kofa Game Range	Lower Main Stem	202,000
22	Castle Dome	Lower Main Stem	125,000
23	Imperial National Wildlife Refuge	Lower Main Stem	12,000
24	Cabeza Prieta Game Range	Lower Main Stem	624,000
25	Chiracahua National Mon.	Gila	4,685

Designated Wilderness

	Name	Subregion	Acres
1	Mazatzal Wilderness	Gila	205,346
2	Sierra Ancha Wilderness	Gila	20,850
3	Superstition Wilderness	Gila	124,140
4	Gila Wilderness	Gila	433,916
5	Galiuro Wilderness	Gila	52,717
6	Chiracahua	Gila	18,000

* BLM lands designated as primitive areas by Secretary of the Interior
** National Forest
*** National Forest which have been proposed
**** Included in the Wilderness System by 91st Congress

d. Recreation [1,141,142,184]

The recreation resources of the project and adjacent areas are used on a year-round basis. There are seasonal peaks for certain types of recreation, with variations in preference of activity by residents and visitors alike. Winter visitors are numerous in the project area, but urban resident population represents over three-quarters of the regional total use. Water-oriented recreation is utilized primarily during warm-weather periods.

It is estimated in the Comprehensive Framework Study that the amount of land available in the lower Colorado region for recreation will be adequate until the year 2000. There are, however, deficiencies in certain types of activities and surpluses for others. In addition, there is considerable geographic imbalance in the locations of these activities with respect to population centers. By 2000, the Comprehensive Framework Study estimates that the Gila subregion will need 29,300 acres of water available for recreation, and by the year 2020, 86,000 acres.

Due to the large populations and rapid growth which has taken place in the CAP service area, recreation demand has grown very quickly and will continue to place heavy demands on the natural environment, especially in the Phoenix-Tucson corridor and the surrounding water and mountain areas. The lower Colorado River main stem, the reservoirs on the Salt, Verde, Gila, San Pedro, and other rivers, and the river areas themselves, will all receive heavy use by residents of Phoenix, Tucson, and the many suburban and rural towns in the project area.

7. Environmental Quality in Central Arizona

a. Air[72]

The increase in air pollution problems in major metropolitan areas is the result of the rapid oxidation of hydrocarbon compounds that contain other elements as impurities. Typical problems result from burning fuels in power production, residence and office heating, large industries and transportation systems, and from incineration and agricultural burning.

Uncontrolled agricultural burning is not a major problem in the project area. Air pollution controls and improved agricultural practices have actually improved conditions over those of a few years back. Under the State of Arizona air pollution laws, primary jurisdiction over pollution matters is vested in the Arizona State Air Pollution Control Division of the Department of Health. An installation and operating permit is required for equipment which may cause pollution or which is installed to control pollution.

The boundaries of Metropolitan Phoenix-Tucson Intrastate Air Quality Control Region were designated and the region established on April 24, 1970, by the Secretary of Health, Education, and Welfare pursuant to the Clean Air Act of 1963 as amended. The region embraces Gila, Maricopa, Pima, Pinal, and Santa Cruz Counties. The following high values are indicative of conditions in the region based on the sampling sites located through the region.

Air Quality Measurements	Annual Average Values			
	Value	No. of Stations	Value	No. of Stations
Suspended Particulate (Hi-Vol)	exceeded 100 ug/m^3	17	exceeded 140 ug/m^3	9
Suspended Particulate (Tape Sampler)	not exceeding 0.46 COHS/1000'	10		
Settleable Particulate (Dust fall)	greater than 10 tons/mi^2/mo	4	greater than 20 tons/mi^2/mo	2
Sulfur Oxide (Continuous)	not exceeding annual average of 0.04 ppm	10		
Sulfation Rate (Candle)	less than 0.1 mg SO_3/100cm^2/day	6	greater than 1.0 mg SO_3/100cm^2/day	2
Sulfation Rate (Disc)	less than 0.1 mg SO_3/100cm^2/day	71		

b. Water[144]

High levels of total dissolved solids in surface and ground waters exist in the project area and influence domestic, industrial, and agricultural uses. In the headwaters of the Gila River, dissolved solids concentrations are generally less than 500 ppm. In the middle reaches, below the point of major diversions, the dissolved solids range from about 500 to 1,000 ppm. There are some salt springs discharging into the Gila River, although most of the increase in dissolved solids results from the concentrating effects of consumptive use and return flow. Total dissolved solids in the Salt River at Stewart Mountain Dam are about 700 ppm. Concentrations in the Verde River range to as low as 280 ppm.

Quality of ground water in central Arizona ranges widely both areally and with depth. The production wells in the project area

produce water ranging between 300 ppm and 4,500 ppm of TDS. The average of all ground water, as pumped, was 955 ppm in 1965.

Fluoride content ranges from a trace to about 4 or 5 ppm. The average is normally about 1 ppm or less in most water of the area. This relatively high level of natural fluoride concentration persists even during flooding on some upstream portions of the Gila River. A few isolated sample points show fluoride contents of more than 10 ppm.

Sediment concentrations in surface water of the region range from very high to moderate. In the Basin and Range lowlands, the yields are moderate with concentrations in the adjacent streams averaging about 20,000 ppm.

Total hardness of the ground water ranges from soft to very hard, from less than 60 ppm to more than 600 ppm. The concentrations of minor constituents such as iron, magnesium, and silica vary considerably throughout the area; but, except for fluoride and nitrates, the concentrations are not objectionable for most uses.

Existing conditions affecting water quality and public health in the CAP area are as follows:

(1) Presence of potentially water-borne disease.

(2) Open surface-water irrigation systems.

(3) Bacteriological quality of water supplies at some recreation areas does not meet USPHS standards.

(4) Chemical, bacteriological, and other pollution resulting from irrigation return flows and municipal and industrial wastes.

(5) Contamination of streams by runoff from natural mineral deposits, livestock feeding operations, and other solid wastes.

(6) Lack of sufficient water to maintain minimum streamflows and outflows from the basin.

(7) The presence of mosquitos and other vectors that may increase health hazards.

c. Noise

Sound levels vary within the CAP service area. In open desert and grassland areas, natural sound is generated by animals, winds,

thunder, and rain. The most common noises resulting from man's activities in these areas would be occasional airplanes traversing the area and/or off-road vehicles (such as a jeep or motorcycle). In agricultural areas, intermittent noise of a high- to low-level type is generated by farm machinery, cars, water pumps, and airplanes. Urban and industrial areas have higher noise levels, with cars, machinery, and other transportation forms (railroads and airplanes) in operation. Noise levels are generally at acceptable levels.

8. Colorado River 5,115

The Colorado River Basin is divided into the Upper and Lower Basins by the Colorado River Compact. The legally-designated dividing point between the two is Lee Ferry, located in the main stream of the Colorado River 1 mile below the mouth of the Paria River. This is about 17 miles downstream from Glen Canyon Dam. (See Figure 1) From Lee Ferry the Colorado River flows through the Grand Canyon into Lake Mead which is formed by Hoover Dam 370 miles downstream from Glen Canyon Dam. Lake Mead (active storage capacity 26,159,000 acre-feet) provides most of the storage and regulation of the lower Colorado River. Proceeding downstream, Davis Dam and Lake Mohave, Parker Dam and Lake Havasu, Headgate Rock Dam, Palo Verde Diversion Dam, Senator Wash Dam and Reservoir, and Imperial Dam and Reservoir provide for re-regulation of stream flows, and storage and diversion of the river's waters for various uses. Imperial Dam, located 28 miles above the northerly international boundary, is the last major diversion point on the Colorado River for users in the United States.

a. Flow 3-9,12,13,134,144,183

The Colorado River is subject to a number of legal documents generally referred to as the "Law of the River," and these documents concern the interests of the United States, seven western states, and Mexico. These documents are referred to here and referenced throughout this statement with regard to water rights pertaining to the Colorado River, and especially the Lower Basin.

Historically the Colorado River runoff or undepleted flow at Lee Ferry has varied from 5 to 24 million acre-feet annually. Many authorities investigating the runoff of the Colorado River have estimated the average annual long-term runoff as between 13 and 15 million acre-feet. At the present time the Upper Basin is using less than half of its apportionment provided by the Colorado River Compact. In the lower basin, annual releases from Hoover Dam to meet the current water requirements of Mexico, Arizona, and California are about 7.9 maf. Most of the small present requirements by Nevada are met directly from Lake Mead. The Mexican Water Treaty of 1944 allocates to Mexico 1.5 maf of Colorado River system waters annually, to be increased in years of surplus to 1.7 maf and reduced proportionately during extraordinary drouth. The U. S. Supreme

Court Decree in Arizona v. California (1964) established Indian water rights for the irrigation of 136,636 acres below Hoover Dam in Arizona, California, and Nevada. These priority rights are for a total annual diversion of 905,496 acre-feet from the Colorado River or the quantity of mainstream water necessary to supply the consumptive use requirements of the irrigated land. Among other things, the decree reaffirmed the Boulder Canyon Project Act apportionment of water provided by Article III(a) of the Colorado River Compact, so that if sufficient water is available for release to satisfy 7,500,000 acre-feet of annual consumptive use in the three lower Colorado River Basin States, the apportionment is as follows:

State	Consumptive Use (acre-feet)
California	4,400,000
Arizona	2,800,000
Nevada	300,000
Total	7,500,000

The long-term diversion is expected to be about 1.2 maf, which assumes full development levels of all prior water rights in Arizona along the mainstream at that time, including Court decreed rights of Indian Reservations adjacent to the river in Arizona. It is estimated that annual diversions to CAP will vary between a minimum of 0.38 maf during extreme drouth and a design maximum of 2.2 maf during periods of surplus water availability. The amount of diversion in any one year will depend on water supply conditions and the extent of Upper Basin development, neither of which are expected to restrict CAP diversions during the early years of the project.

All water requirements below Hoover Dam are satisfied from releases from Lake Mead and tributary inflow downstream. In the past 10 years, no water has been released from Hoover Dam in excess of downstream consumptive use requirements. Diversions to the CAP plus changes in other uses along the mainstream will result in a net increase in release requirements from Lake Mead. The major part of future increases in use along the mainstream in Arizona will be from planned development on Indian reservations and wildlife refuges.

The amount of water released into the lower basin from the upper Colorado River basin will decrease as additional development is

realized in the upper basin. As a result of these increased demands on the river, the average availability of Colorado River water for diversion by the project will decrease from a projected level of 1.64 million acre-feet in 1982 to 0.90 million acre-feet in 2032.

The normal CAP diversion will come from a reduction of over 650,000 acre-feet per year in diversions from Lake Havasu to California which presently exceeds its entitlement, and from additional releases from Lake Mead.

Flows into Lake Havasu behind Parker Dam will be less than releases from Lake Mead by the amount of river losses occurring in this reach. The additional water releases for CAP will be diverted from Lake Havasu. They will not affect the magnitude of releases below Parker Dam. However, additional downstream uses, primarily on Indian lands and wildlife refuges, will increase the release requirement from Lake Havasu by 200,000 - 300,000 acre-feet per year by the early 1980's.

b. Salinity[1,114,119-121,144,160,161]

High levels of dissolved mineral salts in surface and ground waters are a major water quality problem in the entire lower Colorado River basin. With few exceptions, most surface and ground water supplies have mineral concentrations exceeding 500 ppm, and many exceed 1,000 ppm. This salinity limits some municipal, industrial, and agricultural uses.

The Colorado River enters the lower basin at Lee Ferry already containing an average of some 600 ppm of dissolved mineral salts. Nearly 8.7 million tons of these dissolved solids are transported into the lower basin from the upper basin annually. From Lee Ferry the river increases in salinity on its course to the Gulf of California (see Figure 1), reaching about 734 ppm below Hoover Dam, 726 ppm at Parker Dam, and 845 ppm at Imperial Dam above Yuma. This increased salinity is due principally to inputs from saline springs and the concentrating effects of consumptive use and reservoir evaporation.

At least seven salt springs contribute some 685,000 tons of salt annually to the lower Colorado River directly or to its perennial tributaries, the Virgin and Little Colorado Rivers. Blue Spring alone discharges some 547,000 tons annually at a point on the Little Colorado River only 13 miles from its confluence with the Colorado River. The Little Colorado River contributes salts of the sodium chloride type to the Colorado River while the Virgin River contributes sulfates as well as sodium and other chlorides. Salts of the calcium-sodium-sulfate type predominate in the Colorado River from Lee Ferry to Imperial Dam. Little change in the proportions of chemical constituents is noted in this reach of the river and irrigation return flows do not have a material impact on that composition. However, below Imperial Dam irrigation return flows

cause a shift to predominately sodium chloride type salts in the river on the remainder of its course to the international border.

Collectively, these salinity problems adversely affect the quality of the water reaching Morelos Dam for diversion for irrigation in the Mexicali Valley in Mexico. This is a serious problem, recognized as one of national concern by Congress in P.L. 90-537, and acknowledged by the President as recently as June of this year. The salinity of the entire 710 miles of the lower Colorado River from Lee Ferry to the International Boundary is likewise an increasingly serious problem. Without a comprehensive control program, salinity is projected to increase from 40 to 60 percent by the year 2020. This increase will be primarily due to increased developments and their return flows using presently unused rights to water along the entire course of the river. These new uses will include municipal and industrial diversions, irrigation, and thermal power productions. Evaporation from new reservoirs and return flows from newly irrigated land will contribute to increased salinity.

As a result of several years of study by various interested and responsible agencies, the Department of the Interior instituted investigations in 1971 which produced plans for the 10-year Colorado River Water Quality Improvement Program. The responsibility to plan and to implement the program rests with the Bureau of Reclamation, with other Interior agencies such as the Office of Saline Water, the Office of Water Resources Research, the Geological Survey, the Bureau of Land Management, the Bureau of Sport Fisheries and Wildlife, the Bureau of Outdoor Recreation, and the Bureau of Mines assuming cooperative roles. The objective of the program is to maintain salinity concentrations at or below levels presently found in the lower main stem of the Colorado River. Both long and short range solutions will be considered. It is estimated that a reduction in future salinity levels by 160 ppm at Imperial Dam by the year 1990 can be accomplished at a total capital cost in the order of $400 million to $500 million. This estimate includes the effects of controlling salt input at Blue Spring on the Little Colorado River but not the costs of this program element. Investigations are scheduled too for control of salinity at point sources, diffuse sources, and irrigation sources. These investigations are to be integrated with allied programs involving desalting, weather modification, geothermal resources, and basin-wide water resource management.

B. The Projected Future Environment of the Project Area Without the Central Arizona Project 1,15,16

The projected future environment of the project area without the project would continue to include the problems and deteriorating conditions outlined in Chapter I. Trends outlined in Chapter I and Section A

of this chapter would continue to cause environmental change. On the other hand, the impacts discussed in Chapters III and IV which would have been associated with the project would not occur.

If current trends continued unaltered, there would be a general deterioration of the water supply situation in the project area. There would be increased use of water for municipal and industrial purposes coupled with a reduction in overall water availability and an increase in costs of production. Both availability and cost problems would be related to continued overdrafting of ground water in the central service area. This situation would probably force the gradual phasing out of those water uses which yield low income in relation to the cost and amount of water used. This impact would be felt most directly by irrigated agriculture where the land and water use is directly competitive with urban expansion. It is unlikely, however, that municipal or industrial uses would be curtailed seriously for several years, since the safe-yield amount of water available in the project area exceeds the municipal and industrial demand that can be expected in the near and medium-term future. Thus, it cannot be expected that failure to build the project would have a pronounced effect on population growth.

A gradual change in land-use and ownership would continue. Agricultural lands which are close to urban fringe would continue to be subdivided. The rate at which this would occur would be dependent on agricultural greenbelt zoning laws being adopted and used. Without the project, additional agricultural lands would be forced out of production by water problems, but would not be used for other purposes. These lands would in the long term return to natural desert conditions through progressive successional stages. Temporarily there may be some incremental problems with wind and water erosion and sedimentation.

The project is economically attractive to water users who propose to use CAP water for agricultural purposes. Some of the Indian tribes of central Arizona are numbered among these potential users. Denial of project water would slow the economic progress and development of the Indian groups that would otherwise receive the water.

Ground-water quality could deteriorate due to the necessity of using poorer quality and/or deeper aquifers to meet the rising demand for water. Overall, this decline would probably be small, but more pronounced in some areas than in others. Surface supplies would remain approximately the same in quality, although the reduction of poor quality agricultural return waters could have some beneficial results.

Existing recreational resources (especially water-oriented) would be subjected to much heavier use than they would if the project and its recreational facilities were constructed. This is especially true for facilities in close proximity to urban areas. The Salt, Gila, and Verde

Rivers and their present reservoirs would all be heavily used for fishing, boating, and swimming while the shoreline areas would be used for picnicking, hiking, camping, and sports activities. Demand for recreation would not be influenced by the lack of the project, and present geographical imbalances would not be corrected. An expected deficit of 29,300 surface acres of water for recreation by 2000 and 86,000 acres by 2020 is projected by the Comprehensive Framework Study.

Those archeological resources which would have been affected by CAP features would remain intact, although other construction activities and the usual weathering and pilferage would endanger or destroy many of these sites. Concurrently, much of the impetus to investigate these resources will be lost without the project.

The general physical environment would change little. Geology, topography, and climate would be little affected by the changes occasioned by the CAP or the changes which would occur without it. However, one significant condition would continue to be found, that is the expansion of land subsidence in some parts of central Arizona. While it is not possible with existing technology to accurately determine the extent or severity of subsidence in the future due to continued pumping of underground water, earth subsidence and cracking would undoubtedly continue.

Future land subsidence can be projected roughly from estimates of average annual decline of water level. Preliminary figures for the period 1970 to 2030 indicate that, with the CAP, the average water decline will be about 175 feet, and that without the project, the average decline would be 300 feet. Probable subsidence on the average for the period 1970-2030 would be 7 and 12 feet with and without the project, respectively, based on an average of 4 percent of the water decline.

Present patterns of surface water flooding and sedimentation would continue without the CAP unless other control structures were constructed. These continued patterns would: 1) cause serious periodic destruction similar to that which has occurred as recently as June of 1972 in Phoenix and suburban areas; 2) prevent the lengthening of the runway at Sky Harbor International Airport; 3) preclude development of the Rio Salado Project in Phoenix; and 4) continue the serious clogging of irrigation canals with sediment. Additionally, the area would continue to realize the loss of much valuable runoff water due to the lack of adequate conservation facilities.

Vegetation, fish, and wildlife would be affected in varying degrees by the absence of CAP. In some areas, vegetation may be lost due to

overdraft of ground waters lowering the water table below the root zone. The loss of these valuable vegetative communities would reduce available wildlife habitat in the region. Wildlife may also be affected by the areal reduction of grainfields which provide food and shelter for many small mammals and birds. Without the project, some fish species would not have the large reservoir areas in which to expand in numbers, but those species which would have been adversely affected by the pumping, transporting, or storage of project waters would remain in the streams which they inhabit at present. It is likely that recreational pressure on existing stream fisheries would increase, further stressing present fish populations, especially of native fishes.

The lack of a CAP should not have any adverse effects on rare or endangered fish and wildlife nor cause any species to become rare or endangered within the project area. Some ponds and marshes may dry up due to increased water control practices, thus reducing the amount of this relatively rare habitat type.

The projected future environment of the project feature areas would remain similar to present conditions. In the absence of potential separate feature authorization to meet specific needs, none of the construction, esthetic, or operational impacts would occur. No land would be inundated, and no temporary or permanent disturbance resulting from the project to fish, wildlife, or vegetation would take place. Water problems, subsidence, and other existing conditions would continue.

At the Havasu site, virtually no changes in the present environment would occur without the CAP. For the most part, the existing rocky, barren shoreline, artificial reservoir, and increasing mobile home subdivisions, would remain much the same as they are today.

Along the route of the Granite Reef, Salt-Gila, Tucson, and San Pedro Aqueducts, the interruption in the desert environment would be eliminated as would the recreation and fish and wildlife benefits which would be derived from off-canal watering facilities and proposed fishing lakes, and flood control afforded by the aqueduct cross-drainage protection systems.

In the Orme Reservoir area, recreational uses would increase and threaten present wildlife values. Disturbance of vegetation and wildlife in the area and upstream by recreationists may be expected. The Verde well field of the city of Phoenix, which provides employment for some members of the Fort McDowell Yavapai-Apache Indian Community and supplies water to metropolitan Phoenix, would continue to function. The economic and social effects which would occur with the reservoir would be substantially less since none of the reservation lands would be

inundated, present Indian communities and agricultural areas could be maintained, and the ancestral cemetery would remain accessible.

At the Buttes site, little change would be expected. Mineral deposits would remain readily available for future mining, provided it is economically feasible to do so.

The Charleston site would also remain in much the same condition as at present. The lack of a reservoir in this area would permit the open excavation of small quantities of minerals if these should prove profitable at some future date.

Because of its remoteness and protection by Federal ownership, the riparian vegetational and faunal communities as well as the surrounding mountain woodlands in the Gila National Forest, in which the Hooker Dam site is located, would remain much as they are today. Recreational use would become heavier as population pressures increase, and more people are willing to journey further for a "wilderness" experience. This heavier use may degrade vegetation and wildlife values.

Some of the changes, such as economic development, would be moderately affected by the failure to import water. The agricultural segment and agricultural supporting and processing segments of the economy would be adversely affected as agricultural production decreased due to a reduced water supply. Other factors of the overall environment would only feel minimal effects. For the most part, the degree to which all of the progressive environmental and social changes would be felt in the absence of the project would depend on the individual and governmental responses which would be made by the people of central Arizona and western New Mexico.

C. Present Environment at Specific Sites of Project Features

In this section, the environment at each of the major project feature sites is discussed separately. Further discussion will also be provided in the individual environmental statements covering the major features.

1. Environment of the Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 70

A detailed description of the environment at the proposed site for the Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel is contained in the Draft Environmental Statement (DES 72-40), filed with the Council on Environmental Quality on March 7, 1972.

a. Climate

The Havasu feature will be constructed in the sonoran desert region of the Southwest. The climate is hot and dry with an average annual

precipitation of about 5 inches. The mean annual temperature is 70°F., with a January average of 50°F. and an average of 90°F. for July. Summer temperatures are commonly in excess of 100°F., and have reached a maximum of 120°F. The minimum recorded winter temperature is 20°F. The average frost-free period in the area is in excess of 300 days.

b. Topography [158]

The natural environment in the work area underwent major changes upon completion of Parker Dam and impoundment of Lake Havasu in 1938 and subsequent construction of State Highway 95 and a trailer court. Lake Havasu inundated 25,000 acres of the Colorado River and Bill Williams River flood plains and their contiguous rock ridge area. Sediment, originating primarily from the Bill Williams River, has further covered much of the original topography in this portion of the lake and has formed a delta of 1,890 acres.

Several small rock islands and peninsulas are conspicuous land features along the south shore of Lake Havasu in the area of the intake channel. Heron Island, approximately 2 acres in size and rising about 170 feet above the normal lake level, is the largest of the islands and lies about one-quarter mile to the west of the landform embankment site.

The islands and peninsulas are extensions of a series of rock ridges which extend upward from the lake to The Mesa, a high plateau within the Buckskin Mountains that lies directly south of the intake channel and pumping plant site and is the most conspicuous land feature in the area. The Mesa is characterised by a series of rugged cliffs and steep slopes in volcanic rocks along its periphery with washes that have deeply incised the plateau. Maximum elevation of The Mesa is over 1,300 feet above lake level.

c. Vegetation [20,21,135]

Vegetation in the feature area is extremely sparse and characteristic of the sonoran desert environment. The rock ridges, canyons, and talus slopes leading upward from the lakeshore to the top of The Mesa are dotted sparsely with catclaw, cholla, and hedgehog cacti, creosote bush, and paloverde. Small stands of saltcedar and mesquite trees are also found along the shorelines and bottom of wash areas.

d. Fish and Wildlife [146,165,176]

Lake Havasu provides essentially a warm water game fishery, supporting variable populations of largemouth and striped bass, crappie,

sunfish, and catfish. Important nongame species of fish include large numbers of carp and threadfin shad, and numerous populations of other introduced species such as fathead minnows and shiners.

Rare and endangered fish, included in the Bureau of Sport Fisheries and Wildlife's 1968 edition of endangered species[66] are not known to exist in Lake Havasu. The Havasu National Wildlife Refuge encompasses the Bill Williams arm of Lake Havasu and adjacent lands along the lake and the Bill Williams River.

Lake Havasu is on a major flyway and the delta areas annually attract large numbers of migratory waterfowl. The delta area of the Bill Williams arm is an important stop. Heron Island is used from March through July each year by about 15 pairs of great blue heron, Ardea herodius, as a nesting and rearing area.

Deer and desert bighorn sheep are the only big game wildlife species within the area. A sizeable population of feral burros are also found in the area. Construction of State Highway 95 and private recreational development in the area have already modified the migratory routes of the desert bighorn. Even with these barriers, sheep still come to the lakeshore for watering and browsing. The deer have a less restrictive range and are usually observed on lands further upstream on the Bill Williams arm.

Other wildlife species include Gambel's quail, mourning dove, white-wing dove, cottontail rabbit, bobcat, coyote, gray fox, kit fox, badger, skunk, and a variety of small rodents and song birds.

e. Cultural Factors and Land Use [42,73,148,156,177,178]

The main stem of the Colorado River is used heavily for recreation of all types. Lake Havasu's shores are dotted with camping and picnicking areas, resorts, mobile homes, and second home developments. The intake channel and pumping facilities will be 2-1/2 miles east of Parker Dam. The 17-mile stretch from Parker, Arizona, north to the dam, received 1,124,000 visitor days in 1968. (See Figure 19F)

To some, the natural geologic formations and topography of the area have high esthetic values because of the proximity to a high-use recreation area and a state highway. Buckskin Mountains, with numerous ridges, canyons, and plateaus, offer a rugged setting for viewing and picture taking from either the lake or the highway.

A reconnaissance archeological survey of the area contracted under the supervision of the National Park Service, indicated that no historical or archeological sites are known to exist in the area. A subsequent detailed survey identified one lithic tool quarrying site on the top of the Mesa near the tunnel alinement.

2. Aqueduct Systems 20-22,24,42,43,45,61,63,71,108,158,166,177, 178,200

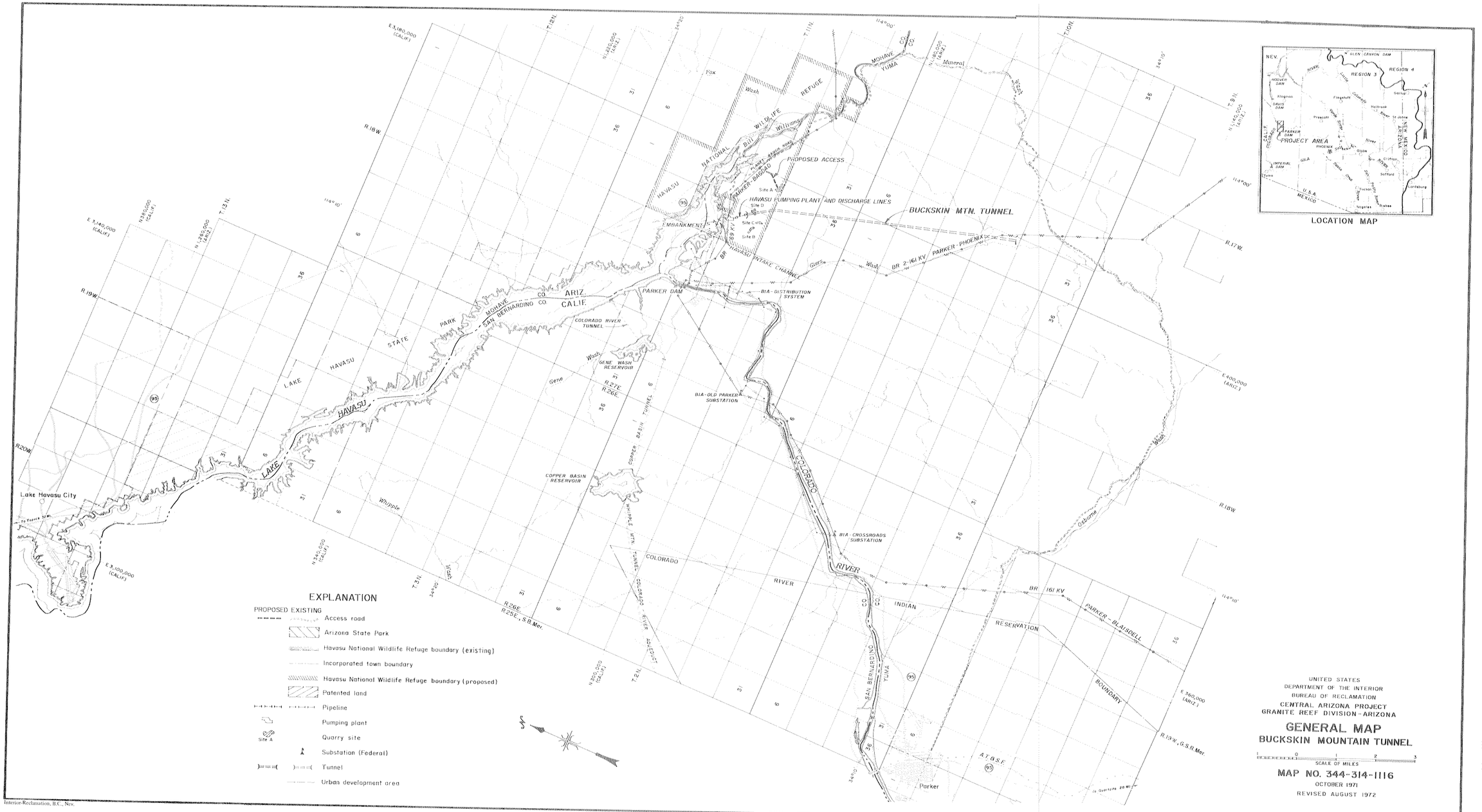
Each of the four main aqueducts will cross open desert country, some urban lands and some agricultural lands. The species of vegetation and wildlife which will be found are those of the sonoran desert environments discussed in Section A of this chapter. The edge areas between desert shrub ecological communities and agricultural lands are often extremely good wildlife habitat. Much of the area in open desert land was used for practice war maneuvers during World War II when the Army conducted desert training in southeastern California and most of Yuma County in southwestern Arizona. Scars are still evident in some areas used for training purposes or artillery impact areas. Climate, topography, geology, vegetation, and wildlife are covered in Section A of this chapter and will be covered in greater depth in the separate environmental statements covering these major features.

a. Granite Reef Aqueduct

The Granite Reef Aqueduct route as described in Chapter I traverses open mountain desert rangeland from Lake Havasu to Orme Reservoir. The last several miles of the route from the Agua Fria River around the north side of the Phoenix metropolitan area, skirt agricultural and suburban developments. It is expected that the urban development will become more dense along this portion of the route before construction is completed. The area is mainly desert shrub with the principal species of plants being creosote bush, paloverde, and cacti, especially saguaro. The scarcity of water in this area restricts vegetation and this severely limits wildlife habitat. Most of the area is only fair-to-poor in habitat quality. New archeological surveys along the aqueduct route have disclosed additional sites; some date back far into Desert Culture. The age of these sites indicates that even though barren and dry now, the open desert area may have at one time consisted of an entirely different environment. Discovery of these sites and the additional research to be directed toward this subject should contribute much information to the knowledge of the historical inhabitants. Between the Agua Fria River and the Salt-Gila Aqueduct, studies by Arizona State University in 1969 identified three sites that contained both habitation remains and terracing and agricultural works. One site has been destroyed by commercial gravel operations.

b. Salt-Gila Aqueduct

The Salt-Gila Aqueduct route traverses the varied landscapes between the end of the Granite Reef Aqueduct near McDowell Mountain and the beginning of the Tucson aqueduct near Marana, Arizona. The aqueduct will deliver water from the Granite Reef Aqueduct and Orme and Buttes Reservoirs to agricultural, municipal, and industrial users along its route. The aqueduct crosses typical basin and range country, with cactus, creosote bush, mesquite, haplopappus, bur-sage, paloverde, and ironwood. In the northern portion, much of the aqueduct route crosses rocky soil slopes. The upper slopes are bajadas. Washes drain the area in general to the southwest. In some portions of the route, agricultural activities are practiced.



Interior-Reclamation, B.C., Nev.

Predominant crops are alfalfa, cotton, and barley with some areas of vegetables. Numerous small animals and birds use the desert shrub and cultivated areas for forage and shelter.

Between the beginning of the aqueduct and the Gila River, ten archeological sites were found along the proposed right-of-way. Two of the sites were off the canal alinement and two others were also not recommended for excavation. Two sites were recommended for testing, two for minor scale excavation, and two sites were considered to be of high value. The archeological reconnaissance report suggested full scale excavation of these latter two sites, Ariz. U:15:27 (ASU) and Ariz. U:14:30 (ASU). These sites represent an example of Classic Period Hohokam of the Civano Phase, about which little is known. Site 15:27 is a large village area with about 40 visible structures.

c. Tucson Aqueduct

The Tucson Aqueduct crosses open desert lands between the end of the Salt-Gila Aqueduct and the outskirts of Tucson. Most of the aqueduct parallels Interstate Highway 10. Three archeological sites were located in this area. One of these was a large Hohokam village with some pithouses, which was recommended for excavation. One site was not recommended for excavation. It was suggested that the third site be tested further to determine its value.

d. San Pedro Aqueduct

The San Pedro Aqueduct will be a buried pipeline carrying water from Charleston Reservoir to the Tucson area. It will cross typical higher sonoran desert areas on its route from Charleston Dam. Fifteen archeological sites were located, of which eight require no excavation. Five were recommended for testing, and the two others for excavation. The route surveyed was not that of the entire pipeline route described in this statement. Resurvey and reevaluation of the report will be necessary.

3. Reservoirs

Four major reservoirs are associated with the CAP. Many environmental similarities exist among the reservoir sites, especially historically, but there are also significant differences. The environmental conditions during the 1800's, the subsequent changes, and the present environment at each reservoir site are discussed in the following paragraphs.

a. Historical Conditions and Changes 23,47,201

Environmental conditions along the streams to be impounded by Orme, Buttes, Charleston, and Hooker Reservoirs have changed radically since the 1800's. Water tables were higher, extensive marshlands

(cienegas) were present in many reaches, and there was widespread and abundant native biota which included many aquatic and mesic plants and animals.

Major changes over the past 100 years along these streams have included: 1) incision of stream channels; 2) replacement of native marshland biotas with differently adapted riparian vegetation and attendant animals; 3) introduction, spread, and dominance of exotic plants and animals which were either introduced or invaded from nearby areas; and 4) specific alteration of the environment by man's more recent activities such as urban development, road building, and changes in land use patterns.

The natural incision of stream channels, perhaps prompted by a cyclic change in climatic conditions and overgrazing, drained the extensive marshlands resulting in narrow corridors suitable for riparian types of vegetation which allowed desert vegetation to invade the areas previously occupied by marshland vegetation. The present environmental conditions are a result of the long period of change in the riparian and marshland environments along the streams of Arizona and southwestern New Mexico.

(1) Orme Reservoir Site [201]

During the 1800's, the lower portion of the Verde River was essentially dammed by the sediments of the Salt River deposited across its mouth for substantial periods of time. The stream was bordered by marshes, in some places boggy enough to imperil men and livestock. There were also extensive backwaters, and ponding created by beaver activities and accumulations of organic debris. These areas extended 10 or 15 miles upstream from the Salt River. Marshes along the river were said to abound with waterfowl and fur-bearing animals. Willow, ash, and "tules" were also noted as being present in these areas.

The Salt River was subject to extensive flooding and was swift and turbulent from its emergence from the mountain canyons to its confluence with the Gila River to the west. Some mesquite "bosques" were found along its banks in the area of present-day metropolitan Phoenix. Since 1906, six large storage reservoirs have been built on the Salt and Verde Rivers which have completely changed the former riverflow regimen. Impoundments on the Salt River include Roosevelt, Apache, Canyon, and Saguaro Lakes, and impoundments on the Verde River include Horseshoe and Bartlett Lakes.

(2) Buttes Reservoir Site

Little information concerning the area of this site can be found in historical records. Available historical comments on

the area imply the existence of extensive sand and gravel bars and the lack of larger phreatophytic vegetation. Most available accounts mention waterfowl, quail, and "wild pigs" as being abundant in the area. Since 1928, Coolidge Dam and San Carlos Reservoir have controlled and regulated most of the flows that pass through the Buttes Reservoir site. "The controlled flow and resultant buildup of broad alluvial sand bars along the river has resulted in a drastic increase in salt-cedar at the expense of the native cottonwood and seep-willow communities."[23]

(3) Charleston Reservoir Site

During the 1800's, the San Pedro River in the area of the proposed reservoir was a flat meandering stream, impounded by numerous beaver dams, which created fish-filled ponds. Heavy marshland vegetation was common along the river. Only in very local areas is there any evidence of the existence of gallery forests of cottonwood and associated woody herbage. Mesquite was not dominant on the terraces near the river. Small trees such as willow, and heavy stands of sedge, grass, and forbs were characteristic of these very wet "malarial" marshes. Since the turn of the century, increasing channelization has permitted the growth of riparian vegetation. Dense mesquite stands formed on the terraces. The grassy hills above the terraces were invaded by shrub species more characteristic of the Chihuahuan Desert, probably due to more summer dominated rainfall and/or overgrazing.

(4) Hooker Reservoir Site [39,51,52]

Hooker Reservoir will be located in a more mountainous region than any of the other reservoirs. Riparian vegetation was and still is transitory and subject to the vagaries of floods. The riparian vegetation mentioned in the historical records includes walnut, alder, sycamore, and some mesquite. Records indicate that Hooker Reservoir area has changed less than any of the others. The velocity of the river, the parent rock, channel nature, and intermittent flooding would have tended to prevent nature induced changes in the river such as stabilization of flow and sedimentation related to increased beaver populations.

(5) Summary and Discussion of Changes

As a result of the warming and drying trend in the climate of the Southwest, many rivers became incised around 1890. This change rapidly drained the existing marsh areas and lowered local water tables. Many aquatic and semiaquatic organisms perished, adapted, or moved into the riverbeds. Aquatic invertebrates including rotifers, crustaceans, and molluscs which require quiet, detritus-lined pools, and a substantial number of insect groups were decimated. Fish

populations must have been radically altered, although there is little evidence of species extinction before the 1900's. Both the humpback sucker and the Colorado River squawfish which were historically found in central Arizona streams have not been found during recent years. The Arizona Game and Fish Department conducted surveys during the summer of 1972 to determine the present status of these species. Waterfowl, shorebird, kingfisher, frog, turtle, bat, beaver, and muskrat populations experienced rapid declines and/or complete decimation.

Following the incision of the river channels, the flood plains were able to support those plants that require not only a substantial amount of water, but also a zone of aerated soil. These plants include cottonwood, mesquite, acacia, bunch grass, and other species. Rivers became lined with gallery forests dominated by an overstory of cottonwood and an understory of baccharis. On terraces above the water level, mesquite became dominant. Another important change which began in the 1800's but now is exceedingly evident is the spread and influence of introduced plant and animal species. Saltcedar, bermuda grass, and several reeds have all become successful competitors for space in the riparian habitat, in many cases replacing native vegetation. Several mollusc species have been introduced and exotic fish now outnumber natives by 2 to 1. Species associated with human use such as sparrows, starlings, and domesticated mammals have had an additional impact on the riparian environment, as human populations increase.

All of the areas designated as reservoir sites for the CAP have changed in proportion to regional changes, or have been altered, since the 1800's. The degree of change varies considerably from site to site and in time. It is evident that the activities of man have contributed to these changes.

b. Present Environment of Orme Dam and Reservoir 23,33,34,38,39,47, 54,108,131,135,183

Figure 10 in Chapter I is an aerial view primarily of the Verde River arm of Orme Reservoir site. Figures 20 and 21 show typical areas within the proposed reservoir. Reference to these figures should be made while reading the following discussion in order to better understand the local environment.

(1) Topography 135,156

The site of the proposed facility lies within the Basin and Range physiographic province of the southwestern United States, at the transition between the sonoran desert section and the Mexican highlands section. The province is characteristically composed of northwest trending mountain ranges and intervening alluvial basins.

The Orme Dam and Reservoir area is in the lower end of the lower Verde River basin, a broad alluvium-filled trough surrounded

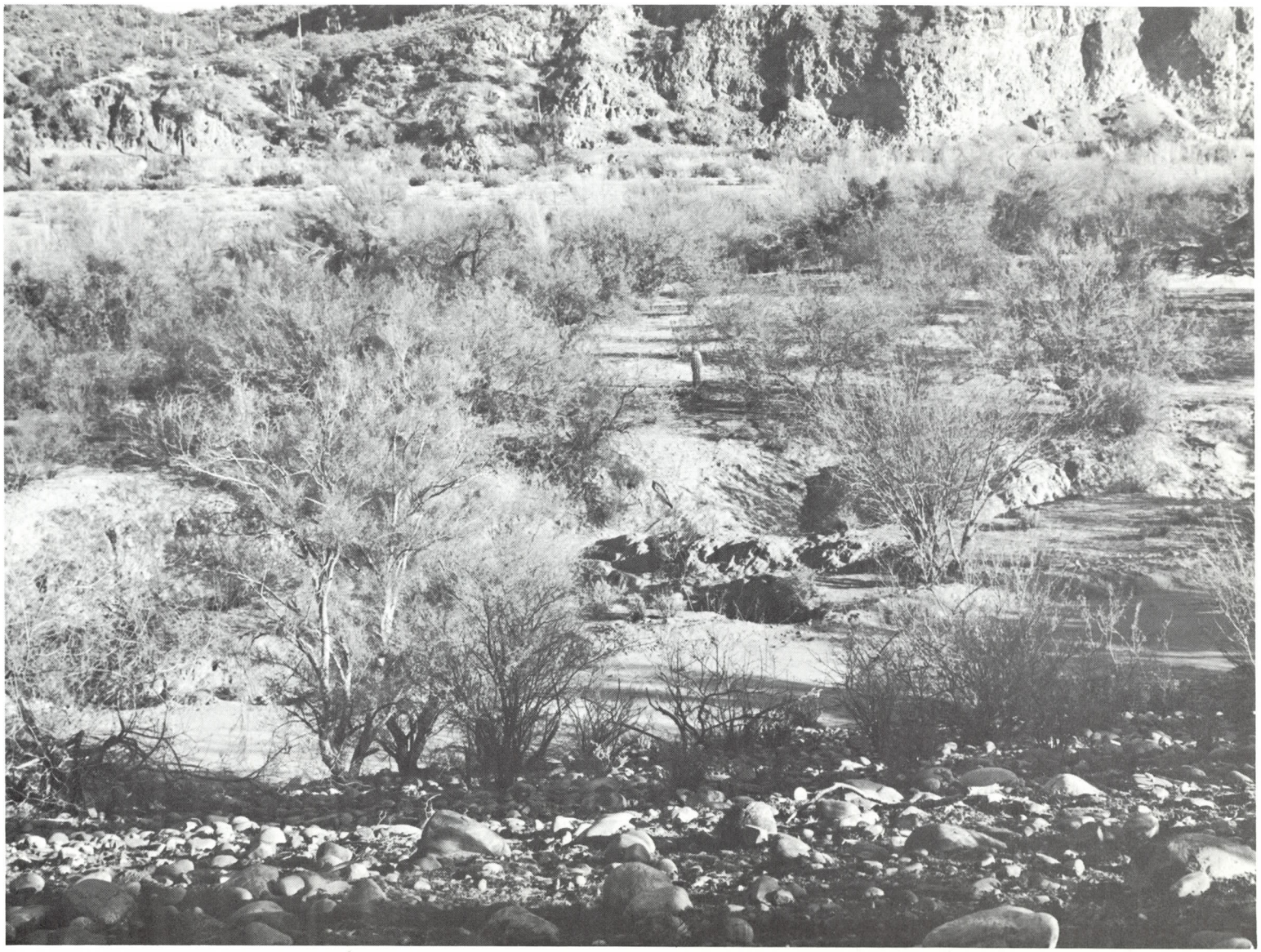


Figure 20

Within the proposed Orme Reservoir looking northeast across the Salt River which is just below the canyon wall. Photograph No. P344-300-12304.

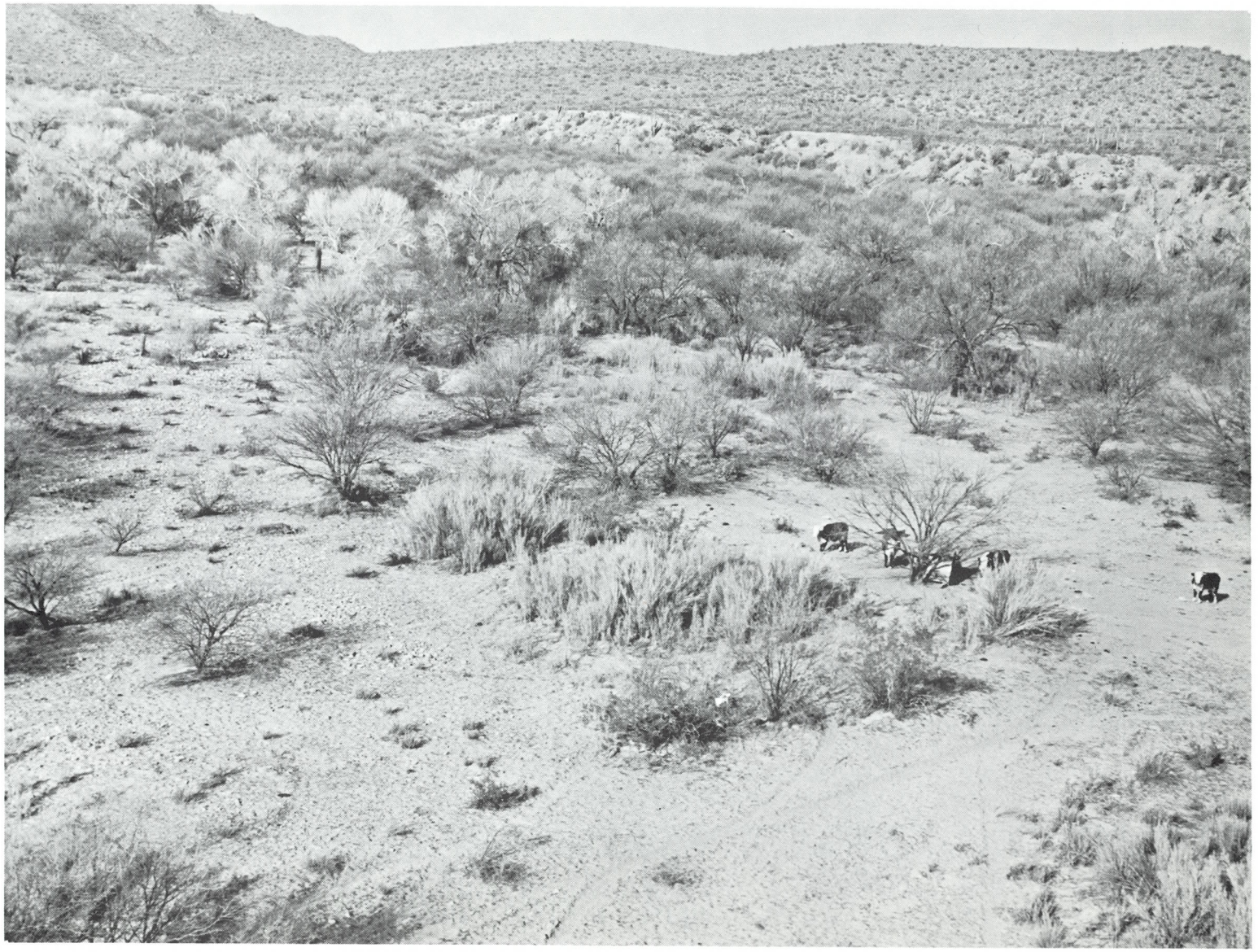


Figure 21

Within the proposed Orme Reservoir showing typical vegetation type. Photograph No. P344-300-12305.

by hills and mountains. The damsite occurs at the confluence of the Verde River with the Salt River where the Salt River cuts through a mountainous area into the adjoining basin. The damsite is formed by Arizona Dam Butte, a portion of Mt. McDowell, on the west and by an unnamed low hill on the east.

The reservoir is along the broad flood plains of the Salt and Verde Rivers, eroded about 100 to 200 feet below a rolling terrain representing a previous, higher level basin floor. Several small hills and peaks also occur along the Salt River. The surface is laced by a myriad of dry desert washes which drain the rolling basin surface and the moderate to steep hills and mountains rimming the basin.

(2) Geology [131,135,136,156,163]

The alternating basins and mountain ranges of the province are the result of large scale faulting. The mountains are composed of various crystalline, volcanic, and sedimentary rocks, some of which were the result of volcanic activity and sediment deposition during the period of faulting. The basins are filled with hundreds to thousands of feet of sediments eroded from the ranges.

The Orme Dam site occurs where the Salt River cuts through a mountainous area of erosion-resistant granite, sandstone, and volcanic rocks. The Salt River arm of the reservoir is largely underlain by relatively thin alluvial-fan, river-terrace, and basin fill deposits consisting of silty sand, clayey sand, gravel, and other soil mixtures. Several small peaks or rolling hills of granite and volcanic rocks occur in the area. The Verde River arm is enclosed almost entirely by dissected basin-fill and lake bed deposits.

(3) Mineralization [163]

The only known mineralization exploited in the area is barite. Although 300,000 tons of ore were mined in the area during World War II, no commercial mining is now taking place. Reserves of unknown grade and quantity may still remain in or near the old workings located southeast and outside of the dam and conservation reservoir area. No mineralization was encountered during foundation drilling programs. The abandoned open shaft of the mine has been filled with soil for public safety purposes.

(4) Vegetation [23,135]

The present vegetation of the Orme Reservoir site follows the pattern described earlier in Section A of this chapter. Figures 20 and 21 show typical types of vegetation within the reservoir area. The alluvial silt bars in the middle or along the edge of the

Salt and Verde Rivers are dominated by baccharis and giant reed. Where the bars are high enough and relatively stable, saltcedar is mixed with seep-willow (baccharis). In the reservoir area, saltcedar occurs only on the stable silt bars or as tree-like stands immediately adjacent to the rivers on silty or sandy soil. Reeds (phragmites) grow in a few locations along the rivers, especially where the shoreline is rocky.

Beyond the immediate area of the rivers, there are a variety of low terraces formed by sand or gravel which have flooded periodically in the past (Figures 20 and 21). Where the soil is mostly sand these low terraces are characterized by scattered mesquite, arrowweed, haplopappus, and paloverde. Nearly pure stands of arrowweed also occur in some of these areas. Scattered desert-broom is common on gravel bars, while other areas have a dense ground cover of goldenweed. Annual grasses often develop in these areas during wet winters. Where the soil of the low terraces is quite gravelly, desert-broom dominates with mesquite and other shrubs playing a subordinate role. Cactus, such as pricklypear, occur on some of these low terraces. Their occurrence may be due, in part, to heavy grazing pressure.

On the edge of the broad channeled flood plains, where the low terraces rise to a higher terrace of finer soils, galleries of old cottonwoods occur (cottonwoods are the lighter colored trees in Figures 20 and 21). These trees cannot stand periods of inundation and thus grow on the edges of the old channeling area of the rivers. Cottonwoods also occur on ridges between old stream channels. At some locations where the cottonwoods grow near the river the riparian forest becomes extremely dense as cottonwood, willow, mesquite, saltcedar, and seep-willow mix together. This occurs only in a few areas near the confluence of the Salt and Verde Rivers.

Above the cottonwoods or on raised terraces, dense mesquite bosques occur along both the Salt and Verde Rivers. Most of these mesquite areas once had a good grass understory but haplopappus and pricklypear cactus have invaded these areas due to grazing by cattle. Depressions in some of the lower areas dominated by mesquite may have cattail with willow along the margins.

As the topography rises the mesquite bosques gradually give way to desert vegetation. This may be seen in Figure 20 on the distant slopes. Saguaro and bur-sage appear along with chainfruit cholla. Where the soil remains fine textured, mesquite gives way to nearly pure stands of creosote bush which then grades into the typical paloverde-opuntia-bur-sage desert found on coarse bajada soils. The upland desert in the Orme Dam area is characterized by the shrubs: bur-sage, brittle bush, and creosote bush; the cacti: saguaro, barrel, pricklypear, and cholla; and the trees: paloverde and ironwood, both of which increase in density in the washes.

(5) Invertebrates [33]

At least 29 orders encompassing some 180 families of invertebrates are found at the Orme Reservoir site. A list of these species may be obtained from the Bureau of Reclamation office in Boulder City, Nevada.

(6) Fish [34,66,142,162,176]

Only three native species of fish are presently found at the Orme Reservoir site (listed in Table 1 in the Appended Material). These species of native fish are the Gila mountain sucker, the Gila coarse-scale sucker, and the longfin dace. Table 4 in the Appended Material lists the 34 species of non-native fishes within or upstream of the Orme Reservoir site and estimates the probability of their establishment in a reservoir at that site. Estimates of past environmental features of the reservoir site as compared to present conditions are included in Table 3 and a compilation of the ecological relationships of native fishes of the Gila River Basin is included in Table 2. Some species on the endangered species list were historically found at this site, but are no longer present.

(7) Amphibians and Reptiles [38,66,176]

A total of 59 species of amphibians and reptiles are found at the Orme Reservoir site. Table 5 in the Appended Material lists these species and Table 6 describes their ecological relationships. Two species of the herpetofauna in the Orme Reservoir site, the desert tortoise and the reticulate Gila monster, are designated as "status undetermined" in the rare and endangered species publication.

(8) Birds [39,66,176]

Table 9 in the Appended Material lists 205 species of birds that are found in the Orme Reservoir area. About 72 of these use the area for nesting. Table 7 in the Appended Material shows the critical life history data for each species. The Orme Reservoir area is somewhat unique in that its diverse vegetation supports a great variety of birds. Two examples are the 18 species of flycatchers and 17 species of warblers found in the riparian habitat. The bald eagle, known as an uncommon winter resident at the reservoir site, is included on the endangered list. Two or perhaps three pairs of bald eagles nest in the area adjacent to the Orme Reservoir site.

(9) Mammals [39,66,176]

Table 10 in the Appended Material lists 54 species of mammals found in the Orme Reservoir area. Table 8 in the Appended

Material shows the level of riparian dependency for each species. The coatimundi, jaguar, and ocelot are listed as having accidental or questionable occurrence in the site. These three peripheral species are not on the endangered list.

(10) Archeological 41,177,182

In 1963 and 1964, reconnaissance archeological surveys of the damsite and reservoir area located 12 ancient Indian sites on the Verde River. The locations represent three types: (1) Sacaton phase Hohokam village sites, (2) Brown ware sites, and (3) Historic sites. Additional sites are known to exist on the Salt River arm of the reservoir above elevation 1,470. Phase I of a three phase survey-salvage program has just been initiated for the total reservoir site.

(11) Land Use Patterns 63,67,125,178,201

The lands in the proposed reservoir area consist primarily of flood plain lands used mostly for recreational purposes and higher lands used for limited, irrigated agriculture, some livestock grazing, and residential sites by residents of the Fort McDowell Indian Community (Figure 21).

On the Fort McDowell Indian Reservation the lands are mostly undeveloped. Of the 1,300 irrigable acres with a water right, only about 300 acres are irrigated in any one season, and then inconsistently. Approximately 53 families live in the Fort McDowell Indian community. Some of these families are employed by the City of Phoenix in the operation of the Verde well field which produces water for the City, and in limited agriculture, mainly grazing of livestock. The well fields drawing water for the City of Phoenix are located just above the Verde River flood plain in the southern half of the Fort McDowell Indian Reservation. The reservation will be partially inundated by the Orme Reservoir and about 70 percent flooded at times of maximum levels.

The river-bottom lands adjacent to and extending the length of the Verde River through the reservation are available on a fee basis for recreation-oriented activities such as picnicking, camping, hiking, and access to the river. The lands also sustain small limited individual woodcutting.

The area is scenic, offering many points of panoramic river valley viewing, an advantage the Fort McDowell and Salt River Indian communities are endeavoring to use in their economic land use planning studies. The Tonto National Forest lands of the Salt River arm offer a different scenic quality. Topographically the area is gently sloping on the south side of the river and more precipitous on the north. The length of the Salt River arm is dotted with recreation areas which are heavily used by the nearby metropolitan population.

The river-bottom area below the Orme Dam site is for the most part covered with riparian growth. For 4 miles the river meanders through an area abundant with small wildlife, terminating as a controlled live stream at the Granite Reef Diversion Dam, where the Salt River Project diverts all of the normal flows into the Salt River Valley. Just below Orme Dam site the City of Phoenix maintains and operates the Verde Water Treatment Plant.

Below the Granite Reef Diversion Dam, the Salt River channel is dry except for periods when floodwaters are spilled. The usually dry Salt River channel goes southeasterly into and through the Phoenix metropolitan area where it crosses the extension of the primary runway of the Sky Harbor International Airport. A number of commercial gravel operations operate in the riverbed. There are additional commercial facilities in or adjacent to the area subject to periodic inundation depending on the flood magnitude. The following tabulation shows the recent flood spills at the Granite Reef Dam that have caused or contributed to damage in the Phoenix metropolitan area.

Date	Maximum Discharge Rate (cfs)
Dec. 31, 1965	70,000
Jan. 1-5, 1966	24,910 Mean Daily
Feb. 15-Mar. 4, 1966	2,454 Mean Daily
Feb. 27-Mar. 1, 1968	1,579 Max. Mean Daily
Mar. 13-14, 1968	3,369 Max. Mean Daily
April 10-23, 1968	1,523 Max. Mean Daily
Sept. 5, 1970	10,000 (approx.)
June 22, 1972	4,700

c. Present Environment of Buttes Dam and Reservoir

Figure 12 in Chapter I shows an aerial view of Buttes Reservoir site. Figures 22 and 23 are views of typical areas within the reservoir.

(1) Topography [155]

The Buttes Dam and Reservoir site is on the border of the sonoran desert section and the Mexican highlands section of the Basin

and Range physiographic province. The area is characteristically composed of northwest trending mountain ranges separated by alluvial basins. The damsite is near the western edge of a mountainous area. Downstream the terrain is rolling, with relief decreasing sharply a few miles below the damsite where the river enters the central service area of the project. Upstream the Gila River flows through a canyon eroded into steeply rolling, to rugged mountains. The river flood plain ranges in width from several hundred feet to one-half mile. The damsite is between North Butte and South Butte, two prominent mountains rising nearly a thousand feet above the rolling terrain to the west. The area is drained by numerous intermittently flowing tributary canyons, including Mineral Creek, Donnelly Wash, Ripsey Wash, and Walnut Canyon.

(2) Geology 48,155,175

In the reservoir area the Gila River flows westward across a mountainous area comprising north to northwest trending blocks of granite and volcanic rocks (See Figures 22 and 23). The rock types are in fault contact. An intervening alluvium-filled basin about 2 miles wide occurs about one-half mile upstream from the damsite, and large alluvial fans locally cover the slopes on the south side of the river.

The damsite is in a narrow gorge (see Figure 12) where the river cuts through an erosion resistant mass of volcanic rock. North Butte and South Butte, for which the site is named, are the most prominent peaks of this volcanic rock mass. The abutments of the dam are agglomerate, rhyolite, and volcanic glass.

(3) Mineralization 48,175

Some copper deposits have been identified in and adjacent to the Buttes Reservoir area. At present the known grade of the ore in the general vicinity is subcommercial. Copper deposits of varying sizes and grades are known to occur near the limits of the reservoir site. They vary in position from under the present channel of the Gila River to the Copper Buttes property on a hilltop 2-1/2 miles north and 800 feet above the top of the flood-control pool of the proposed reservoir. In size, they include small shows of mineralization, very large marginal or subgrade ore deposits, and the producing Ray Mine, one of the Nation's largest.

(4) Vegetation 23,135

The vegetation at Buttes Reservoir site is similar to that at the Orme Reservoir site. Typically, on the sand bars and gravel terraces adjacent to the river, baccharis dominates often in only a small strip. Immediately beyond the baccharis stands, away from the

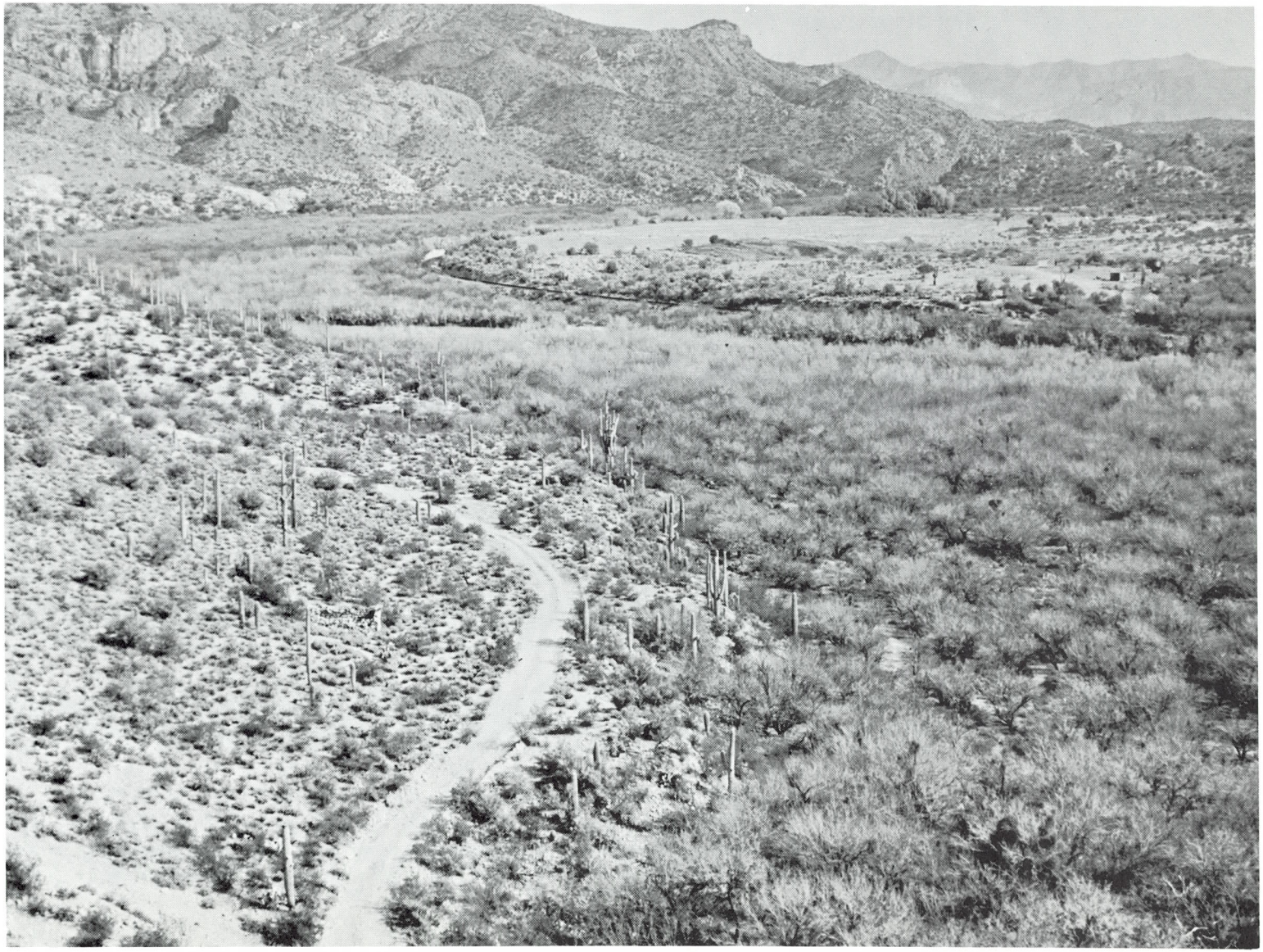


Figure 22

Within the proposed Buttes Reservoir looking east. The Gila River is at the bottom of the valley with railroad tracks on the south side. Dense stands of mesquite and saltcedar are found along the river. Saguaro cactus are present on the upland desert slopes. Photograph No. P344-300-12306

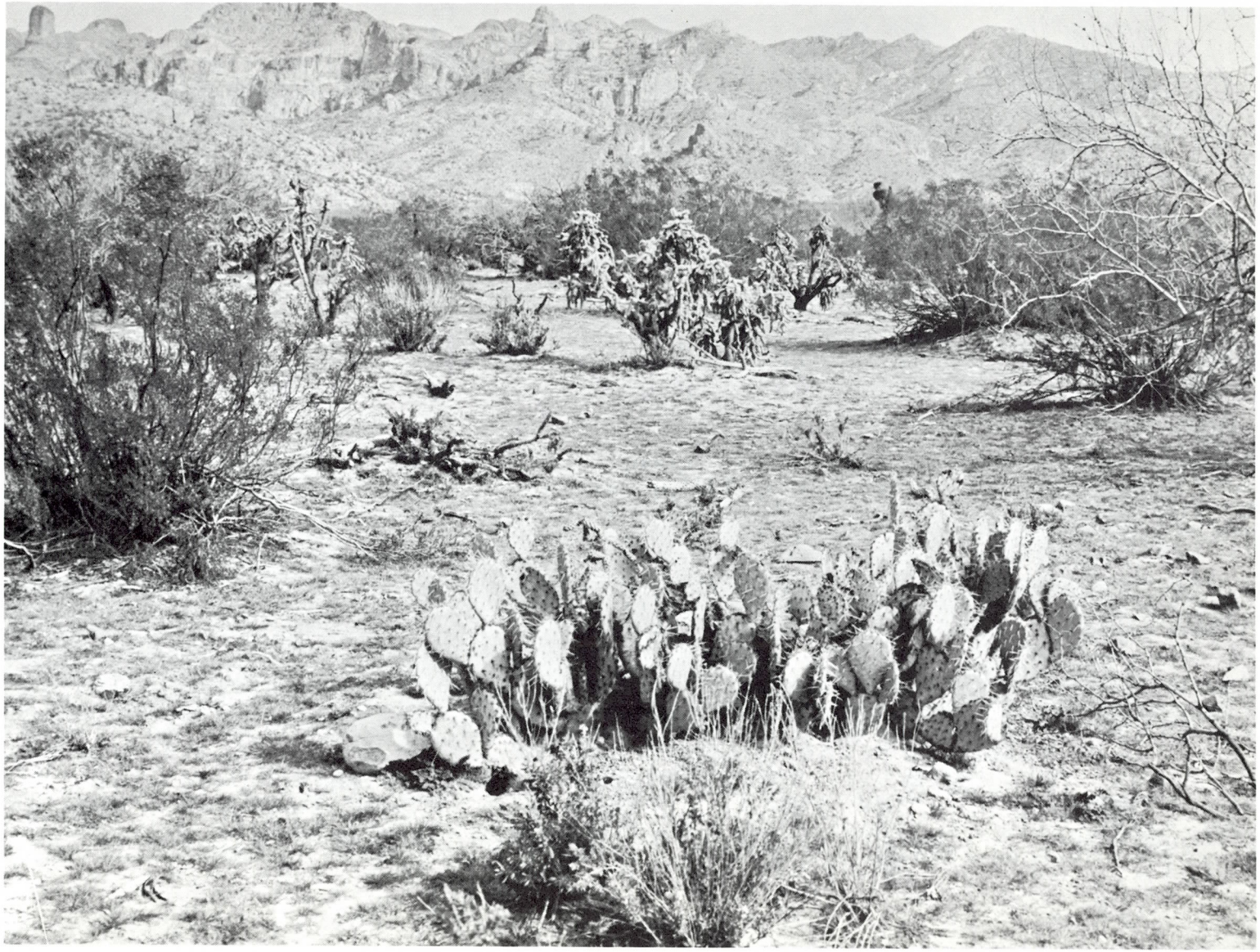


Figure 23

Within the proposed Buttes Reservoir showing typical vegetation type. Pricklypear is in the foreground and cholla in the center. Shrub vegetation primarily consists of mesquite, creosote bush, and bur-sage. Photograph No. P344-300-12307.

river, are communities of saltcedar. Near the damsite where the valley is narrow, the saltcedar stands are limited; however, upstream from the damsite the valley is wider and thus the areas of saltcedar are more extensive. From a vegetational viewpoint the saltcedar stands are quite sterile. Their deciduous leaves form a barren "forest" floor only occasionally interrupted by herbaceous plants.

In limited areas, where flooding has caused standing water and a buildup of salt deposits due to evaporation of water, arrowweed forms dense stands. These areas are not common within the potential impoundment area.

Low flat terraces above periodic high water levels of the river are dominated by mesquite (Figure 22). Some of these extensive mesquite bosques have a dense ground cover of grasses following wet seasons. The appearance of haplopappus and pricklypear or cholla cactus indicates that these mesquite bosques have been heavily grazed (Figure 23). Open areas within the bosques have shrubs, desert-broom nearer the river, and bur-sage and graythorn nearer to the upland desert areas.

In some of the areas where there are steep riverbanks or on the upper edges of the low flood plain terraces, a few cottonwoods and willows occur. These, however, are not very common within the area of the proposed impoundment; although, they do form more dense stands farther upstream.

As shown in Figure 22 on the slope to the left in the photo the mesquite bosque grades gradually into the upland desert, and creosote bush dominates the transition area between the mesquite and the mixed paloverde-saguaro-shrub desert. If the topography becomes steep and rocky beyond the mesquite, a complex mixed desert association occurs. The upland desert is characterized by most of the same species found in the Orme Reservoir area including paloverde, brittle bush, bur-sage, creosote bush, cactus (saguaro, pricklypear, cholla, barrel, hedgehog), ocotillo, and desert mallow. One shrub, jojoba, is found indicating a higher desert than that at the Orme Reservoir site. This area also has much more club moss which probably indicates more rainfall in this area.

(5) Invertebrates [33]

The Buttes Reservoir site is similar in species composition to the Orme Reservoir site. Cazier listed 28 orders and 173 families of invertebrates found in the Buttes Reservoir area. A copy of this list may be obtained upon request from the Bureau of Reclamation.

(6) Fish [34,66,78,80,142,176]

The species of fish found in the Buttes Reservoir area are listed in Tables 1 and 4 in the Appended Material. Only two native species are found in this area, the longfin dace and the Gila mountain sucker. Some of the species listed in the rare and endangered species volume were historically found at the site, but are no longer part of the ichthyofauna of this site. Table 2 in the Appended Material contains a compilation of the ecological relationships of the native fishes. Estimates of past environmental features of the Buttes Reservoir site as compared to the present conditions are included in Table 3. Table 4 lists the 22 non-native fishes within or upstream from the Buttes Reservoir site and estimates of the probability of their establishment in a reservoir at this site.

(7) Amphibians and Reptiles [38,66,176]

Table 5 in the Appended Material lists 54 species of amphibians and reptiles which are found in the Buttes Reservoir area. These species are essentially the same as those found in the other three reservoir areas. The range of the desert tortoise and the reticulate Gila monster, which are both classified as "status undetermined" in the rare and endangered species volume, includes the Buttes Reservoir site. The ecological relationships among the various species are described in Table 6.

(8) Birds [39,66,176]

Table 11 in the Appended Material lists 100 species of birds found in the Buttes Reservoir area. Fifty-two of these species utilize the area for nesting activities. The habitats available at the Buttes Reservoir site are not as diverse as those at the Orme or Hooker sites and consequently the Buttes site does not have the faunal diversity of the other two sites. The bald eagle, listed on the endangered species list,[176] is classified as "uncommon" at the Buttes site by Ohmart. Table 7 in the Appended Material shows the critical life history data for each species.

(9) Mammals [39,66,176]

Table 12 in the Appended Material lists 51 species of mammals historically found in the Buttes Reservoir area. Table 8 in the Appended Material shows the level of riparian dependency for each species. The jaguar and ocelot are listed as being peripheral species, and having accidental occurrence at the Buttes site. Neither of these species is classified on the endangered species list.[176]

(10) Archeological [41,177,182]

A total of six sites were surveyed in the Buttes Reservoir area between the vicinity of Cochran and the damsite. All

of these sites are on the first or second terrace above the river; five were prehistoric and one was historic. Pottery and other items were indicative of Hohokam from the Santa Cruz to the Sacaton phases. The historic site was late 19th century. Excavation of one site was accomplished in 1965, and no further testing or excavation was considered necessary. Additional survey is planned including the area from Cochran upstream to the head of the reservoir.

(11) Land Use Patterns 63,125,178

The lands surrounding the reservoir site are in Federal or private ownership. Man's activities prevalent in the area include cattle ranching, railroad transportation, and mining exploration (Figure 22).

d. Present Environment of Charleston Dam and Reservoir

Figure 14 in Chapter I is an aerial view of the proposed Charleston Reservoir site. Figures 24 and 25 are typical views of the area that will be inundated by Charleston Reservoir.

(1) Topography 157

The reservoir area is in the upper San Pedro River basin of the Mexican highland section of the Basin and Range physiographic province. The basin, which extends from the damsite to the southern watershed boundary in Mexico, is over 50 miles long, varies from 15 to 30 miles in width, and is bounded on the east, west, and south by mountain ranges (Figure 20). The San Pedro River flows northward through a valley which lies about 150 to 200 feet below the general level of the adjacent basin floor. In general, the slopes adjacent to the river flood plain rise relatively steeply to the basin floor level, which is a gently sloping surface incised by numerous subparallel washes becoming narrow canyons on the steep slopes flanking the river.

In the lower reservoir area the river flows through a group of small mountain peaks and hills called the Charleston Hills (Figure 14). The river valley is restricted where it crosses the resistant rock of thick hills; the damsite is at the most prominent constriction which occurs between the higher hills.

(2) Geology 49,157

The San Pedro River is largely incised within the deep alluvial basin-fill deposits of the area. The materials are unconsolidated to weakly cemented, clayey sand and gravel. In the lower few miles of the reservoir area the river valley impinges on

a low range of hills composed of sedimentary, volcanic, and intrusive igneous rocks. The damsite is in a gorge cut into an extensive mass of latite porphyry. The river flood plain is formed of gravel, sand, silt, and clay mixtures.

(3) Mineralization[49]

The Charleston Mining District is partly within the lower reservoir area. The district is a potential source of silver, lead, zinc, and vanadium ore. Historically, the area was highly active in silver and lead mining. Numerous claims still dot the area, but there is little activity at this time. Federal oil and gas leases have been issued for lands in the area.

(4) Vegetation [23,135]

The channel of the San Pedro River above the proposed Charleston Dam is relatively narrow (ca. 100 yds.) and is bordered by abrupt 5- to 8-foot alluvial streambanks. Within these banks the river periodically floods because of no control upstream. Baccharis dominate the gravel beds when the stream is low. This shrub also characterizes the large gravelly washes that feed the San Pedro channel. Periodic flooding destroys much baccharis, keeping the density down and preventing establishment of less hardy shrubs and trees.

Along the terraced streambank, galleries of cottonwood and willow dominate. Where the terrace has eroded into the streambed, sacaton forms an understory.

On the level raised alluvial terraces, extensive stands of mesquite have become established with a dense understory of sacaton and scattered palmilla.

The hilly terrain adjacent to and at a distance from the river is dominated by Chihuahuan desert type vegetation with relics from the past grassland still occurring in places. Acacia, tarbush, and creosote bush dominate. Tarbush and creosote bush are most dense on the flatter area while acacia is most dense in the draws. Other common shrubs are mariola, Mexican tea, and haplopappus. Palmilla and cane cholla also are common. There are scattered areas with grasses such as sideoats grama, black grama, tobosa, and three-awn indicating some vestiges of the grass slopes common 80 years ago.

(5) Invertebrates [33]

Cazier lists 29 orders and 174 families of invertebrates found in the Charleston Reservoir area. A copy of this listing may be obtained from the Bureau of Reclamation.

Figure 24

Within the proposed Charleston Reservoir looking southeast with the San Pedro River in the center of the photograph. The large light colored trees are cottonwood. Shrubs are mostly mesquite. Photograph No. P344-300-12308.

Figure 25

Within the proposed Charleston Reservoir looking northwest with the San Pedro River flowing away from the photographer. The large trees are cottonwoods. Photograph No. P344-300-12309.

(6) Fish [34,66,142,176]

The species of fish found in the Charleston Reservoir area are listed in Tables 1 and 4 in the Appended Material. Two native fishes are found in the Charleston Reservoir site - the longfin dace and the Gila mountain sucker. Some of the species listed in the rare and endangered species volume were historically found at this site but are not presently included in the ichthyofauna of the site. Table 2 contains a compilation of the ecological relationships of the native fishes. Estimates of the past environmental features of the site, as compared to present conditions are included in Table 3. A list of the 8 or possibly 9 non-native fishes within or upstream from the Charleston Reservoir site and estimates of the probability of their establishment in the proposed reservoir are included in Table 4.

(7) Amphibians and Reptiles [38,66,176]

Table 5 in the Appended Material lists 66 species of amphibians and reptiles in the Charleston Reservoir area. The herpetofauna of the Charleston Reservoir site is complex because of recent vegetative changes and the influence of herpetofauna from the adjacent highlands of Mexico and the Great Plains. The desert tortoise occurrence is hypothetical, while the reticulate Gila monster has occurred at the site. Both species are listed under "status undetermined" in the rare and endangered species volume.[66] The ecological relationships among the various species are described in Table 6.

(8) Birds [39,66,176]

Table 13 in the Appended Material lists 143 species of birds found in the Charleston Reservoir area. Sixty species utilize the area for nesting activities. The diversity of habitats at the Charleston Reservoir site is greater than at the Buttes site, but less than at either the Orme or Hooker sites. The bald eagle, an uncommon winter species ranging through the Charleston site, is found on the endangered species list.[176] The prairie falcon, also an uncommon winter species in the area, is classified as rare.

(9) Mammals [39,66,108,142,176]

Table 14 in the Appended Material lists 65 species of mammals historically found in the Charleston Reservoir area. Table 8 in the Appended Material shows the level of riparian dependency for each species. As with the avian fauna, the mammalian fauna of this site is relatively rich, but is exceeded by the mammalian faunal composition of nearby areas. The coatimundi, jaguar, and ocelot are listed as having accidental occurrence in the Charleston Reservoir site. These three species are classified as peripheral.

(10) Archeological [44,46,177]

Of the 133 known archeological and historical sites in and around the reservoir site, 113 have been recently located. These sites indicate both a long and culturally diverse occupation by man in the valley. Anglo-American, Mexican, historic Pima, prehistoric Hohokam, Cochise, and Clovis sites are represented.

The survey of the Charleston Reservoir area and surrounding territory by the Arizona State Museum covered all of the area up to the 4,200-foot contour elevation, and thus included an expanse greatly in excess of the actual reservoir area. To place the identified archeological sites in perspective in relation to the Charleston Dam and Reservoir site, an analysis of the sites in relation to elevation and location must be considered. The Charleston Reservoir space is situated between streambed elevation of about 3,930 feet and the maximum water surface elevation of 4,070 feet. Of the 133 sites enumerated, 9 sites are downstream from the damsite and outside the reservoir area. Of the remaining sites, 4 sites are above elevation 4200, 80 sites are between elevations 4200 and 4100, 33 sites are between elevations 4100 and 4000, and 7 sites are below elevation 4000. The 3 extinct fauna, and the 4 Clovis sites and associated mammoth remains are in the 4200-4100 elevation band.

(11) Land Use Patterns [63,135,178]

The reservoir area has been disturbed by range cattle operations, the Southern Pacific Railroad, highways, mine workings, ruins of early small communities, and early range settlements now mostly abandoned. The reservoir area is almost all in private ownership. Portions of the Fort Huachuca Military Reservation bound the western portion of the lower reservoir area. Portions of this area have been used as an artillery impact area.

e. Present Environment of the Hooker Dam and Reservoir Site

Figure 16 in Chapter I is an aerial view of the proposed Hooker Reservoir site. Figures 26 and 27 are typical views of the type of environment that will be inundated.

(1) Topography [135,159]

The Hooker Dam and Reservoir site is in the Colorado Plateau Province near the eastern edge of the Basin and Range physiographic province in southwestern New Mexico. The damsite is at the mouth of the Gila River canyon on the western edge of the Mogollon Mountains.

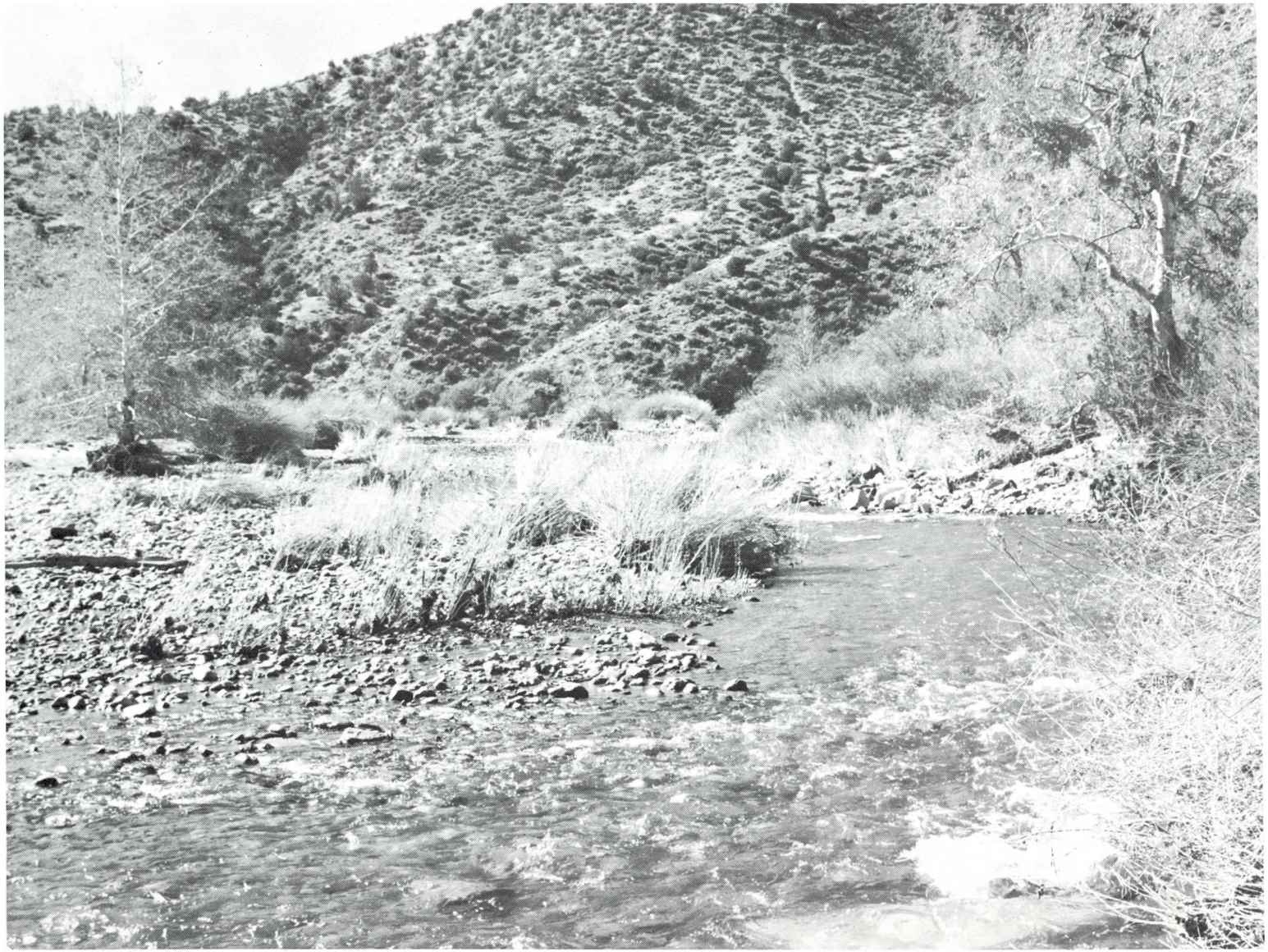


Figure 26

Within the proposed Hooker Reservoir just below the confluence of Turkey Creek with the Gila River looking downstream. Vegetation on the slopes is mostly pinyon-juniper. Photograph No. P344-300-12310.

Figure 27

Within the proposed Hooker Reservoir just below the confluence of Turkey Creek with the Gila River. Large trees are sycamore. Photograph No. P344-300-12311.

(2) Geology [159]

In the Hooker Reservoir area, the Mogollon Mountain range is the result of large scale vertical movement in a wide and complex fault zone along the volcanic-rock mountain front. Downstream from the damsite the river flows across a down-faulted basin filled with deep semiconsolidated alluvium, the Gila conglomerate - and has eroded a broad river valley flanked by a series of river terraces. The bedrock at the damsite is Tertiary volcanic rocks of the Datil formation, consisting of latite porphyry, and "Agglomeratic latite porphyry," and andesite. The rock types are all fine-grained, dense, and hard.

(3) Mineralization [50]

Only small deposits of fluorite of little economic value have been exploited in the past in the upper reaches of the Gila River which would be influenced by Hooker Reservoir. The reservoir site is located in a region which is the major source of copper, lead, and zinc production in New Mexico. Approximately six inoperative fluorite mines would be inundated, none of which appear to contain economically recoverable resources. The fluorite mineralization contributes to the fluorite water quality problem.

(4) Vegetation [23,37,51,52]

The impoundment behind Hooker Dam will cover a very diverse canyon ecosystem. This area is in an environmental tension zone in that any slight change in moisture availability or aspect changes the local vegetative community. The sand and gravel bars appear to be quite stable. Although they are flooded periodically, as may be seen in Figure 27, they are dominated by a shrub community of baccharis and scattered haplopappus. In places the baccharis becomes extremely dense and impenetrable. On the very stable sand bars, pricklypear appears to be an adventive species.

Beyond the sand and gravel bars the riparian woodland begins (see Figures 26 and 27). Sycamore, cottonwood, and willow characterize this zone. However, farther back from the stream, the woodland becomes a complex vegetational unit including hackberry, Arizona walnut, and velvet ash.

The transition from the riparian woodland to the more xerophytic hillsides shows an increase in xerophytic trees, some of which are mixed with the riparian woodland nearly to the sand bars. This includes one-seeded juniper, alligator bark juniper, Emory oak, gray oak, pinyon pine, and mesquite.

The canyon slopes vary in vegetational cover depending on exposure. The south facing slopes are very rocky and are dominated

by haplopappus, catclaw-acacia, sotol, one-seeded juniper, beargrass, scattered mesquites, and cacti (both cholla and pricklypear types). Where the slopes are less exposed, such as on east and west facing slopes, the vegetation becomes a shrub-type almost chaparral in appearance. Here pinyon pine and juniper increase in number, the haplopappus becomes more dominant, and dense stands of scrub oak, buckthorn, and other chaparral species occur. Sotol and beargrass also continue to characterize this zone.

The more mesic locations on the slopes become more dense forests. On the north facing slopes and in the deeper drainages, the pinyon-juniper forest becomes quite dense including pinyon pine, alligator bark juniper, Emory oak, and wavy-leaf oak. In the higher or cool, moist habitats ponderosa pine and chihuahuan pine may occur.

(5) Invertebrates[33]

Cazier lists 28 orders and 171 families of invertebrates found in the Hooker Reservoir area. A copy of the listing may be obtained from the Bureau of Reclamation.

(6) Fish [34,66,77,142,164,176,184]

Tables 1 and 4 in the Appended Material list the species of fish that occur in and adjacent to the Hooker Reservoir area. There are six native species of fish: the spinedace, the longfin dace, the speckled dace, the loach minnow, Gila sucker, and Gila mountain sucker. The fish fauna at this site remains less changed from what it was 100 years ago than at the other three reservoir sites in the CAP. The Gila trout, found in the headwaters of the Gila River in the Gila National Forest, is included on the Bureau of Sport Fisheries and Wildlife's endangered list.[176] Gila trout are not found in the mainstream of the Gila River. Table 2 contains a compilation of the ecological relationships of the native fishes. Estimates of past environmental features of the Hooker Reservoir site as compared to the present conditions are included in Table 8. A list of the 18 to 20 non-native fishes within or upstream from the Hooker Reservoir site and estimates of the probability of their establishment in the proposed reservoir are included in Table 4.

(7) Amphibians and Reptiles[38]

Table 5 in the Appended Material lists 62 species of amphibians and reptiles found in and adjacent to the Hooker Reservoir area. Table 6 describes the ecological relationships of these species. The herpetological complement of the Hooker site is complex due to the invasion of mountain species from nearby higher elevations, as well as the desert and southern or eastern Great Plains species No herpetological species listed in the rare and endangered species volume are found at this site.

(8) Birds 39,52,53,66,77,142,164,176,180,184

Table 15 in the Appended Material lists 226 species of birds that are found in the vicinity of the Hooker Reservoir area. Of these species, 111 utilize the area for nesting activities. The large number of species reflects the heterogeneous assemblage of habitats at the Hooker site. The Hooker site represents a unique area in New Mexico in that it is more typical of sonoran riparian in Arizona than it is chihuahuan riparian in New Mexico. This makes it more highly valued to conservationists in New Mexico because such forms as black hawks, gray hawks, elf owls, and Wied's crested flycatchers have their primary center of abundance for New Mexico in this particular area.

In the upper Gila River Valley and the vicinity of the Hooker Dam site, the "Mexican duck," bald eagle, and peregrine falcon, all classified as infrequent summer avian species, and the prairie falcon, an infrequent transient, are all listed in the 1968 edition of the rare and endangered species. The New Mexico Department of Game and Fish in its letter of comments on the draft of this statement lists 15 additional species which are found in the Hooker Reservoir area and are considered by the Department to be rare in New Mexico.

(9) Mammals 39,66,77,108,142,164,176,180,184

Table 16 in the Appended Materials lists 68 species of mammals historically found in and adjacent to the Hooker Reservoir area. Table 8 in the Appended Material shows the level of riparian dependency for each species. The mammalian fauna, as with the avian fauna, is more typical of Arizona than of New Mexico. The wide diversity of habitats is reflected in the number and diversity of mammalian species for this site. The coatimundi, listed as a peripheral species, is found at this site.

(10) Archeological 51,60,177,182,184

A recent report prepared by the Museum of New Mexico indicates that there are several sites in the area of the proposed dam and reservoir. The most significant of these is the Woodrow Ruin, also known as the Mimbres State Monument, listed in the National Register of Historic Sites and the State Register of Cultural Properties. The site is 2-1/2 miles downstream from the damsite, about 10 acres in extent, and contains over 35 pit houses, 100 surface dwellings, and two very large community ceremonial lodges. Pottery dating from A.D. 500 to A.D. 1150 and of a rare type which is highly valued by antiquarians and collectors, and many other sites along the Gila River have been systematically looted or mined of their relics and now have little value. A more complete survey of the area will be undertaken to determine if there are any sites with remaining value in the areas to be inundated, and the need for salvage work.

(11) Land Use Patterns 51,52,63,137,141,178,184

The major land use in the proposed Hooker Reservoir area is cattle grazing on U. S. Forest Service grazing allotments. Recreation is another land use. Current annual recreation use in and around the Hooker area is estimated at about 1,300 visits. The Forest Service equates this at 500 visitor-use days. This includes camping in primitive condition, picnicking, fishing, backpacking, and use as a "jumping off" place to the Gila Wilderness. Local ranchers guide hunting parties through the proposed reservoir area on excursions into the wilderness area. Three areas within the reservoir site have been patented.

CHAPTER III

ENVIRONMENTAL IMPACT OF THE CENTRAL ARIZONA PROJECT

III. ENVIRONMENTAL IMPACT OF THE CENTRAL ARIZONA PROJECT

This chapter discusses the impacts which will be associated with the CAP. Measures which will minimize adverse effects, mitigate losses, or enhance resource values are discussed later in Chapter IV.

A. Definitions for Impact Evaluation

The evaluation of environmental impacts is dependent on definitions and criteria or standards. Impacts may be beneficial, adverse, or problematical. The definitions used in this statement are:

1. Beneficial environmental impacts are those that directly or indirectly improve the environment.

2. Adverse environmental impacts are those that directly or indirectly degrade the environment.

3. Problematical environmental impacts are those whose effects are unknown or have not been tested.

The environment includes the interaction of climate, soil, and biotic factors that act upon any living organism. Environment also includes the aggregate of social and cultural conditions that influence the life of an individual or community.

B. General Statement of Impact[1,145]

The CAP will have varied impacts upon a number of different aspects of the environment. Some of these impacts will be beneficial and others adverse. Still other impacts are as yet unquantified or are unquantifiable. Certain impacts will be beneficial in some respects and adverse in others. For purposes of this section on the overview of the impacts of the project, the impacts have been divided into two categories: impacts on natural resources; and impacts on people. The impacts on natural resources will have secondary impacts on the human environment as well. Impacts more directly affecting people will in most instances indirectly affect the natural resources in the project area.

1. Natural Resource Impacts [23,39,47,51,67,75,125,175,201]

The first noticeable impact will be from construction activities along the route of the project. These activities will disrupt and have some adverse impact on the natural environments of the project route, although such impact will be of relatively short duration. Mitigating factors discussed hereafter and in Chapter IV will confine the impact from these activities principally to the immediate areas around the various project features.

Vegetation will be disturbed and removed both during construction of the various features of the project and because of

inundation caused by the closing of the dams involved in the project. Vegetational disturbance and removal will be small along the aqueduct routes compared to the overall area traversed. Vegetative clearing will be primarily centered in the reservoir areas.

The reservoirs will provide an adverse impact on native fish in the project area. Formation of the reservoirs and stabilization of downstream flows will provide a habitat favorable to non-native species, but at the expense of native species of fish. Thus, both beneficial and adverse impacts will result. The aqueducts will have an insignificant adverse impact on fish, due in the most part to the fact that the aqueducts are not associated with any perennial streams in the project area. There is a possibility that an exotic or non-native fish could be introduced into new areas through migration along the aqueducts. With respect to wildlife, the most significant impact of the aqueducts will be a change of some migration patterns of certain kinds of animals. Steps outlined in this chapter and Chapter IV will be taken to minimize this impact, as well as reduce drownings in the aqueducts. The major impact of the reservoirs on wildlife will be the loss of natural habitat in the reservoir pool, combined with some alteration of the habitat downstream from the dams. Increased recreational uses associated with the reservoirs will also have an adverse impact on wildlife resources.

Land-related impacts include the right-of-way required for project purposes, involving private, state, Federal and Indian lands. Some land will come from Indian reservations and National forests, and a small amount will be needed in wilderness and primitive areas. The project will have a beneficial impact in the central service area in arresting land subsidence associated with lowering of the water table. This is a problem which grows more serious every day and threatens both municipal and farming areas.

There are many water-related impacts associated with the project. The project dams and reservoirs, and to some extent the aqueducts, will provide facilities for conservation of floodflows and rainfall. Water is a scarce resource in the project area and this conservation will be of benefit to all water users and to wildlife, especially in periods of prolonged drouth. The application of project water will be the major water-related impact of the project. Besides human uses, this water will be used to combat the present ground-water overdraft and its related problems of vegetative deterioration and land subsidence. It will also increase the potential area available for migratory or nesting waterfowl.

There will be some impacts on the natural resources of the project area which are not predictable at the present time. These are enumerated later in this chapter as unquantified amenities. No significant mineral resources will be lost due to construction of the project. Mineral resources in the Buttes Reservoir site, if not removed prior to inundation, will require more difficult or expensive methods than commonly employed in open pit methods of excavation. The project's impact on air and noise quality in general is expected to be minimal. Noise levels during construction will temporarily disrupt wildlife patterns.

Diversion of project water from Lake Havasu at the magnitude of Arizona's remaining entitlement will require increased water releases from Lake Mead. These releases will have a beneficial effect on the flow and salinity of the river between Hoover Dam and Lake Havasu. Neither the flow nor the salinity level of the river below Parker Dam will be adversely affected by diversions of water for the project. The quality of the water diverted to the central service area will be better than much of the present underground water being pumped, but generally of less quality than the surface waters now being controlled and used in the central service area. Thus, mixing of these waters will have both beneficial and adverse impacts on water quality in various parts of the central service area. Salinity-control programs presently under study for implementation on the Colorado River when completed will improve the quality of Colorado River water whether diverted from Lake Havasu for the project or released for downstream uses.

2. Human Impacts [14,54,61,67,122,125,126,129,133-136,139,140,141,143,144,184]

Project construction activities will have generally beneficial human impacts. There will be considerable direct and indirect employment related to construction and operation of the project. Adverse impacts due to noise and dust will be small, since the construction of the project will occur largely away from population centers.

Fish and wildlife aspects related to human impact will be both beneficial and adverse. Reservoir fishing will increase appreciably, whereas there will be some loss of stream fishing. Some aspects of hunting may deteriorate in localized areas of the project. Expected reductions in number and diversity of wildlife in the immediate project areas will adversely affect that part of the population which enjoys wildlife observation in those areas.

Land-related impacts on the human environment are problematical, as are those related to population growth and location. Demographic projections for the central service area indicate an increase in population and concomitant land use. These projections are not dependent upon construction of the project nor upon importation of project water. Indications are that the population grows in water-short areas in spite of existing water shortages. Importation of CAP water will aid in stabilizing the agricultural industry in the central service area and will prolong such land use and the agricultural industry segments of the economy. This stabilizing influence will not materially affect the conversion of agricultural lands for housing and other related uses as population expands in the central service area.

The major human impacts of the project will be related to water. Importation of Colorado River water, combined with conservation of floodflows and rainfall, will augment existing water resources. This additional water will be used for municipal, industrial, agricultural, and other purposes. It will reduce the dangers of land subsidence by

reducing the ground-water overdraft and will aid in controlling the ever-rising cost of water in the central service area. Varied impacts on water quality will be felt in different parts of the central service area, as mentioned above. In addition, reservoirs constructed by the project will provide a major source of water-related recreation, adding to those already present in the state and spreading these resources geographically within the Gila River basin. Recreational activities related to segments of free-flowing perennial streams will be lost in portions of the project area.

Flood control will be another beneficial impact of the project. The dams and reservoirs of the project will conserve and contain flood-flows and the aqueducts will be able to train them away from metropolitan areas and divert them in periods of high runoff and streamflow. Flooding is a matter of major concern in the project area. Significant rainfall is notably seasonal and rains are often quite intense over short periods, especially in the summer. In the last decade, there have been a number of serious and very destructive floods which existing dams and reservoirs were not able to control. This problem was highlighted by the fact that Maricopa, Pinal, and Pima Counties were declared major disaster areas entitled to Federal assistance due to destruction caused by the flooding and high winds that occurred in June 1972.

Irrigated farming and enterprises related thereto will receive a number of benefits from the project. The project will increase the supply of water available to existing agricultural lands, help minimize the cost of agricultural water, and decrease sedimentation which has been a considerable problem in irrigation works. Less ground-water pumping will be needed and the project will have a generally stabilizing effect on the agricultural segment of the Arizona economy. Stabilizing of irrigated agriculture will have a peripheral wildlife benefit in that a number of bird species are benefited by the proximity of grain crops to their habitat areas.

There will be impacts on the archeological resources of the project area. The most significant of these resources are found in the areas of the Charleston, Hooker, and Orme Dam sites. To the extent that these resources are not explored and excavated prior to inundation of these reservoir sites, the predictable impact is adverse. But an intensive program to survey and assess these resources is underway, spurred by the comprehensive planning of the project. Intensive efforts will be made to excavate and salvage the most significant of these archeological resources. In the absence of the project, these resources may not receive the expert attention that is necessitated by water resource development projects.

There will be adverse impacts where project construction involves areas now relatively untouched by man's activities and some esthetic impacts even in those areas already heavily used or impacted by such activities. The reservoirs formed by the project will have beneficial esthetic impacts for some and adverse impacts for others, depending on individual orientation.

The project will have impacts on several Indian communities in the central service area. Indian communities will receive water from the project for irrigation and other purposes on their reservation lands. In the central service area, Indian irrigated agriculture, as well as non-Indian, has been hampered by adverse water supply conditions. A part of two Indian reservations will be required for Orme Dam and Reservoir. The authorizing legislation provides the terms and conditions for use of those lands, and the compensation and other benefits to be furnished to the individuals and communities involved.

Tribes on the Colorado River will not be adversely affected by the project. The authorizing legislation provides for protection of Indian rights as well as non-Indian rights on the river.

The above overviews regarding the impacts of the CAP are discussed in greater detail in the following sections of this chapter. A complete understanding of the impacts of the project is possible only after reading this chapter together with Chapter IV (mitigation and enhancement features) and involves a comprehensive knowledge of the many facets of ecological and environmental components.

C. Direct Impact of the Project

The first part of this section presents overall impacts associated with the project construction. This is followed by more detailed descriptions of the impacts of key features of the project.

1. Impacts Related to Construction Activities

The intention of general and specific sections of construction specifications and Bureau of Reclamation policy, is to exercise care in the preservation or protection of natural landscape during construction operations.

a. Borrow Areas

Project construction within areas containing inadequate or unsuitable earth materials will require excavation of adequate materials from borrow areas. The utilization of areas for borrow will be restricted and controlled.

Borrow areas required for construction will destroy existing vegetation and temporarily displace associated wildlife at the borrow site. The extent of the impact on esthetic values, natural vegetation, and wildlife habitat will be considered in choosing the location, size, and configuration of the borrow areas. Normally, no seeding or replanting of the borrow areas is required under the general construction specifications. Where construction will have a high impact, the area will be restored to its original condition as nearly as practical. In areas where stripping, grubbing, or removal of topsoil will be required to provide access to the desired material, the replaced topsoil should contain adequate seed for revegetation.

Restoration of borrow areas will be accomplished by reshaping the pit to blend with surrounding terrain. The areas will be left with gradual slopes and drainage features to prevent erosion and undesirable ponding of water. In some situations, the entire borrow area may be covered with topsoil if feasible. The area will be scarified or ripped on the contour to create a rough surface capable of entrapping moisture, thereby enhancing natural and supplemental revegetation. The moisture entrapment will in most instances provide water for wildlife and vegetation, and supplement the ground-water recharge. Stagnation of the water and possible mosquito breeding may also occur at times.

Precipitation will generally control the recovery time necessary for vegetation and earth materials to reach a level of esthetic acceptance for each segment of the project. Limited restoration of native vegetation in borrow areas will be attempted when it is feasible.

b. Construction Access Roads and Camps

Construction access roads will be necessary to facilitate the work and allow safe travel of construction personnel. Existing roads in the project area will be used to the maximum extent possible for access to the construction area. New road construction is not anticipated between the existing Arizona State Highway system and the right-of-way of the project features. A minor amount of road improvement would be required for access to the site of any alternate site selected in New Mexico for the Hooker Dam and Reservoir. Existing roads will generally have to be improved to handle the necessary increase in construction traffic. Existing roads in good condition and capable of handling the anticipated increase in traffic will have to be maintained in their present or improved condition. Indiscriminate creation of new trails will be controlled on Federal lands under provisions of Executive Order No. 11644.

Construction roads and on-site equipment storage areas necessary for orderly construction will be located within the project right-of-way whenever possible. Construction access roads will be closed to the general public. The closed roads should limit the contractor's liability, promote public safety, and prevent unnecessary disturbance of surrounding unspoiled desert areas. Upon completion of construction, all used or useless equipment, supplies, buildings, and personal property will be dismantled and/or removed from the construction area and disposed of in an acceptable manner and in conformance with current policy. Temporarily disturbed areas will be restored or returned as nearly as practicable to the original condition or to compliment the natural surroundings.

With the exception of small temporary trailer camps, there will be no new construction camps for personnel. The only trailer camps that are anticipated are those associated with the construction field offices. This would include possible offices, maintenance facilities, and live-in security guard quarters. Existing water and sewage facilities in these

areas of concern are nonexistent. Temporary water and sewage facilities meeting the requirements of Federal and Arizona or New Mexico state health laws will be established. Temporary trailer camps will be provided with portable chemical facilities when other appropriate methods of sewage disposal are not available. Existing small towns in the general area of construction will provide temporary housing, material storage, and construction field office sites. The sanitation facilities in the small towns may have to be supplemented to meet the increase in temporary population and construction office location. These problems will have to be met by the local community in compliance with the applicable regulations of the Arizona or New Mexico State Health Department and the Environmental Protection Agency. One area of concern may be the occasional construction worker who would utilize a camp trailer or pickup-type camper for a short duration of time within the construction vicinity. Control of this aspect will be difficult and is the primary responsibility of the landowner. Contractor's employees may be discouraged from this practice by the contractor's work schedule, contractual relationships, and the establishment of adequate facilities within the right-of-way boundaries or nearby communities or on private lands.

Environmental impact of these construction facilities will be temporary in nature. The removal of buildings and facilities will eventually return the area to the basic original condition. The temporary disturbance of vegetation, wildlife, and esthetic values will be eliminated soon after construction is completed.

c. Waste Material Disposal

Normally, all excavated material will be used for embankment construction within the project. Areas required for disposal of excess material will be evaluated along with the potential borrow areas to lessen any negative aspects. The disposal of excavated waste material will cause a temporary loss of existing vegetation and esthetic values in and around the deposit area. Wildlife in the immediate vicinity may be disrupted by the construction activity. Waste material will be placed in low profile areas and shaped to conform to natural lines and existing terrain.

Some topsoil containing vegetation, seeds, and material unsuitable for construction purposes will necessarily be moved. The material will be deposited in such a manner that the upper layer will support native vegetation. Planting of native vegetation will be accomplished whenever feasible.

d. Dust

Inherent with thunderstorms, windstorms, construction, travel, and other activity in desert regions is the ever-present dust problem. General construction specifications will require that the contractor provide efficient measures to reduce the dust nuisance which has originated from his operation. Watering devices and other acceptable methods of abatement will be used.

Temporary discomfort to people and wildlife may occur in rare instances. However, this discomfort will not exceed that experienced during periods of high winds or duststorms in the area.

e. Storage of Materials

Delivery schedules for necessary materials, lead time, and remoteness of the construction area dictate the use of temporary storage for materials. Storage areas in close proximity to the construction area are desirable for economic handling and onsite distribution or utilization of the materials. Security and vandalism protection are needed for these areas. The storage areas will generally be located either on or adjacent to the right-of-way. The areas will generally be incorporated with construction field offices and temporary camps. The project will also have material storage areas in the existing towns in the project area.

Temporary disturbance of vegetation and wildlife is anticipated. Material storage areas will be fenced, and will consist of wood or metal buildings and open storage space. These areas will serve only as temporary receiving and distribution centers to assure a smooth flow of materials for the construction program. Upon completion of construction in the area, the facilities will be removed, and the area restored as nearly as possible to its original condition.

f. Equipment Storage and Service Areas

Construction equipment will require a certain amount of periodic maintenance and repair. The contractor's investment in equipment is very substantial; therefore, it is imperative to keep down-time on each unit to a minimum. The contractor will generally establish equipment service areas near the right-of-way or service the equipment within the right-of-way. Service areas will generally disrupt the environment because of the continual activity, noise, and problems associated with repair and maintenance of heavy-duty equipment. Vegetation in these relatively small areas will be destroyed and any wildlife present will be displaced. Temporary buildings will generally be used for service facilities. The duration of the facilities at each location will probably be one to two years.

The equipment service areas will probably be centrally located within each contract reach of the canals or pool areas of the reservoirs. The location will be controlled by access from existing roads, field conditions, and proximity to the construction work.

The activities at these areas will be of such nature that oil, diesel fuel, grease, and solvents may be spilled on the ground. These and other waste products of the servicing operation will be disposed of in a manner to avoid water pollution in case of flash flood or runoff. Waste products will generally be collected and disposed of in an acceptable manner and in accordance with current policy.

Equipment service areas will require extra effort to return them to conditions that will support vegetation and will be compatible with the original conditions.

g. Lighting

Adequate equipment and supplemental lighting will be required to support nighttime construction activities in a safe manner. The length of the workday, economic utilization of equipment, and the number of shifts necessary to meet the required contract deadlines are prerogatives of the contractor. In addition, extreme desert heat may force the contractor to adjust working hours to provide for tolerable working conditions. Adequate lighting will also be required in areas of materials storage, equipment service, office, and any camps to provide necessary security. Lighting will be associated with any nighttime or security activities. Due to the remote nature of most of the construction areas, lighting should not affect populated areas. Wildlife will only be temporarily disturbed.

h. Noise

Large earthmoving equipment produces a high level of noise. The noise associated with heavy construction operation is highly objectionable in confined areas or near developed areas. Blasting will also be utilized in many areas. Utilization of equipment on a round-the-clock basis is not uncommon in the construction industry. The greatest relative increase in noise level will occur during the nighttime. The construction areas are generally remote and there should be no great disturbance of the populace. Wildlife will be displaced by the noise and will return to the area after construction is completed.

i. Increase in Traffic Patterns

Vehicular and pedestrian accidents may be greater than normal during the construction period due to the increased traffic. Desert heat, off-highway travel, and substandard roads used for traveling to and from the construction area during all hours of the day present a potentially hazardous traffic situation. Safety provisions will be included in construction specifications to minimize safety hazards caused by heavy construction equipment traffic.

Local residents will not be allowed on the closed access roads, thereby eliminating a major safety concern. Construction personnel traveling through the local area will be controlled by the state and local traffic regulations.

Wildlife in the area of traffic patterns will be disturbed. Completion of construction will allow wildlife to return to the area with minimal detrimental effects.

j. Temporary Disturbance of Vegetation and Wildlife

As previously mentioned, disturbance of vegetation during construction will be kept to a minimum. Restoration of disturbed vegetation will be accomplished by such revegetation techniques as transplanting, seeding where appropriate, and/or preparation of the disturbed areas to accelerate maximum natural regrowth. The technique best suited to each individual area and plant species will be employed following careful evaluation. Native vegetation will be salvaged where practicable, especially vegetation protected by law.

Behavior patterns of most wildlife types in the area indicate that most of the species that move out of an area during construction will probably return after construction and restoration of vegetative cover. Some wildlife will be lost due to increased mortality rates associated with construction activity. Upon completion and operation of the project, an additional source of water will be available for the wildlife in certain areas. Some forms of wildlife such as deer, dove, and quail will eventually increase in these areas.

k. Turbidity of Streams and Lakes During Construction

Construction of facilities in or across existing flowing streams or rivers will cause some initial increase in turbidity downstream from the construction area. The temporary turbidity will have no significant effect on sedimentation in downstream lakes or impoundments. Fish and wildlife will be little affected by this intermittent or temporary turbidity. Quality of water could be reduced in the immediate area during periods of turbidity, and associated recreational activities, where allowed, may be impaired. Areas that could be affected will be limited to (1) a section of Lake Havasu in the vicinity of the landform dike associated with the Havasu Pumping Plant, (2) a 4-mile section of the Salt River between Orme Dam site and the Granite Reef Dam, (3) a 4-mile section of the Gila River between Buttes Dam and Ashurst-Hayden Diversion Dam, (4) a portion of the San Pedro River immediately downstream from the Charleston Dam site, and (5) a portion of the Gila River below the Hooker Dam site. Turbidity in the Bill Williams arm and lower section of Lake Havasu will be minimal and will probably be less than the turbidity of incoming floodflows from the Bill Williams River. The Salt River will even be less affected because of the type of diversion during construction. The Gila River has high turbidity below the Buttes Dam site including pollution from adjacent mines. Turbidity will be minor on the San Pedro River below the Charleston Dam site because of the small flow in the river and protective construction practices. Construction activities at the Hooker site will have proportionally more potential for causing turbidity in the Gila River due to the lack of any upstream regulation or control. Construction specifications will reduce this impact to a minimum. There will be no turbidity associated with aqueduct construction due to the total absence of sustained streamflows along the aqueduct route.

1. Erosion of Disturbed Areas

Erosion control will be required in borrow areas, on cut slopes, and in other disturbed areas. Where possible, the topsoil will be removed, stored, and replaced to provide a good soil base for restoration of the desert vegetation. On long, steep side slopes of canals and other structures, the surface will be covered with a spray or mulch or hemp-type mats to help control the erosion until new growth is reestablished. Where steep cut slopes require blasting or where riprap is required for stability, the latest techniques will be used to minimize esthetic impairment.

m. Water Supply for Construction

The water for construction will be the contractor's responsibility. Where available, the contractor will use the existing supplies. In some areas, new wells may need to be drilled or surface pipelines temporarily installed. In either case, the natural conditions will remain in their undisturbed state as nearly as possible.

2. Impact Upon the Colorado River

Project impact on the Colorado River will be limited to the reach between Hoover and Parker Dams. Some additional releases will be made from Lake Mead to accommodate project diversions, but a large portion of the CAP requirement will come from a transfer of diversions now going to California. The long-term diversion is expected to be about 1.2 million acre-feet (maf) annually, which assumes full development levels of all prior water rights in Arizona along the mainstream at that time, including court decreed rights of Indian reservations adjacent to the river in Arizona. Annual diversions for the project will range from an estimated minimum of 0.38 maf during periods of extreme drouth, to the designed capacity of the aqueduct of 2.2 maf, during periods of surplus water availability. The amount of diversion in any one year will depend upon water supply conditions and the extent of Upper Basin development, neither of which are expected to restrict CAP diversions during the early years of the project. Analysis of the impacts of the project on the river resolves itself into two categories - flow and salinity.

a. Flow 1,3,5,6,8,9,12,13,134,144,173,174,183,198

Diversion of Colorado River water to the project will not result in significant change in water level fluctuations at Lakes Mead, Mohave, and Havasu. Average long-term water levels at Lake Mead may be lower than those experienced historically because of the combined effect of future increased diversions both in the Upper and Lower Basins. Water levels at Lake Mead are currently regulated to allow for higher water-surface elevations during the spring to enhance the survival of young-of-the-year bass which utilize terrestrial vegetation for protective cover.

The present streamflow regimen between Hoover Dam and Parker Dam will be altered slightly by increased releases from Hoover Dam for the project. However, daily and monthly patterns of flow in river stages will remain essentially the same, based in part on power release requirements. Lake Mohave has sustained algae blooms during the summer months. The increased volume of water moving through Lake Mohave will serve to dilute nutrients causing the bloom and should promote a slightly fresher state.

The remainder of the normal CAP diversion will come from a reduction of over 650,000 acre-feet per year in diversions from Lake Havasu to California, which presently exceeds its adjudicated entitlement. Water for CAP will be diverted from Lake Havasu and project pumping will create a minor current or circulation effect in the lower portion of the lake and up the Bill Williams arm. The circulation and mixing should reduce natural turbidity and eutrophication, resulting in a quality improvement. This minor current effect created by pumping will be relatively unnoticeable in Lake Havasu and will not adversely affect the suspended sediment content of the lake.

The CAP diversions will not affect the magnitude of releases below Parker Dam during normal years. However, additional downstream uses, primarily on Indian lands and wildlife refuges, will increase the release requirement from Lake Havasu by 200,000 to 300,000 acre-feet per year by the early 1980's. Also, in years of above-normal releases or spills from Hoover Dam, a portion of the spills could be pumped into the Granite Reef Aqueduct as specified by the authorizing act. Project diversions will be in compliance with the "Law of the River," as discussed in Chapters I and II.

b. Salinity 1,114,119,120,121,134,144,160,161

Present and projected salinity levels in the Colorado River are a serious problem. This problem was discussed in Chapter II. The present salinity levels in the lower Colorado River basin are caused by the relatively high salinity of the river as it enters the basin, contributions from salt springs on the river and its tributaries, return flows from irrigation, and water losses from evaporation and transpiration.

The diversion of water to CAP will have neglible long-term effect on the salinity of the river from Lee Ferry to the Mexican Border. CAP diversions are based on the availability of water in Lake Mead. The factors which determine that availability are wholly independent of the project as are the resulting salinity levels between Lee Ferry and Hoover Dam. To the extent that water releases from Lake Mead for the project will exceed those now being made, the river may experience improved water quality from Hoover Dam to Lake Havasu. This may or may not be offset by full development of present water rights or contracts in that reach of the river. The project will have little effect on water quality in Lake Havasu itself. The circulation and mixing caused by project pumping will not affect the salinity of the water in the lake.

Since water releases from Parker Dam normally will not be affected by the diversion of water for CAP, there will be no net effect on salinity in the reach of the river below Parker Dam due to the project. Water releases at Parker Dam will be affected only in those infrequent and short periods when Lake Mead would have spilled without the additional demand of CAP.

Nevertheless, the salinity of the Colorado is projected to increase substantially over the next 50 years unless a comprehensive salinity control program is instituted. Increased development of presently unused water rights in the upper basin will result in diversions from the river, evaporation from new reservoirs, and return flows from newly irrigated land. All of these factors will contribute to an increase in salinity of the river as it reaches the lower basin at Lee Ferry. Decreased releases from the upper basin will also increase the concentration effect of the salt input from such high salinity sources as Blue Spring and the Virgin and Muddy Rivers. Increased development along the river in the lower basin will also contribute to increased salinity levels. This development will be primarily on Indian lands and wildlife refuges, both above and below Parker Dam and Lake Havasu.

3. Impacts of CAP Water on the Project Area

a. Water Quality 1,2,114,119,120,121,139,140,144,145,160,161

The quality of Colorado River water delivered to users in central Arizona will be lower than local surface supplies that are presently being used. However, the CAP Colorado River water will be of better quality than the current, as pumped, average water quality in the service area and better than or nearly equal to that of the treated waste water available in the Phoenix and Tucson areas. This is based on the 1965-1968 level of total dissolved solids of 726 ppm at Lake Havasu, and the assumption that long-range plans will be implemented, as referred to earlier, to control future salinity increases in the Colorado River.

Production wells in the project area typically produce water ranging from 300 ppm to 4,500 ppm total dissolved solids. The average as pumped in 1965 was 955 ppm. Currently treated waste waters in the Phoenix area have about 900 ppm and the quality of such waters in the Tucson area is about 650 ppm. The present ground-water supply provides approximately 60 percent of the current usage from all sources.

Typical local surface-water quality ranges from about 280 ppm of total dissolved solids in the Verde River, to about 700 ppm in the Salt River at Stewart Mountain Dam, and to about 630 ppm in the Gila River at Buttes Dam site.

For irrigation use, Colorado River water is classified as C3-S1, indicating that it is suitable for growing salt-sensitive crops

on soils having good leaching capability or moderately tolerant crops on soils with poor leaching capability. Based on the U. S. Salinity Laboratory Classification System, the sodium absorption ratio (SAR) is about 2.4 which is in the very low range. This is important because waters with a high SAR may not be suitable for an irrigation supply. There is significantly more calcium and magnesium in Colorado River waters than local waters, which will tend to keep soils permeable by exchanging with sodium on the clay particles.

U. S. Public Health Service (USPHS) standards recommend that domestic water supplies should not exceed 500 ppm total dissolved solids. This limit, based primarily on taste considerations, is often exceeded in the Colorado River basin and those southern California areas to which Colorado River water is diverted, and in local Arizona waters. In some areas the total dissolved solid content ranges as high as 4,000 ppm. Most of the domestic water currently used in Maricopa, Pinal, and Pima Counties has a total dissolved solids content between 400 and 1,000 ppm.

The hardness of CAP Colorado River water will typically be about 360 ppm. This hardness is appreciably higher than all local surface-water supplies but is less than most local ground-water supplies. The hardness of ground-water supplies in the Salt River Valley ranges up to 600 ppm.

The fluoride content of Colorado River water is typically at about 0.4 ppm. Local water supplies in the service area also frequently exceed USPHS recommended limits of 0.8 ppm for fluoride content.

Colorado River water will transport a salt load into the central Arizona area. The water will be used as a replacement for ground water, which on the average, is of poorer quality than the imported water. Thus, while the project will bring in new salt load to the basin, such importation will work to reduce the total application of salts to the land. Considering that the ground-water quality does vary throughout the area, this effect will be modified by the specific relationships of the quality of the ground water and applied surface water at each point in the service area.

The effects and disposition of the salt load contained in the downward percolating recharge waters is a complex subject. Individual ionic constituents of the water can be exchanged or precipitated as the water moves through the aquifer in a series of complex chemical reactions between the water and the alluvium. The salt concentrations in excess of the solubility potential of the ground water may be left behind in the subsurface in the depth interval between the plant root zone and the water table. In most parts of the project area, this depth interval is measurable in hundreds of feet. Although it cannot be said that the additional salt load from the project water will not have some effect on the quality of the ground-water resource, the history of the water use and mineral content of the ground water in the area indicates such effects will be minor in the project area as a whole and probably undetectable.

In estimating the effect of the imported salt load on the ground-water resources, it is necessary to study an area with minimal declines. Such an area is the Salt River Valley, where the average yearly decline (Table 1) has been about 1.8 feet per year in recent years. As shown earlier in Table 3, the average quality did not change significantly in the period 1946-1965. During this same period about 15 million tons of salts were brought into the basin by existing surface water distribution systems. Thus, in this valley, the importation of salts has had only a minor effect. The effect of this additional salt load on the quality of the ground water may be masked by the small changes in water level or may be insignificant when added to the existing ground water. It is also possible that the chemical composition of the percolating water is altered or that the water does not reach the water table.

The mineral content of the ground water in all of central Arizona has generally stayed the same since the 1940's and yet during this period large declines in water level and theoretically large amounts of recycling of ground water have taken place. Thus recycling of the salt load in the declining basins and importation into the area have not affected the quality of the ground water produced, if in fact it is truly recycled.

The evaporation of Colorado River water during transit will have a minor effect on concentration of total dissolved salts in the imported water. The actual effect of evaporation losses on water quality will vary with the amount of water diverted, the point of delivery, and the season. Maximum water quality degradation will occur at the most distant delivery point when the diversion at Lake Havasu is at a minimum during the hot summer. Normal annual evaporation will be relatively uniform from year to year. Over 60 percent of these losses will occur during the May-September period. A minimum diversion of 500 cfs during this period would produce a water quality degradation of about 6 percent between the beginning of the Granite Reef Aqueduct system at Lake Havasu and the end of the Salt-Gila Aqueduct. Similarly, a 500-cfs diversion during the winter would produce a degradation factor of less than 2 percent.

b. Water Quantity [1,15,57,88,134,139,144,168,173,174]

Completion of the CAP will result in additional water for the central service area. The annual Colorado River diversion to CAP will vary from the estimated minimum of 0.38 maf during periods of drouth to the design maximum of 2.2 maf during periods of surplus water availability. The water will be used to support municipal and industrial development, irrigated agriculture, fish and wildlife management, and outdoor recreation programs.

In providing water for municipal and industrial uses, the project will relieve to some extent the dependency of urban areas on ground-water supplies which are already being overdrafted.

Irrigation in the project service area presently depends on ground-water supply and surface runoff. Those sources will be augmented by CAP water. Only developments in the project area which have a recent history of irrigation may receive CAP water for irrigation. The authorizing legislation, however, exempts Indian reservations and permits use of CAP water to develop new agricultural land on these reservations.

Ground-water pumping is presently creating an average annual overdraft of about 2.1 maf in the CAP service area. With CAP completed, the average annual overdraft between 1980 and 2000 is projected to be less than 900,000 acre-feet. Depths to ground-water presently range from 20 to over 500 feet in the project area, with portions of the primary aquifer in the ground-water reservoirs being completely dewatered and some areas approaching basement rock. By the time CAP begins delivery, more than 20 percent of the agricultural area to be served by CAP is projected to have pump lifts exceeding 500 feet.

With one of the objectives of CAP being to stabilize ground-water declines, computer model projections by the Arizona Water Commission of ground-water conditions between 1980 and 2000 indicate a general decline of 25 to 100 feet over this period. In general, areas having ground-water lifts of over 500 feet will have the least decline, because further economic agricultural water use will require the use of CAP water in most areas and because the ground-water resource in some of these areas will be nearly exhausted. Areas with ground-water lifts of less than 250 feet in the initial years of CAP will experience the greatest declines between 1980 and 2000, because ground water can still be withdrawn at a comparatively low cost.

During the initial years of CAP delivery, almost all agricultural areas using CAP water will experience water level increases, with some areas meeting their entire water requirement with CAP water. But as the CAP supply decreases in these areas the deficit will have to be met with ground water and this trend will reverse. By the year 2000, probably all areas using CAP water will be reexperiencing ground-water declines. However, all areas served by CAP water must have lined distribution systems. As these areas return to greater ground-water dependence, less ground water will need to be pumped than with previous unlined systems, with a resultant water savings and reduction in costs of operation. Thus, the overall application of Colorado River water in the service area will not totally eliminate long-term ground-water overdraft or water level declines. It will, however, significantly retard the rate of withdrawal and decline, especially during the earlier years following completion of the project. Long-range needs for ground and surface waters will depend on population growth and economic trends in the project area.

With the application of CAP water, certain very localized areas may experience some problems with lands or plant growth as a result of a rise in ground-water levels. Provisions for future project drainage facilities were authorized as a part of the project to alleviate high ground-water conditions if and when they occur.

Congressional committee reports on the authorizing legislation state that return flows from project irrigation and municipal and industrial effluent must be fully managed. Utilization of water from these sources will be coordinated with other supplies so that optimum water use is achieved.

4. Impacts of Key Features of the Project

a. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 42,70,73,101,146,149,158,165,177

Construction of the Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel will have minimal adverse impact on life forms in the feature area. The major point of environmental concern will be to minimize the impact of the intake channel on the biota of Lake Havasu. An initial study directed at this problem was completed on July 1, 1972.

(1) Vegetation

Vegetation in the feature area is mostly typical sonoran type and generally is sparse. Along the lake shoreline and desert washes, vegetation increases. (See Figure 27A.)

Construction of the Havasu features will have a minimum adverse impact on vegetation. While some 200 acres will be involved in construction, this figure primarily reflects the horizontal plane of the tunnel and also includes the water surface area of the intake channel. The only permanent disturbance of existing surface areas capable of supporting vegetation will be the pumping plant site, its adjacent facilities, the tunnel outlet area, and spoil deposition areas nearby. No significant vegetational communities will be destroyed.

(2) Havasu National Wildlife Refuge 63

The pumping plant and the tunnel will be located outside the existing boundaries of the Havasu National Wildlife Refuge. (See Figure 27A.) Application was made by the Bureau of Sport Fisheries and Wildlife in 1957 and 1958 for expansion of the refuge (as shown on Figure 19F), but approval has not been obtained. The Havasu works will trace a path southeast from the south shore of the Bill Williams arm. They will not cross or pass near the Bill Williams River, the focal area of the refuge. The tunnel and most of the Havasu Pumping Plant will be underground. Once construction is completed, there will be little evidence of disturbance to the area except at the intake channel and pumping plant site and at the outlet portal of the tunnel. None of the delta area of the Bill Williams River, nor its attendant upstream vegetation will be affected. Migration patterns along the Buckskin Mountains into the refuge will not be blocked.

(3) Fish and Wildlife 40,56,66,146,165,176

Adverse wildlife impacts caused by the Havasu feature will be small. The route of the feature will be away from the better

wildlife habitat areas and very little of the constructed feature will remain aboveground. During and after construction, the Buckskin Mountains will continue to be open for migration of the approximately 50 desert bighorn sheep that are presently ranging in the area. Some interference with migration patterns may occur during construction of the discharge lines and tunnel. Dewatering of rock formations during construction will not be significant, since no springs are found in these mountains. The sparse vegetation is supported by precipitation exclusively.

Possible adverse impact on birds is confined to one species, the great blue heron. Approximately 15 pairs of these birds nest during the spring on an island (Heron Island) some 4,500 feet northwest of the pumping plant site. Heron Island will not be physically touched during construction and the sediment barrier forming the intake channel will not reach the island, nor come within 1,000 feet of it. Nor will sediment deposition form a land bridge to the island. Construction activities with noise, dust, and increased human presence may disturb the colony during the period it uses the nesting ground. The most severe impact will be blasting noise. The construction specifications will contain certain requirements, discussed in Chapters I and IV, designed to protect these birds from such impacts. No other significant bird-related impacts will result in the area, due to the fact that the path of the Havasu feature will avoid the Bill Williams River and its associated habitat, which is noted as a stopover point for migratory waterfowl. None of the habitat of the Yuma clapper rail, included in the endangered species list,[176] will be affected. The only such habitat in close proximity to the Havasu feature is above the bridge where State Route 95 crosses the Bill Williams River, and in the Topock Marsh near Needles, and thus away from the path of the feature. (See Figure 27A.) From recent bird counts, only about 15 percent of the Yuma clapper rail inhabitating the area upstream of Parker Dam are found in the Bill Williams arm of the Havasu National Wildlife Refuge.

Potential adverse impacts on fish have been of special concern in analyzing the environmental impacts of the Havasu feature. The only significant possible impact is the effect of pumping on fish populations in the immediate intake channel area. The intake channel should provide a new brood area for largemouth bass in the lake.

The report of July 1, 1972, by the Arizona Game and Fish Department differs somewhat from preliminary assessments. That study concludes that accurate predictions of fish losses are not now possible, but that some type of screening device will probably be necessary in the future. The study bases this conclusion on several points. The Bill Williams arm differs from the rest of Lake Havasu in that the arm area experiences moderate to heavy turbidity and siltation due to seasonally variant flows from the Bill Williams River. This fact, coupled with recent sampling and fisherman interviews, led to the conclusion that the major immediate impact of intake channel construction will be on channel catfish. Once the area stabilizes, it will become increasingly suitable for other fish as well, including striped and largemouth bass, green sunfish, and bluegill. The report recommends that a monitoring program be set up for the first year of operation to determine

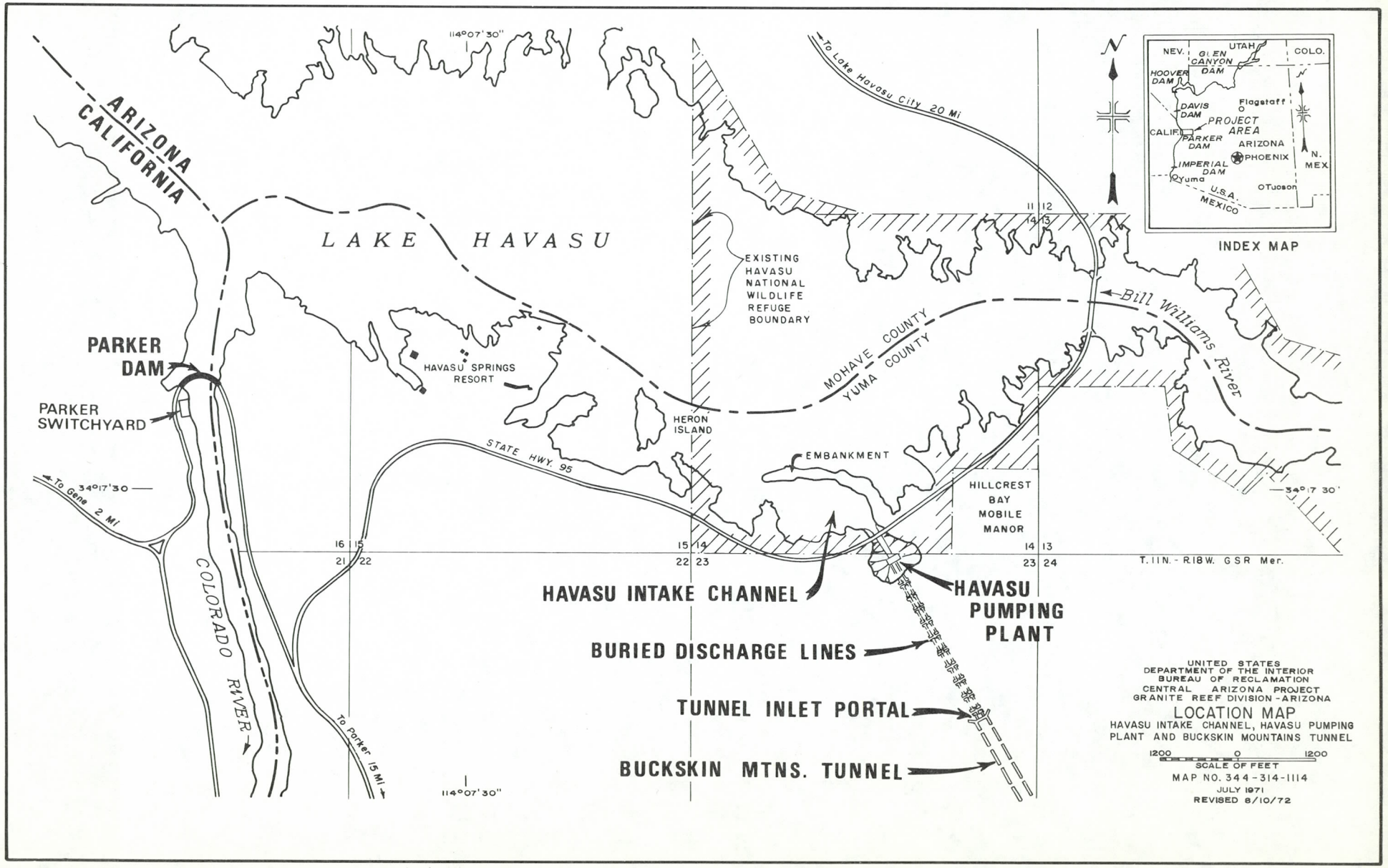

ARIZONA
CALIFORNIA
LAKE HAVASU
114°07'30"
To Lake Havasu City 20 Mi
EXISTING HAVASU NATIONAL WILDLIFE REFUGE BOUNDARY
Bill Williams River
MOHAVE COUNTY
YUMA COUNTY
PARKER DAM
PARKER SWITCHYARD
HAVASU SPRINGS RESORT
HERON ISLAND
STATE HWY. 95
EMBANKMENT
HILLCREST BAY MOBILE MANOR
34°17'30"
To Gene 2 Mi
COLORADO RIVER
To Parker 15 Mi
T. 11N. - R18W. GSR Mer.
HAVASU INTAKE CHANNEL
HAVASU PUMPING PLANT
BURIED DISCHARGE LINES
TUNNEL INLET PORTAL
BUCKSKIN MTNS. TUNNEL
INDEX MAP
NEV.
UTAH
COLO.
GLEN CANYON DAM
HOOVER DAM
DAVIS DAM
Flagstaff
PROJECT AREA
CALIF.
PARKER DAM
ARIZONA
PHOENIX
N. MEX
IMPERIAL DAM
Yuma
Tucson
U.S.A.
MEXICO
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION - ARIZONA
LOCATION MAP
HAVASU INTAKE CHANNEL, HAVASU PUMPING PLANT AND BUCKSKIN MOUNTAINS TUNNEL
1200 0 1200
SCALE OF FEET
MAP NO. 344-314-1114
JULY 1971
REVISED 8/10/72

Figure 27A

fish losses. Implementation of this program is discussed in Chapter IV. If at that time, protective devices do not seem warranted, the report recommends a five-year followup program. Experience to date at the Intake Pumping Plant of the Metropolitan Water District of Southern California which pumps directly from the main body of Lake Havasu 4 miles to the northwest does not demonstrate that fish are being pumped to an extent adverse to the population.

Mechanical or chemical methods may be required in spot applications to control operational problems in the intake channel and pumping plant forebay area caused by aquatic weeds, mosses, algae, ditchbank weeds, and fresh water (Asiatic) clams. No precise assessment of such uses can be made until the effects of pumping plant operation on the channel can be observed. Thus, the impact of such methods cannot as yet be quantified. In any event, use of any of these methods will be carefully controlled by policy and regulations of the Bureau of Reclamation, the Department of the Interior, and the Environmental Protection Agency.

(4) Water Flow and Quality[149]

The lower end of Lake Havasu and the Bill Williams arm will be only slightly affected by the minor current or circulation effect resulting from project pumping and the flow through the intake channel. Velocities of flow into the intake channel will be low and generally unnoticeable in the arm and not at all noticeable in the rest of the lake. This flow may have a slight scouring effect on the lake bottom in the area outside the intake channel.

The circulatory effect of the project pumping through the intake channel will provide a mixing effect in the lower portion of the lake by bringing mainstream flows into the lentic portion of the Bill Williams arm. The mixing should reduce natural turbidity and eutrophication. A minor quality improvement is foreseen in the arm as a result of this action.

There will be periods during construction when deposition of materials to create the landform embankment for the intake channel will displace lake sediment causing localized turbidity. Existing turbidity is characterized as moderate to heavy. That fact, plus other factors, including water depth, quantity of materials deposited, and time for displaced sediment to settle, indicates that the effect of this turbidity will be small and only temporary. Bottom organisms and fish that feed on them in the construction area may experience minor adverse effects.

(5) Other Impacts [42,46,63,73,177,178]

There will be short-term economic benefits due to the construction of the Havasu feature for the local populace, including the residents of Parker and Lake Havasu City and the members of the Colorado

River Indian Tribes community. There will also be short-term adverse impacts in limited areas on recreation associated with construction activity. While the long-term adverse impact on recreation will be slight - a small reduction in lake surface - this will be offset by benefits in fishing and boating opportunity due to the landform embankment. There will also be a minimal long-term adverse impact on esthetics due to the presence of the pumping plant on the shoreline. The area already supports a trailer park east of the feature and a marina to the west along the south shore of the Bill Williams arm. State Highway 95 connects these developments as it passes along the south shore of the arm to the bridge across the Bill Williams River. Advanced techniques to be used in construction, described in Chapters I and IV, will minimize the esthetic impact of the feature. Interim and final assessments have determined that there will be no archeological impact due to the construction of the Havasu feature.

b. Inline Relift Pumping Plants

In addition to the Havasu Pumping Plant discussed above, there are nine inline pumping plants associated with the project aqueduct system. On the Granite Reef Aqueduct, there are the Bouse Hills Pumping Plant, Little Harquahala Pumping Plant, Belmont Mountains Pumping Plant, and the Hassayampa Pumping Plant. Associated with the Salt-Gila Aqueduct will be the Salt-Gila Pumping Plant, Picacho Mountains Pumping Plant No. 1, and Picacho Mountains Pumping Plant No. 2. The Marana Pumping Plant will be located at the beginning of the Tucson Aqueduct and the San Pedro Pumping Plant will be on the San Pedro Aqueduct. In addition to these inline units, the Orme-Granite Reef Pumping Plant will pump flows released from Orme Reservoir to the Salt-Gila Aqueduct near the Salt River crossing.

The criteria set forth in Reclamation Instructions will be used as guidelines in the planning and design of these relift pumping plants. Design of these pumping plants will include soft lighting, abatement of harmful or bothersome noise levels, and an external appearance environmentally compatible with the surroundings.

There will be minor loss of vegetation due to installation of the pumping plants. Loss of vegetation will be confined to the actual sites and necessary access roads. Changes in natural esthetic values will involve the physical features of the pumping plants, including the access roads, and associated power supply.

Further evaluation of the impact of the inline relift pumping plants will be included in the individual environmental statements on the aqueducts.

c. Aqueducts

The four aqueducts to be constructed to transport project water to the service area will traverse a total of 371 miles and require

a total right-of-way of approximately 15,740 acres. Adverse impacts from the 84 miles of buried pipeline comprising the Tucson and San Pedro Aqueducts will be small, consisting primarily of temporary wildlife disturbance during construction and impacts associated with continuing maintenance and inspection of the pipeline along the right-of-way. The 287 miles of mostly open aqueduct (Granite Reef and Salt-Gila) will hinder present migration patterns of large mammals and present a drowning hazard to wildlife, and to people in urban areas. These adverse impacts will be mitigated by fencing, wildlife watering facilities, and other measures as described in Chapters I and IV. Vegetative losses due to the aqueduct system will be relatively small. For the most part, the aqueducts will cross sparsely vegetated desert. Riparian areas associated with major washes will be crossed with underground siphons, minimizing disturbance of these areas and permitting natural revegetation. Increases in vegetation suitable for wildlife habitat are projected for areas behind the flood-control dikes along aqueduct routes, based on past experience with similar structures. Associated increases in wildlife populations are expected. Flood-control benefits from the dikes will accrue primarily in urban and agricultural areas below the aqueduct. Impacts on fish from the aqueduct system will be negligible. No perennial streams will be crossed and the siphon crossing under the Gila River will be located in an area frequently dry. A few fish species may enter the open aqueducts and migrate to new locations as invading and unwanted species. But water velocities, periodic aqueduct evacuation, and other operational characteristics will prevent establishment of significant populations within the aqueducts. No endangered birds or mammals will be adversely affected by the aqueducts. No unmitigated adverse impacts on archeological resources will result from construction of the project aqueducts. There are no known mineral resources that will be adversely affected by the aqueducts. Recreational possibilities on the open aqueducts are being considered as discussed in Chapter IV.

(1) Granite Reef Aqueduct

(a) Fish and Wildlife 56,66,71,108,166,176

The major impacts of the Granite Reef Aqueduct will be the interruption of normal range and migration of desert mule deer and desert bighorn sheep and the creation of a drowning hazard for these animals. This projection is based on experience along the unfenced Wellton-Mohawk Canal as constructed and without escape and mitigation features as planned for the CAP aqueducts. The Arizona Game and Fish Department has identified desert bighorn sheep populations along the aqueduct route in only three mountain ranges: the Buckskin Mountains (about 50 animals); the Harquahala Mountains (only a remnant population); and the Eagletail Mountains (about 30 animals). Other adjacent ranges historically supported sheep populations but now have only occasional transient individuals. Remote ranges support active herds. The Department considers about 120 miles of the 190-mile aqueduct route to be occupied desert mule deer habitat. It estimates that between 300 and 600 deer populate a 10-mile-wide strip (the impact area) along this 120 miles of the route, while the mule deer population of the state is estimated at about 128,500 animals.

Drowning history along the Wellton-Mohawk Canal of the Gila Project indicates that only occasional stray sheep, usually young rams, will wander out of their normal mountain habitat and drown while trying to drink from the canal. Desert mule deer drownings have been much more frequent, and the Department estimates that the deer herd in the Gila Project canal area has been reduced 90 percent due to deer drowning. The Department projects a similar experience for an unfenced aqueduct section without escape devices and without watering oases located near the aqueduct as planned for the Granite Reef Aqueduct. This estimate is based on a 10-mile-wide area surveyed along the route chosen for the Granite Reef Aqueduct.

With the measures discussed in Chapter IV, actual losses from the feature as planned will be much less. Construction activities will most likely keep deer away from the aqueduct until such activities are completed and man's presence becomes less constant. Upon returning to the area, deer and sheep will encounter specially designed fences, escape features, aqueduct crossings, and watering facilities all designed to minimize hazards to wildlife. These special facilities plus gradually increasing familiarity with them are expected to significantly decrease local wildlife losses due to the aqueduct. These facilities are also expected to keep losses of other animals at insignificant levels.

There will be a net increase in hunting of upland game species due to the availability of water in remote areas and increased vegetation behind flood-control dikes. Only time will allow determination to be made of the net loss, if any, in big game and the effectiveness of the proposed mitigation measures along the aqueduct. If unexpected big game losses occur under project conditions, a reassessment of the measures provided could be made to keep losses to a minimum.

(b) Vegetation[56,63]

The 190-mile route of the aqueduct will traverse typical open desert plain and desert mountain rangelands from Lake Havasu to Orme Reservoir. Construction of the aqueduct will involve 8,900 acres. The vegetative cover of this area is typically open and sparse. The principal species of plants include creosote bush, paloverde, saguaro, and haplopappus on the open desert and mesquite, ironwood, paloverde, and other species of riparian vegetation in the many washes that will be crossed. A low level of annual precipitation in this area noticeably restricts vegetation and most of the area is considered as only fair-to-poor in habitat quality. This sparseness in vegetation accounts in part for the minimal wildlife impact from the aqueduct described earlier. Small amounts of riparian vegetation, mostly paloverde, ironwood, and haplopappus, will be disturbed where the aqueduct crosses desert washes. These stands will reestablish at major washes crossed by underground siphons.

About 160 miles of low earth dikes will be constructed above the aqueduct to train floodflows to cross-drainage structures to protect the aqueduct and related features. Habitat for doves,

quail, and cottontail rabbits will be improved behind these cross-drainage control structures, since the temporary backup of storm runoff will provide water necessary for establishment of vegetation. This will also offset losses in habitat that may occur below these dikes.

The right-of-way of the aqueduct will traverse about 40 miles of terrain that presently support sparse stands of vegetation protected by state law. The most significant plant is the saguaro cactus. Where it is necessary to remove plants of these protected species, they will be replanted where factors of species behavior, age, and new locations will be favorable. Coordination with the Arizona Agricultural and Horticultural Commission will be accomplished with regard to clearing of native vegetation and permits that will be required for transportation and transplanting of salvaged plants.

(c) Other Impacts 42,45,46,61,73,177,178,188,191,193,200

The present esthetic values along the aqueduct route will be further modified by the presence of additional manmade structures and associated facilities. These impacts will not be significant along much of the route of the aqueduct because of the generally uninhabited character of the route. However, the impact may become more significant to some people over the last several miles of the route from the Agua Fria River around the north side of the Phoenix metropolitan area. The aqueduct's impact on archeological resources will be mitigated. Recreational possiblities for the aqueduct have been studied and are receiving further analyses by state and local agencies for bicycle and horse trails. Any recreational benefits from the aqueduct would probably be small in comparison to recreational benefits from the reservoirs. The aqueduct will also have some direct flood control benefits, especially in the Phoenix metropolitan area, by providing control of floodflows in the Indian Bend Wash area and an outlet for them. The major flood control benefit from the aqueduct will be achieved through its general operation and in conjunction with Orme Reservoir.

The major resource impact of the aqueduct will be the commitment of 8,900 acres for right-of-way. Commitment of this acreage will have no adverse impact on mineral resources and such development should have a minimum impact on land-use patterns and population distribution. Some water loss will occur due to evaporation from the exposed water surface area of the aqueduct. This is estimated at 8,600 acre-feet annually.

(2) Salt-Gila Aqueduct

(a) Fish and Wildlife 55,71,172

The Salt-Gila Aqueduct will have a minor impact on wildlife. The 97-mile route of the aqueduct will involve about 5,800 acres.

The typical sonoran desert vegetation along the route varies with soil types which also vary from rocky soil slopes, alluvial washes, silty clayey soil, to bajadas. Numerous small animals and birds use the desert shrub and cultivated areas for forage and shelter.

Impacts on big-game animals, primarily mule deer and javelina, will be from drowning and alteration of migration routes. The loss of deer and javelina from drowning should diminish as they become familiar with the aqueduct as an obstacle and new migration routes to aqueduct crossings are established. As discussed in Chapter IV, measures similar to those to be provided for Granite Reef Aqueduct will minimize the losses. Zero impact on big-game hunting has been projected.

Upland game and waterfowl will benefit from the increased supply of water and maintenance of food grain production in the project service area. No significant increase in hunting is expected. Other small animals and birds will experience similar impacts.

There is no perennial fishery resource along the route of the aqueduct. The Salt and Gila Rivers occasionally contain sediment laden floodflows at the points where the aqueduct will cross. The presence of fish under this condition is inconsequential. Operation of the aqueduct is not conducive to the establishment of a permanent fishery resource, due to periodic evacuation of the aqueduct, swiftness of water movement, and other factors.

(b) Vegetation[55,63]

The loss of vegetation associated with construction of the aqueduct will not be significant. Vegetation along the route of the aqueduct is sparse except in the vicinity of drainage courses where storm runoff concentrates and provides more moisture for plant growth. Most of the open areas have been cleared of native vegetation. Underground siphons will be used to cross these drainage areas and the Salt and Gila Rivers. The native vegetation will regrow at these crossing points.

(c) Archeological [43,45,46,177]

Reconnaissance archeological surveys of the Salt-Gila Aqueduct route were conducted by the Department of Anthropology at Arizona State University, and by the Arizona State Museum at the University of Arizona under contracts with the National Park Service. A detailed survey was started in July 1972 by the Arizona State Museum under contract with the National Park Service. From the reconnaissance surveys, eight sites of archeological significance were recommended for further investigation. Further evaluation after completion of the ongoing survey will determine the final archeological findings that should be excavated and/or salvaged. This archeological work will be accomplished prior to or during construction.

(d) Other Impacts 61,63,178

The present esthetic values along the route of the Salt-Gila Aqueduct will be further modified by the presence of the aqueduct and associated facilities. Aqueduct design and landcape treatment after construction will reduce adverse effects wherever possible. Recreational potential for the aqueduct has been studied. Recreational impacts from the aqueduct will be small in comparison with those of the reservoirs. Approximately 60 miles of low dikes will be constructed for cross drainage flood protection along the route of the aqueduct. These dike areas will serve to increase wildlife habitat in the vicinity of the dikes by temporarily retaining water, while decreasing habitat below them. Primary flood control benefits associated with this feature will be derived from its operation in conjunction with potential and existing Soil Conservation Service flood retarding structures.

The 5,800 acres of right-of-way necessary for construction of the aqueduct will be the major commitment of natural resources to this feature. Construction of the aqueduct itself will have a minor impact on land-use patterns. No mineral resources will be lost due to construction of the aqueduct. Some water loss will be associated with the aqueduct due to evaporation from its exposed water surface area. This is estimated to be about 3,200 acre-feet annually.

(3) Tucson Aqueduct

(a) Fish and Wildlife 71,176

The Tucson Aqueduct will have no significant effect on wildlife. The aqueduct will be an underground pipeline some 20 miles in length and have a 50-acre regulating reservoir. Since the aqueduct will be underground and run parallel to Interstate Highway 10 along most of its route, it will not be a barrier or hazard to wildlife in the area. No loss of wildlife will be associated with maintenance and operation of the aqueduct. There is no fishery resource along the aqueduct route.

(b) Vegetation 63

The aqueduct will cross typical open sonoran desert. The vegetation is sparse except where the aqueduct crosses washes. Loss of vegetation will be temporary except to the extent necessary to provide a maintenance road along the route of the aqueduct. As with other project features, the disturbed area will be revegetated if found necessary following construction, in accordance with the guidelines set forth in Section 376.4 of the Bureau of Reclamation Instructions. Natural revegetation will occur in successional stages, especially along the washes crossed by the aqueduct.

(c) Archeological 43,177

An archeological survey of the Tucson Aqueduct route was conducted by the Arizona State Museum, University of Arizona,

in 1969 under contract with the National Park Service. Upon completion of the survey, one possible Hohokam village site was recommended for further investigation and/or excavation. It is estimated that this site (AA:12:74) will require about 120 man-days for further investigation plus 3 days for heavy equipment salvage excavation. Further review of the 1969 survey is being made.

(d) Other Impacts 63,178

The esthetic impact from this feature will be small, since the aqueduct will be buried and much of the area is already man-disturbed. Revegetation of the right-of-way will reduce the impact. There will be no loss of mineral resources along the aqueduct route due to construction of this feature. In all, 340 acres will be committed to aqueduct right-of-way.

(4) San Pedro Aqueduct

(a) Fish and Wildlife 71,176

Aside from temporary disturbance during construction, the San Pedro Aqueduct will have no significant impact on wildlife along its approximately 64-mile route. The 750 acres involved in construction will be largely revegetated after the pipeline is buried. Fish and wildlife will not be affected.

(b) Vegetation 63

The aqueduct will cross typical upper sonoran desert grassland areas between Charleston Dam and its terminus near Tucson. As with the Tucson Aqueduct, temporary loss of vegetation will occur during construction. Natural revegetation will occur through successional stages.

(c) Archeological 43,177

A reconnaissance archeological survey was conducted by the Arizona State Museum, University of Arizona. Fifteen archeological sites were located, of which eight need no excavation, five were recommended for further investigation, and two were recommended for excavation. A review of the reconnaissance survey will be accomplished using more detailed route information.

(d) Other Impacts 63,178

Since the aqueduct will be buried and its right-of-way revegetated, the esthetic impacts of the feature will not be significant. No mineral resources will be lost due to construction of this feature. The land commitment will be approximately 750 acres.

d. Reservoirs [7,75]

The four project reservoirs will influence approximately 37,140 acres. Of this, some 18,820 acres will be inundated below the conservation level. Vegetation associated with this acreage will be lost. Riparian vegetation of various ecological niches will be included in this loss, totaling about 5,943 acres. Inundation will also cause the loss of any unmitigated archeological resources identified within the reservoir pool. The loss is more likely to occur at the Orme and Charleston Reservoirs because of the large number of sites at each. The mineral resources undeveloped at the Buttes Reservoir will be more difficult to recover.

In addition to water supply benefits from the project as a whole, the reservoirs will provide flood control benefits and water conservation benefits, both of which are badly needed. Floodflows and runoff will be captured and sediment levels will be reduced. The reservoirs will provide new sources of water-based recreation, expand the existing fishery resource, and help to geographically distribute these resources more evenly throughout the project area.

(1) Reservoir Inundation and Subsequent Successional Changes [23,33,34,38,39]

Certain general impacts occur in an area following closure of a dam and inundation of the reservoir area. Regardless of whether the area had a permanent or intermittent streamflow prior to dam construction, there is a distinct alteration of the environment. Stream characteristics are generally modified hydrologically, chemically, biologically, and physically.

The introduction of exotic aquatic biota into a reservoir may disrupt preexisting ecological balances both above and below the impoundment. Changes in the streamflow regimen below a dam will probably cause a reduction in overall area of the riparian vegetation and a loss of flood channel backwaters and potholes to successive stages of terrestrial vegetative growth. However, due to the reduction of floodflows and scouring action, the density of riparian vegetation remaining should increase along the new and more permanent stream channel. These changes in channel conditions will probably lead to changes in related faunal communities. These changes have already been experienced on the Verde River from Bartlett Dam to its confluence with the Salt River, the Salt River between Stewart Mountain Dam and Granite Reef Diversion Dam, and the Gila River between Coolidge Dam and the Ashurst-Hayden Diversion Dam. They are expected at the four reservoir sites in the CAP, as discussed below.

Following construction of a reservoir, the aquatic environment undergoes successional changes until an equilibrium is attained. This equilibrium may not be reached for a number of years, depending on the type and quantity of introduced biota. There is an initial surge in biological production in reservoirs due to the release of nutrients by decomposing submerged vegetation. The increase in

nutrient levels is reflected in an increase in growth rates and abundance of species of micro- and macro-flora and fauna. The reaction to a higher nutrient level ultimately results in an increase in basic production of the biota in a body of water. After a period of time, production stabilizes or declines, depending upon management practices. Production levels of game and nongame fish will increase after impoundment, but without proper management rough fish may predominate. Good management of a reservoir environment can result in a many-fold increase of desirable fish species over those produced in a stream environment. Benefits derived from such increase in the number and volume of reservoir fish are weighed against the detriment arising from alteration of the original stream. As a reservoir ages, further changes normally occur in the bottom fauna as a result of sedimentation. All these changes will be evident in the project reservoirs.

The impact of impoundment will result in changes in the fish fauna, displacing natives, except wanderers, in the reservoir areas and will influence their populations both upstream and downstream from the site in a detrimental manner. This will be due to introduction of competitors through stocking and use of bait fishes in reservoirs or movement of non-native fishes enhanced by the artificial conditions. Downstream, the decrease in heterogeneity of environment may be anticipated to produce monotony of fauna (fish or otherwise) to the detriment of native and perhaps resident non-native fishes. Specifics of vegetation and other losses and replacement of native species by increased populations of non-natives are described below under discussion of each reservoir. No endangered species of fish will be affected by reservoir construction.

The impact of impoundment on the terrestrial biota will be either to eliminate it (in the case of vegetation), cause it to increase or decrease, or cause it to move upstream or upslope. Here the animals will encounter habitats already occupied by others of their species, and there will be a brief period of adjustment involving the elimination of some animals. Riparian, terrace, and cliffside habitats which are flooded will be gone, and the fauna adjacent to the reservoir will depend upon the kinds of habitat present above the flood-pool margin. The impact on most forms of amphibians and reptiles will be to cause them to move upstream or upslope. A general numerical reduction is expected.

The building of the four dams and resulting reduction in invertebrate numbers will not threaten any of the biotypes of invertebrates that now exist at the reservoir sites. By replacing an area of riparian vegetation with a lake and shoreline environment, areas for additional forms of invertebrate life will be made available.

In general, the impact on bird species will be reduction in numbers of individuals and in divergence of species. Introduced species such as English sparrows and starlings will increase and proliferate in man's presence. Native species such as grebes, coots, and diving ducks that feed primarily on small fish or aquatic vegetation will also increase. Emergent vegetation which would support rails, bitterns,

or marsh wrens will be less prevalent. The forms most affected will be large raptors which require large trees for nesting and which rely on high density of fish, lizards, and small mammals for their food supply. Unless access to nesting areas is restricted, such as the eagle nesting area in the Tonto National Forest on the Verde River near the head of the Orme Reservoir site, molestation by people will drive away any raptors whose nest sites are not inundated. Other groups that will show marked decrease or elimination are solely dependent on the riparian habitat for their existence. These include: bitterns, Virginia rails, herons, flycatchers, thrashers, and towhees. Nesting habitat areas of mesquite and saltcedar for white-winged and mourning doves, will be eliminated.

It is more difficult to predict the effects of the reservoirs on mammals. Many are nocturnal and numbers and life history data are scanty or not available. An example is the spotted bat that has only been observed 4 times through 1967 in Maricopa and Yuma Counties in Arizona. Due to its natural rarity it will not likely be affected by the project. Those burrowing forms that do not exist out of the river bottom will be eliminated from the reservoir area, e.g., the southwestern pocket gopher, and populations of beaver and muskrat, which are less abundant now than they were in earlier years, except at the Hooker site, will be reduced even further and possibly eliminated from the reservoir areas because they do not do well in large lakes. The desert forms will decrease slightly because some of their habitat will be inundated.

Some rare or endangered species of birds, including the bald eagle, will be affected by reservoir construction and subsequent human use, more than direct habitat inundation. Several peripheral mammals will be likewise affected.

Contracts to obtain preliminary information on the biota of the reservoir sites were completed in February 1972. The six reports furnished to the Bureau of Reclamation under the contracts included lists of the invertebrates, vertebrates, and plants known or expected to be found in each of the reservoir sites. The reports also estimated the impact of dam construction on the biota in the area. Tables 1 through 16 in the Appended Material have been extracted from these studies. The Bureau of Reclamation will describe in greater detail the biota and the probable impacts on the biota at the four reservoir sites in the individual environmental statements for the reservoir features.

An explanation of how to use the tables follows:

(a) Fish, Amphibians, and Reptiles

For fish use Tables 1-4. Table 1 lists the native fish fauna at each reservoir site. By referring to this table, the range of each species of fish can be determined. Table 2 shows the ecological relationship of each native species. By comparing data from Tables 1 and 2 the probable impact on a particular species may be

observed. For example, if the impact on loach minnow, Tiaroga cobitis, in the Gila River at Hooker is desired, first refer to Table 1 which indicates that loach minnow are known to be present at that location. Then refer to Table 2 and it shows that this species prefers a sand/gravel bottom of moderate stability with a moderate to swift streamflow through riffles. From these data it is assumed that the loach minnow will not live in a reservoir environment; therefore, in the area to be inundated the loach minnow will be eliminated. Table 4 presents an estimate of the effect on non-native species of the presence of a reservoir. For example, the threadfin shad, Dorosoma petenense, can be expected to become established in Orme and Buttes Reservoirs, but not in the Hooker or Charleston Reservoirs. Table 5 lists the amphibians and reptiles in the four reservoir areas and Table 6 shows their ecological relationships. Amphibians and reptiles, because they are terrestrial, will be displaced from the area that is inundated. Depending on the amount of use by humans, most of these species will benefit by the presence of ponded water.

(b) Birds

Table 7 lists all the species of birds known to occur and those expected to occur at the four reservoir sites, and ecological and predicted impact data on each species. This is a composite list. Table 9 is a list of birds at Orme Reservoir, Table 11 of birds at Buttes Reservoir, Table 13 of birds at Charleston Reservoir, and Table 15 of birds at Hooker Reservoir. Tables 9, 11, 13, and 15 give the common and species names of the birds, indicate whether or not they nest at each site, and tell the status of their occurrence (e.g. common winter, irregular summer, etc.). By using these tables, the impact on any particular species may be estimated. For example, if the impact on the killdeer, Charadrius vociferus, is desired, first using Table 7 (second page) it indicates whether the killdeer is found in the reservoir areas. It is shown that this species is known to nest in the CAP project area on the ground. Its primary habitat is dense vegetation near water and its primary food is aquatic invertebrates. The expected impact of the CAP will be a marked decrease of this species in the areas to be inundated. The killdeer population found in the irrigated agricultural areas will not be affected as long as irrigated agriculture continues. Tables 9, 11, 13, and 15 indicate that killdeer are common residents to all four of the reservoir sites. From all these data, it may be concluded that this species will lose some of its habitat and will therefore be eliminated from the areas that will be inundated. This does not mean that the species cannot and will not be found in equal abundance after construction as it is at the present time in areas above and below the reservoirs that remain suitable habitat for the species. The same procedure as just described can be used for all bird species. These tables may be used in other ways too. If the number of species that will be expected to increase in abundance and the number to be eliminated from the reservoir areas following construction is desired, refer to Table 7. This table indicates that an expected impact of the project will be an increase in abundance of 34 species of birds, while 42 species will be eliminated from the reservoir areas.

(c) Mammals

Table 8 lists all the species of mammals known to occur and those expected to occur at each of the reservoir sites. This is a composite list and is set up like Table 7. Tables 10, 12, 14, and 16 are lists of the known and expected species of mammals from Orme, Buttes, Charleston, and Hooker Reservoirs, respectively. These tables indicate if a species is rare or endangered. By using these tables as described for the tables on birds, the impact on any species desired or the impact on numbers can also be determined. The impacts shown on Table 8, no matter what classification, are impacts for the reservoir area only. For example, the table suggests that the brush mouse will be eliminated from the area of impact. This means that in the area where there is a loss of riparian vegetation this species will be eliminated. Where riparian vegetation still occurs, such as upstream from the reservoir, the species will still exist.

(2) Orme Dam and Reservoir

(a) Inundation of Lands [201]

Orme Reservoir will influence about 10 miles of the Salt River and about 10 miles of the Verde River under normal operating conditions. At the active storage level, the reservoir will inundate about 9,700 acres of portions of the Salt River Indian Reservation, Fort McDowell Indian Reservation, and lands of the Tonto National Forest. In extreme flood surcharge conditions, a total land area of 24,000 acres could be inundated. (See Figure 27B.) The various land areas inundated by the various reservoir functional levels are as follows:

Function Elevation	Lands Inundated (acres) Ft. McDowell Indian Res.	Salt River Indian Res.	Tonto Nat'l. Forest	Total
1374	800	600	900	2,300
1437 *	5,400	900	3,400	9,700
1513.5 **	14,800	1,300	7,900	24,000

* Active storage level.
** Flood control and surcharge level.

The stretches of the Salt and Verde Rivers subject to inundation are intensively used for cattle grazing, off-road vehicle riding, and family-type recreation such as innertubing, picnicking, fishing, and camping. Some small game and varmint hunting exists as well. The flows of both rivers are primarily controlled and sustained by upstream storage reservoirs operated by the Salt River Project.

(b) Mineralization[163]

The abandoned Granite Reef (Arizona barite) mine, located on the proposed left abutment of the dam, is the only mineral

resource known to exist in the vicinity. At least 300,000 tons of the known ore body have been mined. Some reserves of unknown grade and quantity may still remain near the old workings. According to the Bureau of Mines, present ownership of the mine cannot be found in courthouse records.

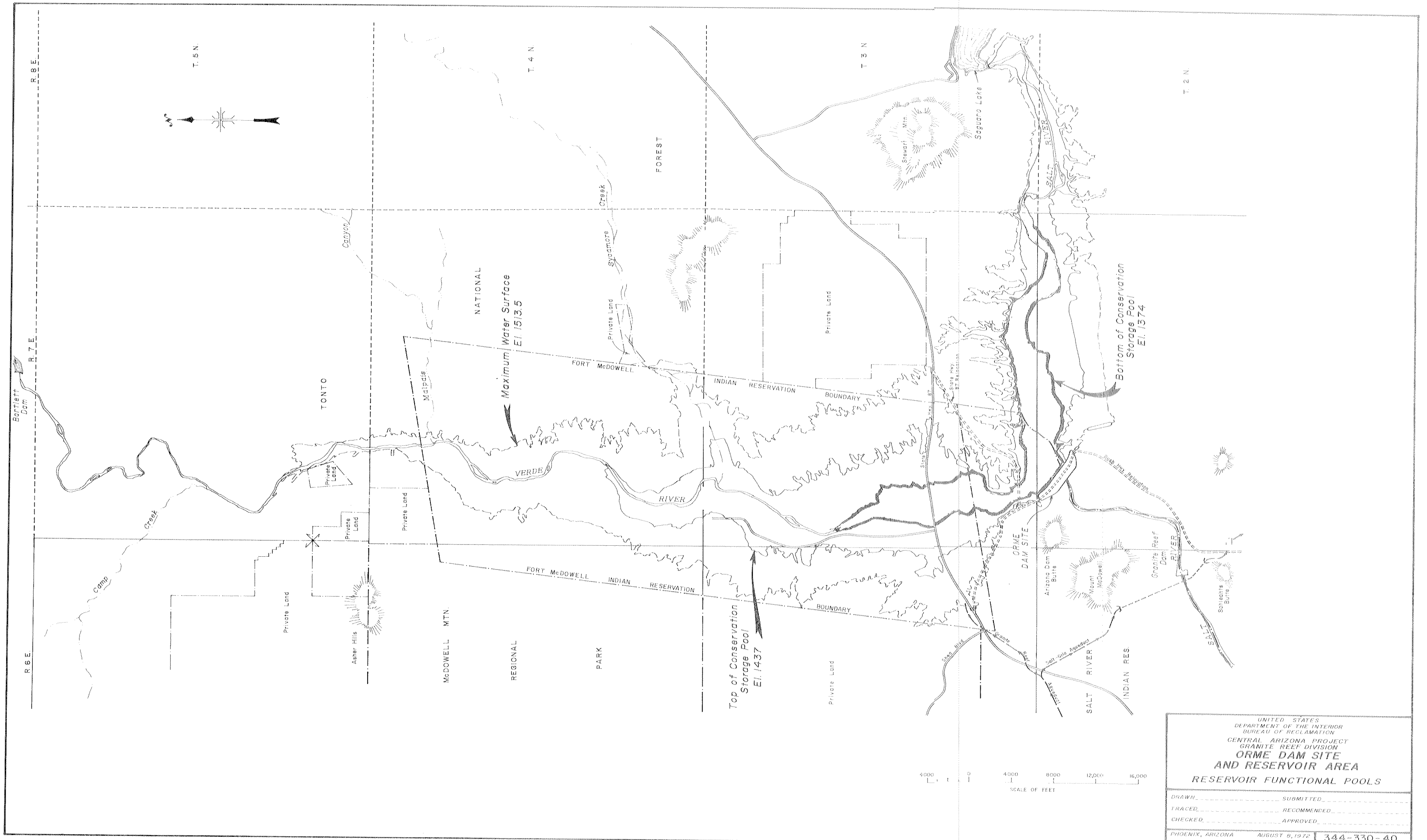
(c) Vegetation[23]

Approximately 3,500 acres of riparian vegetation and nearly all of the desert shrub will be removed up to elevation 1437. This will reduce debris in the reservoir, improve water quality, and facilitate safe boating. Between elevations 1437 and 1513.5 (the flood control and surcharge area), the effects of short-term inundation, generally less than 10 days, will have varying effects on vegetation, depending on the plant variety, depth of inundation, and frequency of occurrence. The area subject to short-term flooding is 14,300 acres.

The steep shorelines that are subjected to lake-level fluctuations will be barren. Vegetation will begin above the waterline where inundation will be less frequent. The gradual slopes, as on the south side of the Salt River and west side of the Verde River, will become plains with some silt mantling. Saltcedar will attempt to invade these areas when the lake level is low and will be inundated at high water. This will provide good potential spawning areas for large-mouth bass and good habitat for young-of-the-year. A few mesquite bosques will establish or expand on these broad slopes. The broad silt slopes will have a brief ephemeral establishment of herbs. The riparian vegetation will never reestablish in any area adjacent to the lake.

(d) Fish and Wildlife[33,34,38,39,66,71,176]

Wildlife range and habitat will be influenced by the facility and its hydrologic operation. Characteristic wildlife occurring in the reservoir area include desert mule deer, javelina, Gambel's quail, white-winged and mourning dove, cottontail rabbit, jackrabbit, bobcat, coyote, grey fox, skunk, badger, and various waterfowl. Reservoir operations will require removal of approximately 3,500 acres of riparian vegetation now serving as habitat for wildlife. Most wildlife species now in the conservation pool area of the reservoir will experience immediate displacement and will move to areas where riparian habitat remains or onto higher ground. Competition between species for available space will occur and some animals may be lost. There are no known endangered species in the reservoir area. However, there are two and possibly three pairs of bald eagles which nest in the area adjacent to the reservoir. An active bald eagle nest located near Malpais Canyon near the northern boundary of the Fort McDowell Indian Reservation and about three miles from the highest normal reservoir operational level may be disturbed by reservoir use. Control of access to the nesting area by Tonto National Forest restrictions will minimize any adverse effects.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION
ORME DAM SITE
AND RESERVOIR AREA
RESERVOIR FUNCTIONAL POOLS

DRAWN _____ SUBMITTED _____
TRACED _____ RECOMMENDED _____
CHECKED _____ APPROVED _____
PHOENIX, ARIZONA AUGUST 8, 1972 | 344-330-40

Figure 27B

Some 205 species of birds (of which about 72 use the area to nest) and 54 species of mammals range in the reservoir area. Tables 7 and 8 of the Appended Material catalog the species of birds and mammals and the projected impact of the reservoir on each. Some 88 species of birds commonly are found in the reservoir area, either during the summer or winter or year-round. Forty-five of these species use the area to nest.

While 15 native species of fish were known to inhabit the Orme Dam site area in the past, only 3 and possibly a 4th species presently are found in the area. These native species will be displaced from the reservoir area. No endangered species of fish will be affected by the reservoir. Some 34 species of non-native fishes now occupy the area within or upstream from the Orme Reservoir site. Of these, 25 will probably become established in the reservoir with an additional 4 species also likely to become established in the reservoir. Only 5 species are likely to be eliminated.

There are 59 known species of amphibians and reptiles in the reservoir area, 7 of which, while not uncommon, are not found at any of the other reservoir sites. All of these species will experience a nonsignificant decrease in number due to the inundation of the reservoir site with the exception of two species of turtle. No rare or endangered species of amphibians and reptiles will be affected.

At least 29 orders encompassing some 180 families of invertebrates are found in the Orme Reservoir area. Inundation of the site is not expected to have any material detrimental effect on any of these invertebrates.

The reservoir will introduce a fishery that will be heavily utilized, provided some areas are not subjected to heavy recreational use by high-speed powerboats. The reservoir surface area will range between 2,300 acres and 9,700 acres, except during flood control operations. An estimated average of 352,000 fisherman-use days of fishing annually will occur. With additional management improvements, an additional 115,000 fisherman-use days can be expected. There will be a loss of stream fishing in the 20 miles which will be inundated. However, reservoir releases could improve the quality of fishing in the 4-mile reach of the Salt River between Orme Dam and the existing Granite Reef Diversion Dam.

The area now provides an estimated 4,900 man-days annually of hunting. With construction of Orme Reservoir, hunting will decrease to about 600 man-days annually or less, depending on the amount of other recreation uses,and will generally be confined to waterfowl and small game hunting. The expected increase in human activity in and around the reservoir may ultimately reduce the numbers of the wildlife species now commonly utilizing the reservoir area and nearby foothills. Safety restructions on hunting and Indian community regulations and permit practices will also be a consideration in future use of the area for hunting.

(e) Recreation[54]

Orme Reservoir, to be located about 25 miles northeast of Phoenix, will attract water-oriented recreational activity including fishing, swimming, water skiing, pleasure boating, camping, and picnicking. Lands surrounding the reservoir are either Federal, private or Indian lands. Recreational development will conform to master planning criteria to be developed for the area as directed in authorizing legislation and approved by the Secretary of the Interior. Zoning of the reservoir area will be necessary to insure compatibility of the various uses, including wildlife needs. About 100,000 visitor-use days are expected in the initial years with increases to 1,500,000 visitor-use days by the 10th year.

Portions of the Verde and Salt Rivers are currently used for innertubing, picnicking, and other uses. These uses will be largely replaced by recreational uses common to reservoirs. About 15 miles of the Verde River from Bartlett Dam to the level of the conservation pool water surface of Orme Reservoir will ordinarily be available for river recreation, but the river reaches which are now most heavily used will be lost to this type of recreation.

(f) Archeological[41,46,177]

The normal operation of Orme Reservoir will inundate 10 of the 12 identified sites on the Verde River arm. Future studies will further evaluate these sites to determine specific needs for salvage work and will also resurvey both the Salt and Verde River arms in more detail. The initial phase of these studies was initiated in July 1972.

(g) Indian Lands[63,67]

The reservoir will adversely affect the Fort McDowell Indian community. About 53 families, composed of about 335 individuals, will require relocation. The relocation or memorializing of the tribal burial grounds and old Fort McDowell will be resolved during right-of-way negotiations. Approximately 14,800 acres of Fort McDowell lands will be required for the dam and reservoir. Of these, 9,400 acres of land needed above the conservation level will be available to the Indians for uses compatible with reservoir operations. As discussed in Chapter IV, 2,500 acres of Federal land will be added to the Indian reservation as partial compensation.

How the developed culture of this community will be affected is not fully known. The project influences will add to the cultural impact already being experienced by both the Fort McDowell and Salt River Indian communities as non-Indian development continues to move toward their lands. Loss of employment by the Indians due to inundation of the Verde River well field of the City of Phoenix is expected to be more than offset by employment opportunities at the dam and reservoir

with their expected operational and maintenance requirements, plus the employment generated by the recreation concession.

A portion of the dam and reservoir will lie on lands belonging to the Salt River Indian Reservation. Approximately 1,300 acres of Salt River Indian Reservation land will be required. Operations will not adversely affect any reservation residents. Orme Dam and Reservoir will be an economic benefit to this Indian community. The reservoir will not only provide a recreation attraction to higher elevation reservation lands but should, through flood protection, enhance the value of lower flood-plain lands located downstream from the dam.

The construction and operation of Orme Dam and Reservoir should economically bolster the general welfare of both Indian communities. Intangible cultural disruptions may never be mitigated.

(h) Water Rights [132]

Rights to the use of water from the Salt and Verde Rivers were adjudicated by the Kent Decree of 1910. The operation of Orme Reservoir will not interfere with existing water rights.

(i) Hydrologic Regimen [134,183]

Portions of the Verde and Salt Rivers will be inundated as mentioned earlier. More flood and sediment control will be provided. The periodic low flow years and the floodflow years will recur in the future as they have in the past. The magnitude of future flood spills will be reduced primarily in rate and some in volume.

(j) Water Quality

The operation of Orme Reservoir will not affect the water quality of the Salt and Verde Rivers except when used to store Colorado River water. When Colorado River water is stored in Orme Reservoir, the resulting mix with water from the Salt and Verde Rivers will be of lesser quality. Orme Reservoir will reduce turbidity by removing suspended sediments in storm runoff originating from the more than 400 square miles of uncontrolled drainage area below Bartlett and Stewart Mountain Dams on the Verde and Salt Rivers, respectively.

(k) Flood Control [190]

Flood control provided by Orme Reservoir will permit more effective and safe commercial and industrial use of lands along the downstream river areas. The control of floods will permit lengthening of the main runway at Phoenix's Sky Harbor International Airport. The ground transportation network for the metropolitan area will also be more fully protected. Metropolitan flood control plans are

coordinated with, and to a certain extent dependent on, Orme Reservoir. The proposed Rio Salado Project must also have this flood protection in order to be developed.

(1) Other

In addition to its role as a terminus and temporary storage facility for Colorado River water, Orme Reservoir will permit more effective conservation of floodflows occurring on the Salt and Verde Rivers. This will add to the supply of water available in the service area for beneficial use.

(3) Buttes Dam and Reservoir 82,172

(a) Inundation of Lands 63

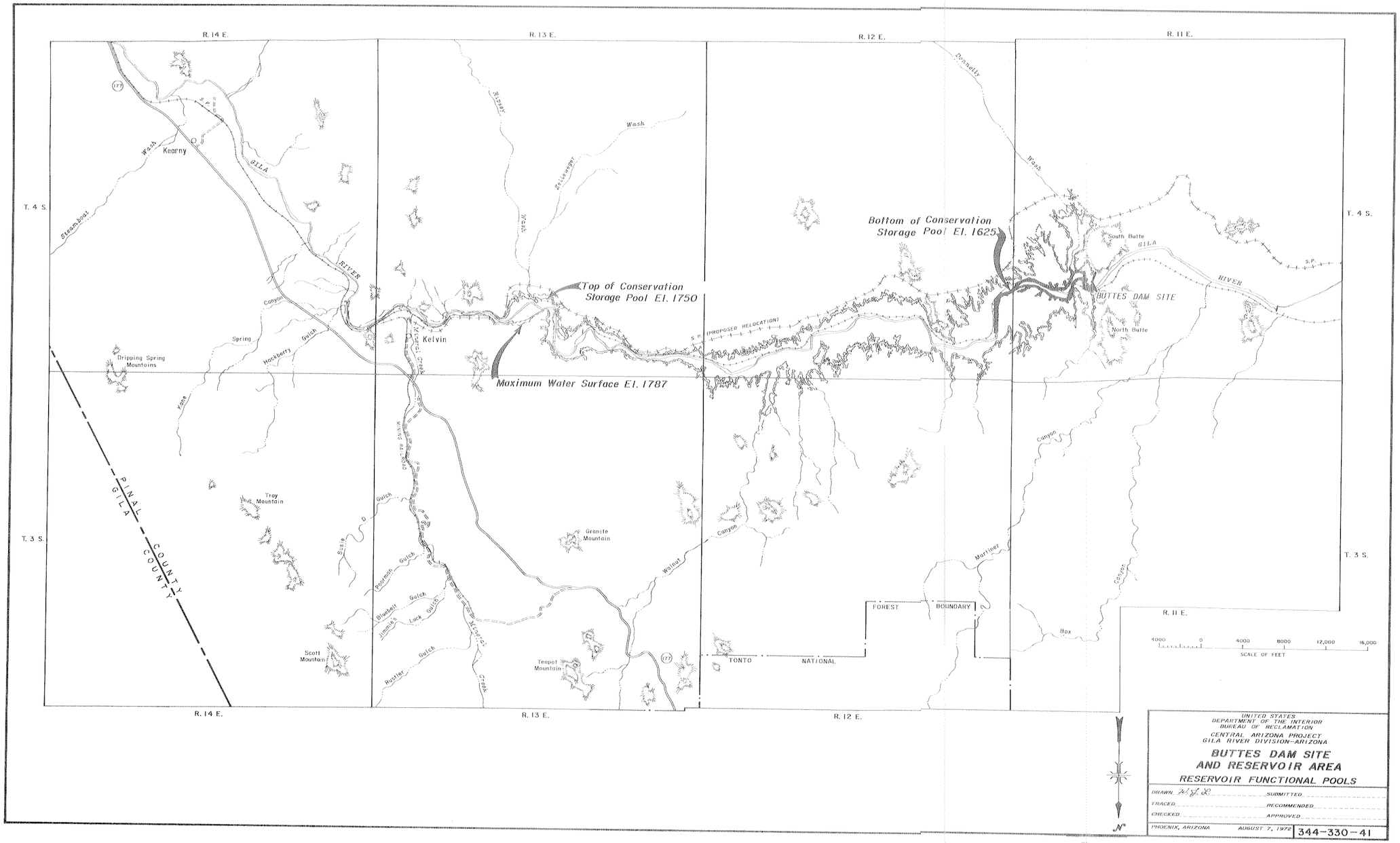
Buttes Reservoir will extend approximately 12 miles upstream on the Gila River and will inundate about 4,000 acres at maximum conservation level and about 5,500 acres at the maximum flood control storage level (Figure 27C). The areas inundated by the various reservoir functional levels are as follows:

Function	Elevation	Inundated (acres)
Sediment Control	1625	200
Conservation Storage	1750	4,000
Flood Control Storage	1778	5,500
Surcharge Control	1787.5	6,200

(b) Mineralization 48,175

The Bureau of Mines in its 1964 report suggested that construction of Buttes Dam should not be initiated until the mineral potential of the reservoir basin is explored adequately, the national significance of the submarginal rock is appraised, and the commercial grade ore, if any, is mined. While most of the area discussed in the report lies a considerable distance from the reservoir, some areas of indicated mineralization would be inundated.

Recent discussions with Bureau of Mines personnel and their 1972 report indicate that several mining companies are initiating exploration programs in several key areas. The programs should establish the occurrence or nonoccurrence of commercial-grade ore. These discussions also established the possiblity that in the event commercial-grade ore was discovered, mining activity could be compatible with the construction and operation of the reservoir.



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GILA RIVER DIVISION-ARIZONA

BUTTES DAM SITE AND RESERVOIR AREA

RESERVOIR FUNCTIONAL POOLS

DRAWN 2-4-72 SUBMITTED
TRACED RECOMMENDED
CHECKED APPROVED
PHOENIX, ARIZONA AUGUST 7, 1972 344-330-41

Figure 27C

There will be a period of at least 7 years before construction of Buttes Dam and Reservoir is completed. This period should be ample time to establish the existence of commercial-grade ore within the reservoir area and to evaluate the measures to be taken to extract the deposits or determine that they are not feasible for production.

(c) Vegetation[23]

The reservoir area to be impounded by Buttes Dam is under the influence of a controlled streamflow from the San Carlos Reservoir and uncontrolled flows from the San Pedro River and other tributaries. Controlled flow and resultant buildup of broad alluvial sandbars along the river have resulted in a replacement of native cottonwood, mesquite, and baccharis communities with saltcedar. Construction and maintenance of the railroad track through the area have permitted invasion of species such as stick-leaf and wild tobacco on the disturbed areas along the track. Baccharis often dominates in only a small strip on the sandbars and gravel terraces adjacent to the river. Saltcedar lines the riverbanks in narrow bands in some sections between the water's edge and the mesquite bosques. Immediately beyond the baccharis stands, away from the river, are communities of saltcedar and/or mesquite. Near the damsite where the valley is narrow, and along the riverbank fringes, the saltcedar stands are limited; however, upstream from the damsite the valley broadens and in conjunction with this, the areas of mesquite are more extensive. From a vegetational viewpoint, the saltcedar stands are quite homogeneous, the deciduous leaves forming a barren "forest" floor only interrupted here and there by herbaceous plants. A few dense stands of arrowweed are found where flooding has caused standing water and the consequent buildup of salt deposits after evaporation. Mesquite is found on the low flat terraces above periodic high water levels of the river. These stands are often associated with a dense cover of grasses.

Approximately 1,500 acres of riparian and allied vegetation up to elevation 1,750 will be removed in clearing operations to minimize reservoir debris, improve water quality, and provide safe boating conditions. Operating plans call for rapid evacuation of water in the reservoir down to the minimum recreation pool. The resultant impact will be one of loss of the present saltcedar stands and mesquite bosques and development of a barren area between the lake level and the high water mark. This shoreline area will be maintained in accordance with Reclamation policy and for recreational opportunities.

(d) Fish and Wildlife 33,34,38,39,66,71,78,80,81,108,176

The establishment of Buttes Reservoir on the Gila River should enhance overall fishery and wildfowl habitat. While a 12-mile reach of the Gila River will be inundated, controlled reservoir management will improve residual habitat conditions. The fishery is presently limited to warm-water species, mainly suckers, catfish, and minnow types. Terrestrial wildlife species occurring in the area include

rabbit, javelina, bobcat, deer, mountain lion, duck, dove, quail, and various other small mammals and birds. One endangered species, the bald eagle, is listed in Table 11 of the Appended Material as uncommon, but is not known to nest in the area. Bald eagles will likely avoid the area after inundation of the reservoir and the attendant increase in use of the area for recreation.

The area presently supports 100 bird species, of which 61 are common to the area (52 of which use the area for nesting). In all, 51 species of mammals are found in the area. The projected impact on each bird and mammal species is found in Tables 7 and 8 in the Appended Material.

Thirteen species of fish are thought to have occurred in the Gila River system at the Buttes Reservoir site. Of these 13 native species, only 2 are presently found in the area. Inundation of the area would eliminate these 2 species from the reservoir site. Of the 22 non-native species of fish found in the vicinity of Buttes Reservoir site, 15 and possibly one additional species probably will establish themselves in the reservoir, with 6 species not being able to do so. No rare or endangered species of fish occur in the area.

Fifty-four species of amphibians and reptiles occur in the Buttes Reservoir site area. None of these species are unique to the area and, with one exception, all will be eliminated from the area of the reservoir as a result of impoundment of water.

At least 28 orders and some 173 families of invertebrates have been identified in the reservoir area to date. Any immediate loss of habitat of one species due to impoundment will be replaced by another type of habitat allowing other species to become established.

The reservoir will provide considerable fishing, estimated at about 30,000 net fisherman-use days annually following full development. There will be an annual loss of about 200 man-days of big-game hunting, and 100 man-days of quail hunting. Presently, fishing and hunting activity along the Gila River in the reservoir site area is very small.

(e) Recreation [54,63]

Operation of the reservoir will provide water-oriented recreation activities including fishing, swimming, boating, camping, and picnicking. Some Federal lands adjacent to the reservoir should facilitate development. Some private lands may be needed to optimize potential benefits.

It is estimated that about 85,000 net recreation use days annually will ultimately be developed as a result of the reservoir. This includes the 30,000 fisherman-use days. These projected uses take into account present conditions without the project.

(f) Indian Lands [170]

For years the Gila River Indian community downstream from the Buttes Dam site and non-Indian irrigators of the San Carlos Indian Irrigation Project have sought development of Buttes Dam and Reservoir to control floods and attendant heavy siltation and to further conserve the flows of the San Pedro River and tributaries which enter the Gila River downstream from Coolidge Dam. The reservoir development will aid in reducing water shortages which prevent full utilization of Indian lands.

(g) Archeological and Historical Sites [41,46,177]

No prehistoric ruins of major significance have been identified to date within the Buttes Reservoir area. Excavation and studies of several prehistoric trash mounds have already been conducted by the Arizona State Museum under contract with the National Park Service. Five historic kilns used historically for the production of mesquite charcoal are located within the reservoir area. Their historic value in terms of possible salvage has not been determined. Further archeological examination is programed to determine the need for any mitigation measures for the reservoir area.

(h) Existing Facilities [178]

Buttes Reservoir will inundate about 15 miles of the Southern Pacific Railroad, which will be relocated. The impact is not expected to be significant and will be discussed in the individual environmental statement for Buttes Reservoir.

All relocation and/or removal of existing facilities within the area of the conservation pool will be completed prior to or during construction.

(i) Water Rights [11,150,151]

All Arizona rights and rights of Virden Valley in New Mexico to the surface flows of the upper Gila River were adjudicated by the Gila Decree of 1935 (Globe Equity No. 59). To maximize water conservation, operation of Buttes Dam will require mutual agreement between water users of the San Carlos Project and water users of the Gila Valley located upstream from Coolidge Dam. Additionally, water contractors receiving CAP water will have to agree to water exchanges as a qualification for receiving water.

(j) Streamflow Regimen [183]

The storage provided by the reservoir will eliminate much of the flooding experienced downstream from the damsite in the past. This will allow more effective use of Gila River bottom lands. The reservoir will also eliminate heavy siltation now occuring in the San Carlos Project diversion headworks and distribution complex. The releases

of stored water from the dam into the connecting canal will alter the overbank river habitat between Buttes and the Ashurst-Hayden Diversion Dam.

(k) Water Quality

The quality of water released to the project service area below Buttes Reservoir will improve. This will result from the effectiveness of the reservoir in trapping upstream sediment inflow. Some mine pollution occurring upstream is expected to be eliminated under new pollution control laws.

(4) Charleston Dam and Reservoir 75,172

(a) Inundation of Lands

Charleston Reservoir on the San Pedro River will extend about 9 miles upstream during flood conditions. At maximum conservation storage, the reservoir will inundate about 4,000 acres and during maximum flood control storage up to about 5,600 acres (Figure 27D). The various land areas inundated by the various reservoir levels are as follows:

Function	Elevation	Inundated (acres)
Sediment Control	4000	700
Inactive Storage	4010	1,000
Conservation Storage	4055	4,000
Flood Control Storage	4070	5,600

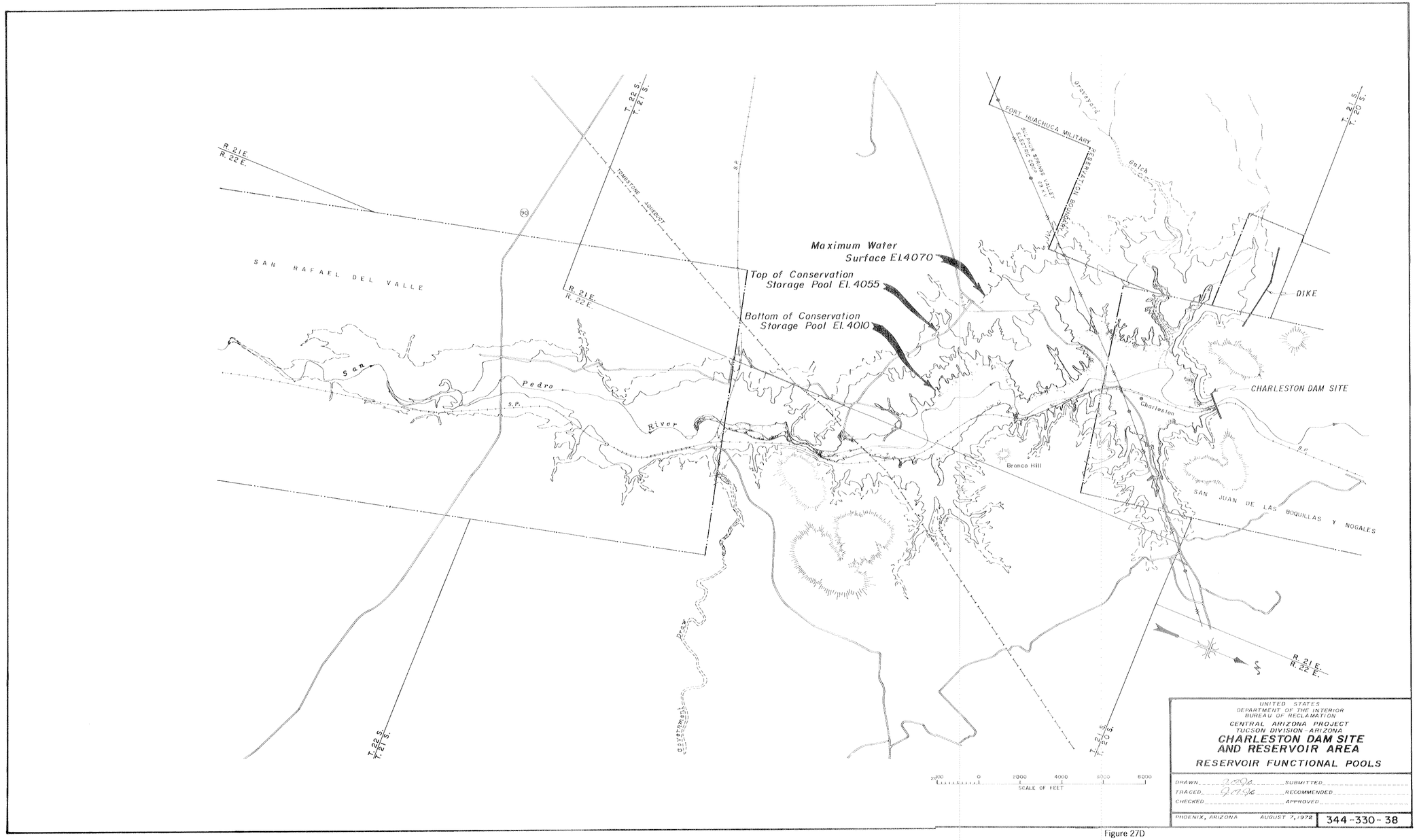
(b) Mineralization[49]

The now inactive mines of the Charleston district are within one mile of the Charleston Dam site. Parts of the district will be below the water level of the reservoir as now planned. Veins are present in extensively altered and weakly mineralized outcrops of the Bronco volcanic rocks. Commercial deposits of lead, zinc, or vanadium may exist in the volcanic rocks or more likely may occur in underlying sediments.

Oil or gas may be present in commercial quantities in the sediments underlying the reservoir site. Such deposits probably could be developed by directional drilling from the shore if a reservoir is established.

(c) Vegetation[23]

The construction of the reservoir will require clearing of approximately 4,000 acres of the riparian and desert shrub


Maximum Water Surface El. 4070
Top of Conservation Storage Pool El. 4055
Bottom of Conservation Storage Pool El. 4010
DIKE
CHARLESTON DAM SITE
SAN RAFAEL DEL VALLE
San Pedro River
Tombstone Aqueduct
Charleston
Bronco Hill
SAN JUAN DE LAS BOQUILLAS Y NOGALES
FORT HUACHUCA MILITARY RESERVATION
R. 21 E.
R. 22 E.
T. 22 S.
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2000 0 2000 4000 6000 8000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION - ARIZONA
CHARLESTON DAM SITE
AND RESERVOIR AREA
RESERVOIR FUNCTIONAL POOLS
DRAWN 7-28-72 SUBMITTED
TRACED 7-28-72 RECOMMENDED
CHECKED APPROVED
PHOENIX, ARIZONA AUGUST 7, 1972
344-330-38

Figure 27D

vegetation up to elevation 4055. Of the 4,000 acres, 670 acres are riparian growth, consisting of saltcedar, mesquite, baccharis, haplopappus, cottonwood, willow, and some sycamore.

The future impoundment will inundate the present riparian communities and low-lying desert shrub communities. Because there is no flow control upstream, the lake level will fluctuate, causing a relatively barren area to develop between the high waterline and the actual lake level. Mesquite and sacaton communities may establish in flatter areas just above the high waterline. Riparian vegetation is not expected to reestablish along the lake margin and development of marsh areas is highly unlikely. Other than loss of the present vegetation, the greatest impact will be on the vegetation downstream. Two small diversion dams below the Charleston Dam site exercise very minor control but do divert almost all of the low flows. Saltcedar is becoming increasingly established along the banks of the entrenched river channel. Construction of Charleston Dam will even more greatly control the flow of the San Pedro River and thus permit more extensive stands of saltcedar to establish. Species such as baccharis, mesquite, and willow, may decrease in abundance.

(d) Fish and Wildlife[33,34,38,39,66,71,108,176]

The Charleston Reservoir site has a relatively rich mammalian and avian fauna, but its animal composition is overshadowed by more diverse faunal areas which are nearby. Typical wildlife inhabiting the area includes javelina, deer, rabbit, quail, dove, and many varieties of small mammals and birds. One endangered species of bird, the bald eagle, is listed in Table 13 of the Appended Material as uncommon in the area. Recreational activity in the area of the reservoir will most likely keep any bald eagle away from the reservoir area in the future. One rare species of bird, the prairie falcon, is listed as an uncommon winter visitor to the reservoir area. Establishment of the reservoir will not affect it. Other wildlife now in the reservoir area will relocate upstream or on higher ground, but some numerical reductions can be expected and a few species will be eliminated from the area. The reservoir itself will provide new habitat for both fish and some species of wildlife.

There are 143 species of birds (60 of which use the area for nesting) and 65 species of mammals found in the area that will be displaced due to inundation of their habitat. Tables 7 and 8 in the Appended Material show the predicted impact on each species. Of the 143 species of birds found in the area, 85 are commonly found either in summer or winter or as year-round residents. Forty-five of these nest in the area. There are 58 species of birds not commonly or rarely or accidently found in the reservoir area. Fifteen of these species nest in the area.

At one time, the San Pedro River at and above the Charleston Reservoir site supported 10 and possibly 13 species of native fish. At present, two and possibly three native species exist in the

river. These native species will be displaced from the reservoir area. Eight and possibly nine non-native fishes are found within or upstream from the Charleston Reservoir site on the San Pedro River. These non-native fishes are expected to establish populations in the reservoir upon impoundment. No endangered species of fish is found in the area.

Sixty-six species of reptiles and amphibians are found in the reservoir site area. Eight of these species are unique to the Charleston site in comparison to the other reservoir sites. Impoundment of the reservoir will eliminate these species from the area of the reservoir. One species will be enhanced by the impoundment of the reservoir. There are no rare or endangered species of reptile or amphibian in the area.

Some 29 orders and 174 families of invertebrates have been identified in the reservoir area to date. Inundation of the Charleston site will not deplete the population of any species to any material extent.

Virtually no fishing now takes place on the San Pedro River. The development of the Charleston Reservoir is ultimately expected to provide approximately 180,000 fisherman-use days annually. The facility may also improve fishery conditions below the dam on the river.

(e) Recreation[14,54]

The Bureau of Outdoor Recreation has studied the need for lands around Charleston Reservoir for public use. An additional 1,150 acres of land will be acquired in connection with acquisition of reservoir land for such purpose.

It is estimated that the reservoir will provide from 270,000 recreation-use days annually in the early project years to about 435,000 recreation-use days in year 2000. These numbers include fishing activity. These estimates consider the recreation and fishing losses under nonproject conditions.

(f) Archeological[44,46,177]

A survey of the Charleston Reservoir area and surrounding area up to elevation 4200 was conducted by the Arizona State Museum, University of Arizona, under contract with the National Park Service in 1968. The total known number of sites within the survey area is 133. The survey area extended to elevations above the maximum water surface elevation and above the direct influence of the reservoir. These sites indicate both a long and a culturally diverse occupation by man in the river valley. Anglo-American, Mexican, historic Pima, prehistoric Hohokam, Cochise, and Clovis sites were represented. Of the 133 sites 21 have been recommended for further study and possible excavation. Thirteen of these sites are above the maximum water surface elevation of the proposed reservoir. It has also been suggested that an interpretive

center be included as part of the visitor center for the recreation complex.

(g) Water Rights

The dam and reservoir will be operated so as not to impair existing downstream water rights. The reservoir should aid in exercising existing water rights due to better control of the river.

(h) Streamflow Regimen 183

The storing of floodflows will change the regimen of the river downstream and may affect some riparian growth. All flows required to meet downstream rights will be released through the dam. Flood control at the reservoir will decrease the incidence of damaging floods on the downstream reaches of the San Pedro River Valley.

(i) Water Quality

The operation of Charleston Reservoir will improve the overall quality of the water. Sediment retention in the reservoir, especially during floods, will minimize turbidity below the dam.

(j) Land-Use Patterns 63,135,178

Land use of the reservoir area includes range cattle operations, the Southern Pacific Railroad, highways, mine workings, ghost towns of early small communities, and earlier ranch settlements now mostly abandoned. The reservoir area is almost all in private ownership. Portions of the Fort Huachuca Military Reservation join the western portion of the lower reservoir area. Portions of this have historically been used as an artillery impact area.

(5) Hooker Dam and Reservoir 169,172,189

(a) Inundation of Lands 51,63

The land areas to be inundated by the various reservoir functional levels (see Figure 27E) are as follows:

		Lands Inundated (acres)			
		Gila National Forest			
Function	Elevation	Forest	Primitive	Wilderness	Total
Sediment Control and Inactive	4780	580	---	---	580
Conservation	4863	900*	80	140	1,120
Flood Control and Surcharge	4890	1,070*	90	180	1,340

*Includes patented lands within the Forest

(b) Mineralization [50,159]

An investigation of mineral resources in the Hooker Reservoir site was made by the Bureau of Mines in 1964. The report reveals that only small deposits of fluorite of little economic value have been found and exploited in the past along the reach of the Gila River which will be influenced by Hooker Reservoir.

(c) Vegetation [23,37,52]

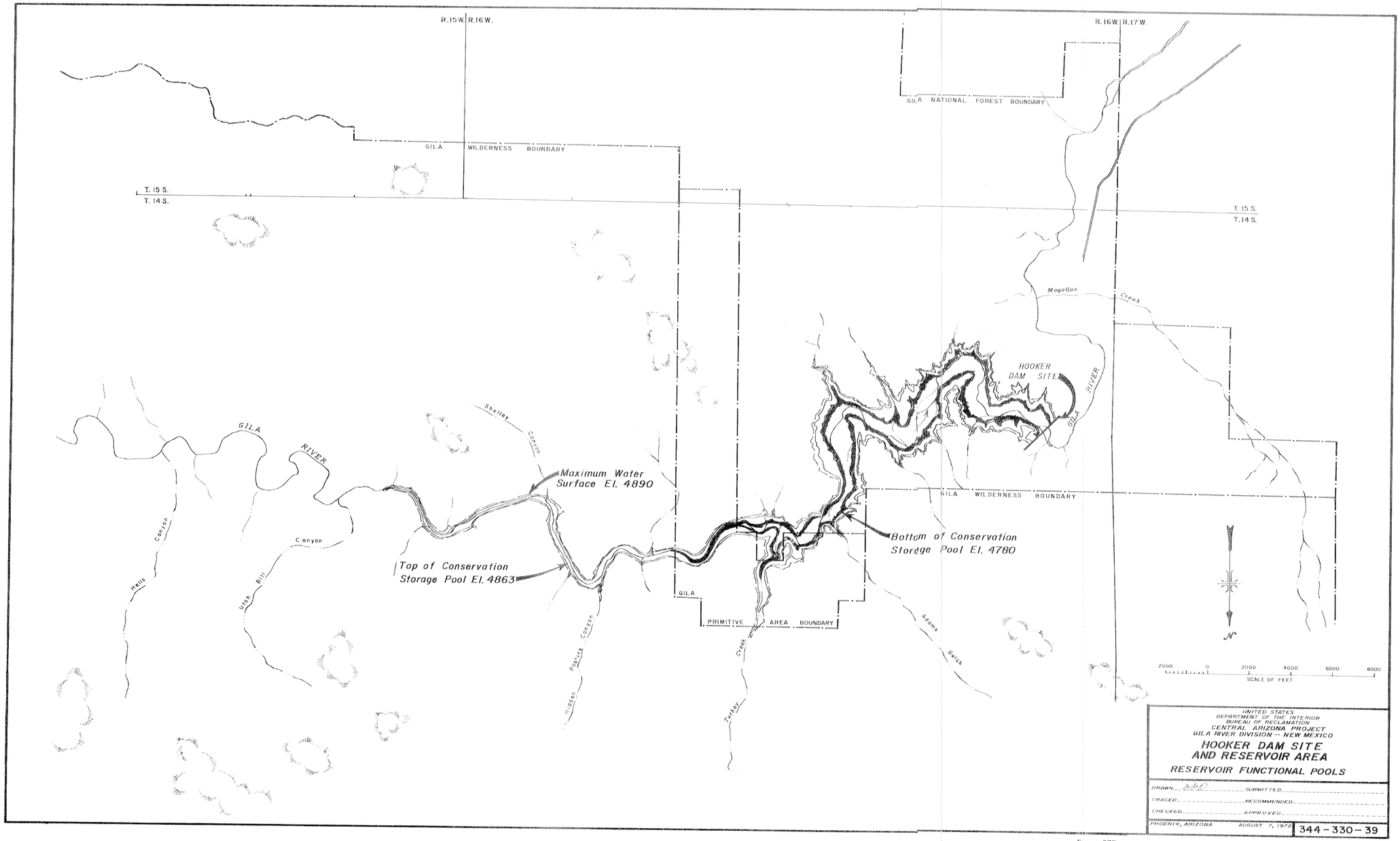
The reservoir will result in inundation of about 1,064 acres of vegetation. This consists of 112 acres of riparian shrub, 161 acres of riparian woodland, 289 acres of pinyon-oak-juniper, and 502 acres of xeric shrub.

Assuming the reservoir will not be stabilized at any level, the riparian communities will not reestablish on the lake margin. The vegetational communities found on slopes are all intolerant of wet conditions, even for a short period of time. These areas will have sparse growth of annuals that will reseed downslope with the reservoir drawdown. Large trees will be cleared from the reservoir area to eliminate debris and reduce potential operational problems. Barren areas will develop on the slopes between the actual water level and high water mark.

Marsh habitat is very limited in the upper Gila River Valley. Extensive marshes formerly existed near Mangas Springs on Mangas Creek, a tributary downstream from Hooker Dam site, where American bitterns were common. Existing marsh areas near Cliff will not be affected by Hooker Dam. No marshes will develop at the upper end of a reservoir at the Hooker Dam site.

(d) Fish and Wildlife [33,34,37-39,52,53,66,108,164,176,184]

The upper Gila River in the vicinity of the Hooker Dam site has changed little in character and faunal composition in the last few hundred years. This is due in part to the fact that the area has not been grazed as heavily as other areas, the area is less accessible to people, and the river channel is primarily parent material and less subject to change. The velocity of the moving waters combined with intermittent flooding tends to discourage or frequently sweep away any increasing beaver populations that tend to stabilize waterflow and allow soil deposition to support emergent vegetation. The Hooker site is more typically sonoran than chihuahuan in character and thereby supports a number of faunal elements more similar to Arizona than New Mexico. Certain species of birds have their primary center of abundance in New Mexico in this one particular area. In addition, mammals more typical of Arizona, such as the coati and javelina, are found there as well. The immediate impact of inundation of the reservoir site will be a loss of riparian wildlife habitat. The short-term effect of this reduced carrying capacity will be reflected in a displacement and loss of some wildlife. The long-term impact below the Hooker site will be partially alleviated


R.15W.
R.16W.
R.16W.
R.17W.
GILA NATIONAL FOREST BOUNDARY
GILA WILDERNESS BOUNDARY
T. 15 S.
T. 14 S.
T. 15 S.
T. 14 S.
Mogollon Creek
HOOKER DAM SITE
GILA RIVER
GILA RIVER
Shelley Canyon
Maximum Water Surface El. 4890
Top of Conservation Storage Pool El. 4863
Bottom of Conservation Storage Pool El. 4780
GILA WILDERNESS BOUNDARY
Hells Canyon
Canyon
Utah Bill
GILA PRIMITIVE AREA BOUNDARY
Hidden Pasture Canyon
Creek
Turkey
Adams Gulch
2000 0 2000 4000 6000 8000
SCALE OF FEET
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
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HOOKER DAM SITE
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DRAWN
SUBMITTED
TRACED
RECOMMENDED
CHECKED
APPROVED
PHOENIX, ARIZONA
AUGUST 7, 1972
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Figure 27E

by the net increase in riparian vegetation which should result from a stable, regulated flow of water from the dam into the river channel downstream, and the maintenance of ground-water level in the downstream valley. This long-term benefit is predicated on the assumption that recreational visitor use will not increase appreciably in the flood plain downstream from the dam and no extensive development will occur in this area.

There are 226 species of birds (111 of which use the area for nesting) and 68 species of mammals which will be displaced by inundation. The predicted impacts on each species of birds and mammals are summarized in Tables 7 and 8 in the Appended Material. Of the 226 species of birds, 66 commonly use the area in summer or winter or are year-round residents. Forty-five of these nest in the area.

There are 3 endangered species of birds - the bald eagle, Mexican duck, and peregrine falcon - which are classified as rare summer species in the Hooker Dam site area. The peregrine falcon will not be affected by the reservoir. Any infrequent use of the reservoir site by the Mexican duck and bald eagle will be terminated by inundation of reservoir lands. The prairie falcon, a rare transient in the area, will not be affected.

As with vegetation, the fish fauna of the upper Gila River has changed little. Whereas, the river in the vicinity of the Hooker site once supported seven and possibly two other species of native fish, it now supports six species. All six of these native species will not be able to survive in the reservoir environment. They may also be eliminated from the river below and above the reservoir unless artificially maintained. No rare or endangered species of fish is involved. The endangered Gila trout is found upstream from the Hooker Dam site in the headwaters of the Gila River in Diamond, McKenna, and Spruce Creeks, in the Gila National Forest and in McKnight Creek which is in the Rio Grande drainage. The upper Gila River in the vicinity of the proposed Hooker Reservoir also supports 18 and possibly 20 non-native fish species. Of these, 14 would probably establish themselves in the reservoir.

There are 62 species of amphibians and reptiles in the Hooker Reservoir area. One species of turtle will be enhanced by the reservoir. The remaining forms will be displaced from the reservoir area. No species of amphibians or reptiles in this area is on the endangered species list.

Some 28 orders and 171 families of invertebrates have been identified so far in the reservoir area. Construction of Hooker Reservoir will cause a loss of a variety of habitats that invertebrates live in. However, the reservoir will provide a different variety of habitats.

The New Mexico Department of Game and Fish responded to requests for comments on the draft statement by stating that alternate

site locations to the Hooker site could be destructive of habitat used by wildlife species rarely found in New Mexico. Location of the dam at either of two proposed alternative sites could inundate a portion of already scarce habitat now occupied partially or totally by these species in New Mexico. One important big-game species, the reintroduced Rocky Mountain bighorn sheep, could also be adversely affected by damsite selection. In addition, the Department felt that careful location of the upper Gila damsite would establish a valuable fishery and recreational facility. It is estimated that the Hooker Reservoir will provide 70,000 fisherman-use days annually. Stream fishing below the dam will increase to about 24,000 fisherman-use days annually.

(e) Recreation [54,63,184]

The Bureau of Outdoor Recreation estimates that Hooker Reservoir will provide about 11,000 recreation-use days annually in the early years of development, increasing to about 36,500 recreation-use days by the 50th year. Federal lands around the reservoir area should facilitate development of the needed facilities.

About 500 visitor-use days annually now occur in the Hooker area. For the most part, the same activity will continue under project conditions.

(f) Archeological [46,51,60,177,182,184]

In addition to Woodrow Ruin, mentioned in Chapter II, there are nine other archeological sites in close proximity to the construction site. Some of these sites may need to be salvaged prior to construction of the dam and reservoir. Additional studies are necessary to fully evaluate these, as well as other sites that may exist in the area. The results of future studies will be reflected in the individual environmental statement on Hooker Dam and Reservoir or alternative site. A program has been initiated to determine the archeological impact of the several alternative structures.

(g) Wilderness and Primitive Areas [51,141,184]

Hooker Dam and Reservoir will result in the inundation of a small portion of the Gila Wilderness Area and the Gila Primitive Area. During normal reservoir operations, up to 140 acres of wilderness area and 80 acres of primitive area will be affected. Up to 180 acres of wilderness area and 90 acres of primitive area will be inundated during extreme flood conditions. The narrow penetrations of the impounded waters at maximum water level will extend across the narrow north-south leg of the primitive area (about $\frac{1}{2}$ mile wide) and into the wilderness area for an additional 4 miles on the Gila River. On Turkey Creek, the penetration will extend across the primitive area, which is about 0.6 mile wide at this point, and into the wilderness area for only about $\frac{1}{4}$ mile (see Figure 27E).

(h) Water Rights [8,9,11,150,151]

Several different procedures have been applied in determining rights to water use in different sections of the Gila River

in New Mexico. Water rights to flows of the Gila River in New Mexico have been adjudicated by the State of New Mexico, confirmed by the Arizona v. California Decree and in part by the Gila Decree. Public Law 90-537 allocates to the State of New Mexico an average annual supplemental consumptive use of 18,000 acre-feet from the Gila River, including evaporation losses. The average figure is based on any 10-consecutive-year period. This supplemental consumptive use must be exercised without imposing economic injury to downstream water contractors.

(i) Streamflow Regimen [135,183]

Hooker Reservoir will store and regulate large and infrequent floodflows. As required to meet the Gila Decree, lesser flows will be bypassed as natural flows so as not to interfere with downstream direct flow rights. Storage in the reservoir will occur only when such flows would otherwise accrue, unused, to the storage right in San Carlos Reservoir. These stored waters are to be used exclusively for the additional consumptive use in New Mexico and no direct benefits will accrue to Arizona water users. There will be no reregulation of most natural flow occurring upstream from the Hooker site. This may have an effect on downstream riparian growth, possibly more on the cottonwood which requires a certain amount of flooding to assist in establishing its growth. Otherwise, flows will continue to downstream users, less the depletions incurred as a result of authorized supplemental uses.

(j) Water Quality [144]

The water quality of the Gila River below the dam will be improved slightly due to diminished sediment flow during high floods. It should be noted that the waters of the Gila River at this point of the system have higher fluoride concentrations than are presently acceptable for domestic and municipal use by U.S. Bureau of Public Health Standards. These concentrations range upward to nearly 4 ppm during periods of minimal flow. The fluoride concentrations result from natural leaching of local fluorites and not from commercial operations in the area.

(6) Fish Hatcheries [76]

One warm-water and two cold-water fish hatcheries will be provided as discussed in Chapter IV. These hatcheries will have a beneficial impact on the fishery and recreational resources of the project area, facilitating optimum management and development of these resources in and near the four proposed reservoirs.

e. Irrigation Distribution System [75]

As described in Chapter I, Public Law 90-537 requires irrigation conservation practices, such as lining of irrigation canals, or

pipeline distribution system. These practices will have a beneficial impact on the water resource in the central service area by reducing evapotranspiration and seepage losses and promoting more efficient application of project water. At the same time, the reduction of seepage losses will reduce the ground-water recharge in some areas. The placing of existing unlined canals in underground pipe systems will reduce maintenance costs, safety hazards, and the amount of land used for open ditches.

f. Drainage and Reuse Facilities 75,173,174

Drainage and reuse facilities will also have a beneficial impact. Recapture of drainage flows with or without effluent treatment will conserve water and supplement downstream supplies as well as direct user supplies. Waste water treatment and recycling by metropolitan users will increase this benefit. Depending on methods ultimately employed for use of reclaimed flows, streamside and swampy habitat conditions on the Salt and Gila Rivers could be affected.

g. Transmission System 69,118,167

The CAP transmission system will consist of high-voltage transmission lines, distribution lines, feeder lines, and two new intermediate substations, as described in Chapter I. The transmission lines will generally parallel existing transmission lines or be constructed on existing right-of-way. In areas where existing right-of-way is not sufficient or the environmental considerations indicate that the lines should be located elsewhere, additional right-of-way will be required. Since the new lines will parallel existing facilities as nearly as possible, additional access roads for construction and maintenance will be held to a minimum. Design and location of the transmission lines and substations will conform with the "Environmental Criteria for Electric Transmission Systems," as published by the Departments of the Interior and Agriculture. These criteria have been developed to minimize the effects of transmission line construction on the environment. Other appropriate environmental design criteria, such as the Western Systems Coordinating Council's "Environmental Guidelines," will also be used. In order to further minimize impacts, existing transmission lines will be rebuilt for CAP use wherever possible. Distribution lines will be required from the high-voltage transmission lines to provide the necessary power to all of the CAP pumping plants. All of the new distribution lines will require acquisition of right-of-way for construction and maintenance. In addition, feeder lines will be required to provide electrical service to the check structures along the aqueducts. These feeder lines within the aqueduct system right-of-way will be located underground to the extent practicable.

The impacts of the CAP transmission system will be similar to those described in the Navajo Project environmental statement. Some right-of-way will be acquired and some vegetation thereon will be lost during construction. Vegetation losses will be minimized by choice of

route alinement and clearing of only selected areas where necessary. Areas requiring clearing will generally be restricted to the tower footings, substations, switching station sites, and operation and maintenance roads. In view of the terrain involved, the area under the conductors will generally not require clearing. Wildlife will undoubtedly be disturbed during construction of the system. The presence of the system will also have an esthetic impact, which should be relatively small in light of the use of existing right-of-way and the presence of existing facilities.

h. Communication System

A communication system will be necessary to provide monitoring of the various pumping plants and aqueduct checks associated with the CAP. In general, the communication and microwave systems required on the CAP will utilize already existing and developed sites on the Parker-Davis system. It will probably not be necessary to make new entries in remote areas. Data acquisition and control from the various check structures will be provided by buried cable from the pumping plant sites. The minimum excavation required for burying the cable will be accomplished in conjunction with aqueduct and pumping plant construction. The communication system will have no identifiable environmental impacts not associated with the major features of the project and otherwise discussed herein.

5. Local and National Economic Impact Resulting from Project Construction

The CAP is estimated to require ten years to construct, although actual construction time will be dependent on the availability of funds. About $480 million will be paid in wages during the construction period. This will, in turn, stimulate retail, service, and wholesale segments of the economy, especially in Arizona. During construction, about 36,000 man-years of labor will be required - 27,000 onsite and 9,000 offsite. Approximately $720 million will be expended for equipment, materials, and supplies. Twenty-five percent of this amount will be spent in Arizona. The other 75 percent will be spent in other parts of the country. The total value of business received from CAP, distributed geographically, is shown on Figure 28.

As examples of the materials and supplies that will be required during construction, it is estimated that over 940,000 tons of cement will be required, all of which will probably be manufactured in Arizona. Some 3.5 million cubic yards of concrete and over 240 million pounds of reinforcing and miscellaneous steels will be required for the entire project. Earth movement for dam and aqueduct construction will total about 140 million cubic yards.

On the average, about 3,600 jobs annually will be provided by private contractors during the construction period. This figure represents direct employment on project construction and does not reflect

other support jobs generated by this increase in employment. After construction is completed, approximately 225 people will be required to operate and maintain the project works. At the peak of construction, about 600 people will be employed by the government.

After completion of the project, annual expenditures for its operation, maintenance, and repair are estimated at about $13 million. Of this amount, approximately $11 million per year will be expended locally for wages, equipment, and supplies. The remaining $2 million per year will probably be expended elsewhere for replacement equipment.

6. Impacts Related to Physical Operation and Maintenance of the Project

a. Operation

Automatic controls for operation of the dams, pumping plants, and switchyards will minimize human activities at these facilities, resulting in less attendant disturbance. There will be a constant low-intensity sound from within the immediate area of these facilities. Pumps and motors will be enclosed within a building, minimizing sound. The transformers located outside the pumping plant and surrounded by an enclosing fence will have a low humming sound. In addition, lights will be provided at these structures to facilitate safety, observation, and maintenance activities during the night.

The low-intensity sound and light levels due to illumination at night will not have a significant impact on wildlife or on human activity, since the facilities will be located in remote areas away from population centers. Noise and light will be buffered by using shielding and screening consisting of baffling, vegetation, walls, and other devices.

Fluctuating water levels both in the reservoirs above and in the streams below Orme Dam and other project dams, will affect recreation activities and facilities, causing temporary inconvenience to recreation users, and having possible minor adverse impacts on fish and wildlife. To the extent possible, project facilities will be operated so that changes in reservoir water levels will occur over a period of time to minimize any adverse effect on fish and wildlife. In the case of game species of fish, control of water levels may actually enhance spawning and hatching during certain periods of the year. Proper planning of recreation facilities with floatable docks and walkways will aid in adjustment and reduce inconvenience to recreational users. To the extent possible, releases from project dams will be controlled to provide for a rather constant flowing stream with fishing available, although daily changes in flow rate may be noticeable in the channels. This added control will be beneficial to fishing since present channel conditions, i.e., high floodflow or dry streambed downstream from Charleston and Hooker Dams, preclude a stable fishery resource. This control will also enhance recreational uses. These regulated flows and those in the aqueduct system will provide a more dependable water resource which will enhance wildlife use of the area near project facilities.

VALUE OF MATERIALS, EQUIPMENT AND SUPPLIES NEEDED FOR PROJECT CONSTRUCTION GEOGRAPHIC AREA

(IN MILLIONS OF DOLLARS)

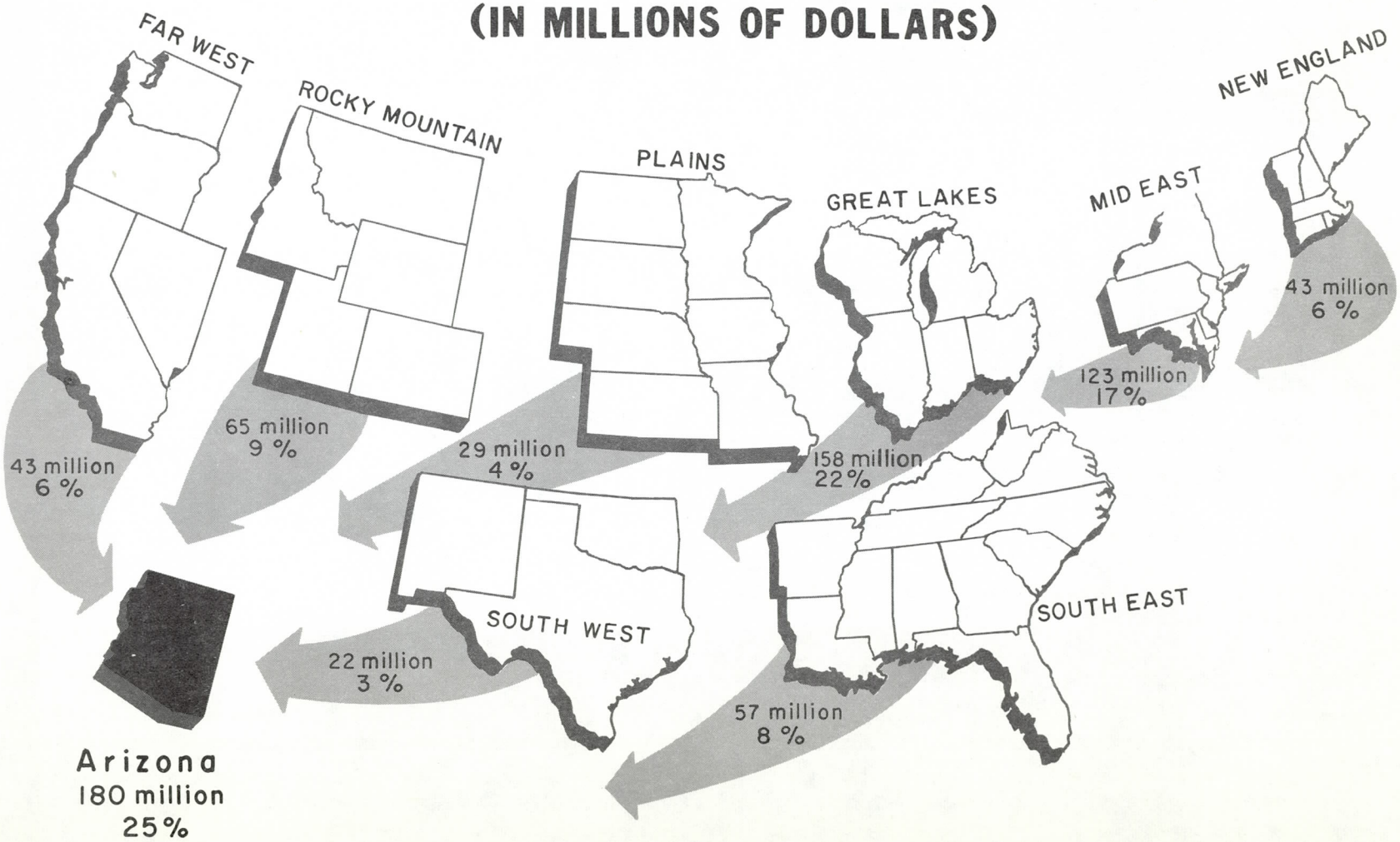


Figure 28

b. Maintenance

Human activities and vehicular traffic along project maintenance roads, coupled with daily patrol of the aqueducts, will cause minor disturbance to wildlife in remote areas and to people in urban areas residing near project facilities. The use of fencing and gates to control access to project facilities will help minimize the disturbance. Also, restriction of maintenance traffic to daylight hours, except under emergency conditions, will minimize any disturbance of nearby residents.

Operating plans call for an annual 1-month dry-up for repair and painting of underwater features, such as gates, gate-lifting devices, pumps, and appurtenant equipment of the aqueduct system. In addition, there may be an emergency dry-up of part of the aqueduct system due to storm damage. Periodic drainage, as well as accidental outage, will cause a minor loss of any aquatic fauna and plants in the system, along with the disruption of some wildlife use patterns in the immediate area. Because the aqueducts are designed with checks about every 7 miles, only the section requiring maintenance will need to be drained while the rest of the aqueduct will remain full, limiting the temporary adverse effect to the section being serviced.

Aquatic weeds, mosses, algae, ditchbank weeds, and fresh water clams will need to be controlled in the aqueducts and related conveyance systems. Unchecked aquatic growth has been shown to reduce water carrying capacity of similar systems up to 80 percent of their designed capacities. Present plans call for control of this growth by using mechanical means such as chaining. Biological controls are also under study. In the Yuma, Arizona area, the introduced tilapia, Tilapia mossambicca, has been successfully used in drains to control pond weed and algae. This fish consumes aquatic growth, but dies when the water temperature drops below approximately 55°F. Canal temperatures in the CAP will vary between about 50°F. and 90°F. Other biological controls are being developed. Problems associated with introduced species will be thoroughly studied before any such program is initiated for the CAP. Limited use of herbicides and pesticides may be required to control the adverse hydraulic effects upon aqueduct systems of invading biota such as aquatic growth and fresh water clams. Use of these chemicals will be kept to a minimum and only registered and approved chemicals will be used. Any such use will be strictly controlled under policies and regulations of the Department of the Interior and the Environmental Protection Agency. The use of chemicals as is determined necessary may have adverse effects on the biota in the aqueduct system. Care will be exercised to prevent possible adverse effects on wildlife and other animals and to protect domestic water supply.

7. Indian Water Rights Affected by the Project [8,9,11,150,151]

Concern has been voiced relative to the effect of the project on existing water rights of the Indian reservations in the lower Colorado River basin and the ultimate allocation of water to reservations in the central service area.

The five Colorado River main stem reservations below Hoover Dam have had their water rights adjudicated and decreed by the Supreme Court in the case of Arizona v. California.[8,9] These are the Fort Mohave, Chemehuevi, Colorado River, Yuma, and Cocopah reservations. Their diversion rights provided under the decree are presented in Table 14. These decreed water rights, including those not presently utilized, will not be affected by the diversion of water to central Arizona. In addition to these five main stem reservations, the water rights of 18 other reservations were asserted in Arizona v. California, but not adjudicated. These 18 reservations claimed only rights on tributaries, rather than rights on the main stem of the Colorado River. This fact alone should prevent the possibility of CAP interfering with these rights. In any event, the CAP will not be operated in derogation of these or any other unadjudicated prior rights.

In any period during which reduced storage and discharge cause there to be insufficient water supply to satisfy the requirements of all main stem water users, main stem water rights of earlier priority than CAP - including Indian, contract and other rights - will be satisfied first and diversion amounts for the project will be reduced accordingly.

Reservations located in the central service area have asked the Secretary of the Interior for project water to augment existing supplies and to develop new lands. These are the Fort McDowell, Salt River, Gila River, Maricopa (Ak-Chin), and Papago reservations. Project water will aid in the expansion of planned municipal, industrial, and agricultural projects on the reservations.

Water rights for the Fort McDowell Indian Reservation land to be occupied by Orme Reservoir will be recognized. The replacement of 2,500 acres of land to this community will be for its beneficial use and development. The Salt River Indian Reservation's existing water rights will be unaffected by the operation of the aqueduct system or the Orme Dam and Reservoir.

The Gila River Indian Reservation includes land, with decreed water rights under the Globe Equity No. 59. These water rights are recognized in the operation criteria for the Buttes Dam and Reservoir.

The Maricopa, Papago, and San Xavier Indian Reservations have no reliable surface water supply and rely upon ground-water pumping to provide for their consumptive use requirements. They look to an allocation

TABLE 14

DIVERSION RIGHTS (ACRE-FEET) OF EACH OF THE [1] COLORADO RIVER MAIN STEM INDIAN TRIBES AS PROVIDED UNDER THE SUPREME COURT DECREE IN ARIZONA V. CALIFORNIA

Tribe	Arizona	California	Nevada	Total
Fort Mohave	96,416	13,698	12,534	122,648[2]
Chemehuevi	0	11,340	0	11,340
Colorado River	662,402	54,746	0	717,148[2]
Yuma	[3]	51,616	0	51,616
Cocopah	2,744	0	0	2,744
Totals	761,562	131,400	12,534	905,496

1/ From Bureau of Indian Affairs (PSWP - January 1964).

2/ The Supreme Court did not determine boundaries in cases of controversy. Figures shown are those recommended by the Special Master, and subsequently adopted by the Court in its decree.

3/ Indian Homesteads included with non-Indian lands of Yuma Project (USBR).

of CAP water from the Secretary of the Interior for their beneficial use and development.

D. Indirect Impacts of the Project

1. Relationship of the Project to Population Growth 1,126,127,129, 133

One important consideration concerning the CAP is the effect of the project on population growth and land use. It is expected that the CAP will have little, if any, effect upon population growth. The rapid population growth that has taken place in central Arizona since World War II has occurred without the availability of Colorado River water and has contributed to the present water supply problem. It is expected that population growth will continue in the future, although at a somewhat lower rate, regardless of whether or not the CAP is constructed. Supplemental Colorado River water from the CAP will probably be used to the greatest extent as replacement water for high cost, pumped ground water. Its effect will, therefore, be to reduce the rate of ground-water depletion, thus prolonging the life of the available ground-water supply rather than to make additional supplies available for consumptive uses.

An increase in the available water in the area will provide additional capacity and flexibility in meeting the demand for water imposed by agriculture and expanding industrial and municipal sectors of the economy. These elements (capacity and flexibility) will make it easier to find a reasonable balance between existing agricultural demands and the anticipated urban demands. Absolute levels of urban population and economic activity will not be affected significantly by the project. The additional water supply made available by the project will increase the options regarding distribution of growth to a limited degree.

Shown below are population predictions for the area included in Maricopa, Pima, and Pinal Counties.

Year	Population	Population Growth Rate
1980	1,730,400	1980
		2-3/8%
2000	2,750,000	2000
		1-7/8%
2030	4,700,000	2030

The Office of Business Economics has projected populations for the lower Colorado River region and the United States as a whole. The figures are shown on the following page.

Year	United States Population	Rate	Year	Lower Colorado River Region Population	Rate
1980	234,208,000		1980	2,585,970	
		1-3/8%			1-11/16%
2000	306,782,000		2000	3,588,508	
		1-3/8%			1-7/16%
2020	399,013,000		2020	4,789,590	

Population is shown to increase at a decreasing rate. It is anticipated that the area's rate will approach a National rate of about 1-3/8 percent by the end of the study period shown above.

The Office of Business Economics' population projections presented here are those currently being considered by the National Water Resources Council as the population background for all Federal land and water resource planning.

2. Changes in Patterns of Water Use 1,134,139,140,168

As the population and industrial growth continue in the project service area, there will be a continuing conversion of irrigated lands to urban use. As this land use changes, the water use associated with the land will also change. The areas with the strongest potential for conversion include a high proportion of lands which hold basic surface water rights.

Most of the project water supply will initially be allocated and predominantly used for irrigation. As municipal and industrial requirements increase, especially on those lands not having an adequate supply or safe ground-water yield, then the proportion of M&I to irrigation use will also increase. The initial water allocation assignment for M&I purposes was 312,000 acre-feet annually as a maximum for project analysis purposes. Present partially completed studies by the Arizona Water Commission have used a quantity in the magnitude of 500,000 acre-feet.

E. Unquantified Amenities

Some aspects of the CAP remain unquantifiable. For this reason, it has been impossible to determine the extent of the impact, if any, which these matters will have in the project area. The purpose of this section is to recognize matters about which such assessments have not yet been possible so that methods and procedures may be developed to study and consider them.

1. Some effects of the Orme Reservoir on the Fort McDowell Indian community have not been projected over a long period of time. Although the exact acreages to be inundated and the numbers of Indians to be relocated can be determined, prediction of the cumulative social and

economic effects on the community can be made only with specific assumptions which are hypothetical with respect to cultural integrity and identity, education, and similar factors.

2. The effects of the reservoirs and aqueducts on some mammals cannot be accurately predicted. This is mostly due to a lack of information about the habits of some mammals, especially nongame species. The extent of displacement and subsequent unsuccessful competition for habitat niches in other areas are unknown at this time, as well as the migration from one river riparian area affected by a reservoir to another riparian area.

3. The effect of the aqueducts on the desert bighorn sheep populations cannot be accurately predicted. The impacts on these animals are dependent upon the extent of wandering beyond their present normal territorial limits to refill historical niches now vacant; the effectiveness of the protective measures which are to be installed along the aqueducts, such as fencing, watering ponds, escape facilities and bridges; and the effectiveness of game and land management programs to protect the integrity of their present habitat or vacant niches.

4. There will be an effect on the patterns of land use, especially in irrigated agriculture. These changes will result from a variety of developments, including population growth, industrial growth and CAP construction. It is not possible to delineate CAP's projected contribution to these changes at this time.

5. It is possible that some of the alternative sources of water described in Chapter VIII may eventually be developed for use in the project area as additional supplement. These would change the water supply outlook and could allow different water use patterns. However, the contribution of supplemental water to existing resources depends on future technological advances and cannot be presently predicted with any certainty.

6. The exact impacts of the importation of CAP water on water quality, soil fertility, and land subsidence are not known at this time. Studies to date show no material adverse impact on water quality and soil fertility from application of surface water. The rate of land subsidence is expected to be reduced in the central service area. Definitive assessments of these impacts cannot be made prior to construction and operation of the project.

7. A small portion of the primitive and wilderness areas will be needed for Hooker Reservoir. While this will be a physical infringement on these areas, use of the area for the reservoir is permissible under Section 4(d)(4) of P.L. 88-577 if it is determined to be in the best interest of the people. However, the emotional effect of such use is difficult to quantify.

CHAPTER IV

ENVIRONMENTAL CONSIDERATIONS INCLUDING MITIGATION AND ENHANCEMENT FEATURES INCLUDED IN THE PROPOSED ACTION

IV. ENVIRONMENTAL CONSIDERATIONS INCLUDING MITIGATION AND ENHANCEMENT FEATURES INCLUDED IN THE PROPOSED ACTION

A. General

This Chapter is concerned with the presentation of an overview of the tangible environmental considerations of the CAP. They are presented and evaluated as three subject headings, i.e., 1) standard Reclamation rules for design and construction; 2) protective measures and mitigation features included under P.L. 90-537 as a project cost; and 3) proposed enhancement measures not authorized under Public Law 90-537.

Standard policy under which the Bureau of Reclamation operates provides criteria for improved appearance of structures and preservation of landscape at all installations. These criteria are applicable in the planning, design, and construction of all facilities in an effort to minimize the impact on the environment.

Measures included are those which have been adapted or added to the project in order to provide environmental protection. Mitigation features are included in the project as replacement or substitution for losses incurred as a result of project construction. Protective measures and mitigation features are provided to protect fish and wildlife, recreation, esthetic values, and other environmental qualities.

Potential enhancement not yet authorized includes additional features that are recognized by the Bureau of Reclamation and recommended by cooperating land-use agencies as being desirable, beneficial, and important undertakings, but which were not part of the project during the Congressional authorization process.

1. Research and Monitoring 165,166,200

In order to fully evaluate the environmental impact of the CAP, a broad program of research and monitoring is being developed. This program will include all aspects of environmental life systems that may be affected by the project. This program will continue through the pre-construction and construction phases of the project. Some monitoring will be conducted after construction is complete as a part of the operation and maintenance activities. Results of future research studies will be reflected and considered in the individual environmental statements to be prepared for major features of the project.

For example, a monitoring program is planned to determine the losses of fish and other aquatic biota in Lake Havasu resulting from construction of the Havasu Intake Channel and Pumping Plant, to evaluate the requirements for protective measures, and to study the potential

impact of introducing Colorado River biota into existing systems in the project area. Initial studies of the requirements for fish screens in the intake channel and an aquatic bass survey in Lake Havasu have already been completed. The results of the fish screen study are discussed in Chapter III. This monitoring program will be continued as an overall study of the operation of the Havasu feature and its impact on Lake Havasu biota.

Six reports compiling known data on the biota of reservoir areas of the CAP were completed in January 1972. The studies are referenced in the Appended Material and are cited throughout this statement.

A research program concerning management of vegetation along the lower Colorado River is planned for initiation in October 1972. This management study is intended to be multiple purpose in scope, including all aspects of fish and wildlife, recreation, water salvage, and other environmental concerns.

2. Analyzing Alternative Features 164,169,172,189

To maximize enhancement of environmental values and to decrease adverse impacts, alternatives to individual project features have been (see Chapter VIII) and are continuing to be analyzed. Examples are the three potential dams on the Gila River and two on the San Francisco River being investigated as possible alternatives to the proposed Hooker Dam. Factors to be considered in the evaluation of any alternative are exemplified by opposing views on the Hooker Dam site alternatives. Evaluation of alternatives to the Hooker Dam site will have to consider the position of the New Mexico Department of Game and Fish, in its letter of March 7, 1972, where it states on page 2, "A dam located at either of two proposed alternative sites could inundate a portion of already scarce habitat now occupied partially or totally by these species (15 birds) in New Mexico." (Definition supplied.) A similar position on alternatives to the Hooker Dam site on the San Francisco River was taken by the New Mexico Interstate Stream Commission. However, that agency was concerned with the reservoir yield and the additional conveyance facilities including additional pump lift required to deliver water to the prospective municipal and industrial uses located in the Tyrone-Silver City-Bayard area. In contrast, on page 5 of the Sierra Club's letter of October 26, 1971, it states "We believe that it is possible to design an alternative that will avoid violation of the Gila Wilderness and the Gila Primitive Area and also will avoid damaging the water and riparian areas along the Gila main stream and the San Francisco."

3. Standard Reclamation Rules for Design and Construction

The Reclamation Instructions provide criteria for the improved appearance of structures and preservation of landscape at all installations. These criteria are applied in the planning, design, and construction of all facilities. An example of implementation of these criteria

is the recent changes made in design of the Havasu Intake Channel and Pumping Plant. Reevaluation of design criteria for the Havasu Intake Channel, Pumping Plant, and discharge lines has resulted in a more environmentally acceptable design than the preliminary concept presented in the September 1971 Draft of Environmental Statement for the Central Arizona Project. The intake channel dike is now planned as a landform structure to be constructed with materials that will blend with the local terrain, be accessible for public use, and provide additional largemouth bass brood area. The intake channel will not physically intrude on Heron Island.

Studies are being conducted to evaluate largemouth bass nesting potential and possibilities for further fishery enhancement in the area adjacent to the intake channel. The pumping plant structure has been redesigned to present a lower profile that will blend in esthetically with the mountain background; the switchyard structures will be located some distance from the pumping plant and highway at a point where electrical lines are initially placed underground; the discharge line to the tunnel portal will be buried; and the areas disturbed by project construction above the pumping plant will be restored to their original appearance as nearly as possible.

Specific requirements which are included in the Reclamation Instructions and are applicable to the CAP include the following:

a. Locating the required structures of the project to take advantage of the natural topography.

b. Designing the aqueducts to minimize the required cuts and fills.

c. Designing the structures to be compatible with the surrounding area.

d. Incorporating the external appearance of the structures and dams into the design program so as to be environmentally compatible with the surroundings.

e. Establishing cut and fill slopes to blend with natural terrain.

f. Concealing the required waste areas and borrow pits.

g. Locating the required construction and access roads along the natural contour of the land and where possible along the alinement of the maintenance roads.

h. Clearing only the minimum amount of vegetation that is necessary.

i. Restoring the damaged areas and scars to as natural a condition as possible.

j. Revegetating the damaged areas where necessary.

k. Landscaping the features to improve their appearance.

l. Installing soft lights, where appropriate to be adequate for work and for protection of the facilities.

m. Designing the pumping plants to eliminate harmful and bothersome noise levels.

Construction contractors will be required by specific specifications provisions to reduce the impacts by the following methods:

a. Controlling operations so as to disturb the minimum amount of right-of-way.

b. Restoring the areas that are disturbed to a natural landform.

c. Maintaining heavy equipment in a condition to eliminate excessive air pollution.

d. Providing construction equipment with features to minimize noise pollution.

e. Maintaining access and haul roads by application of water to eliminate dust.

f. Making efforts to keep waste water returns to a minimum.

Special procedures to protect wildlife such as those which have been developed in specifications to protect the great blue heron colony at Lake Havasu will be incorporated in construction specifications as each additional requirement is identified. With regard to the great blue heron colony, the specifications for construction of the Havasu Intake Channel require control of potentially harmful operations, such as blasting, so that these actions coincide with periods of least activity of the colony on their island nesting ground in Lake Havasu.

The application of Reclamation Instructions for design and construction to the CAP is exemplified by plans for aqueduct construction through the open desert. In order to preserve as nearly as possible the natural desert setting, all aqueducts will be located and constructed to minimize large cuts or fills. The degree and type of slope will be planned to maximize reestablishment of native vegetation. The total right-of-way width, which will average from about 200 to 300 feet, will

allow a buffer zone on each side of the open aqueduct sections. Except where greenbelt areas and wildlife and recreational facilities are planned, right-of-way width will be kept to the minimum amount necessary to construct, operate, and maintain the aqueducts. The earth materials accumulated during aqueduct construction will be placed in low profile areas or on hillsides where the line of the hill may be smoothly extended. Disposal areas will be revegetated to as near natural conditions as possible. Quarry sites required for rock material will be selected in remote areas. After removal of the required material, quarry sites will be left in a condition that will minimize the impact on esthetics and will not endanger people or wildlife.

The transmission lines and substations will be designed and constructed in accordance with the Department's "Environmental Criteria for Electric Transmission Systems" and other appropriate Reclamation guidelines to minimize visual modification of the natural surroundings. The towers will be located to make maximum use of existing topography for screening. Substations will be constructed using modern low-profile structures. The steel structures and major electrical equipment will be designed to blend with the natural surroundings. Insulators, hardware, and related materials are all designed to reduce electronic interference to a minimum.

B. Protective Measures and Mitigation Features Included as Part of the Project 55,56,166

Several agencies, including the Arizona Game and Fish Department and the Bureau of Sport Fisheries and Wildlife, have expressed a strong interest and have assisted in developing and outlining mitigation and protective features for the CAP. The Bureau of Reclamation outlined a tentative plan for mitigation features in the Draft of Environmental Statement issued in September 1971. The Bureau of Sport Fisheries and Wildlife in its 1967 report on the Salt-Gila Aqueduct and 1969 Report on Granite Reef Aqueduct presented a plan for fish and wildlife features along these aqueducts. These two plans of the Bureau of Sport Fisheries and Wildlife were concurred in by the Arizona Game and Fish Department. Recommendations set forth in the Bureau of Sport Fisheries and Wildlife reports have been accepted as valid means of providing mitigation and enhancement features compatible with the CAP along the Granite Reef and Salt-Gila Aqueducts. Recommendations included in these reports are quoted in the discussion on the following pages. Extractions from the reports are identified.

1. Granite Reef and Salt-Gila Aqueducts

Chapter III of this statement presents the impacts of the aqueduct system. Protective measures and mitigation features which will be included in the construction work are discussed below.

a. Fencing 56,63,166

Fencing of the right-of-way will be provided for public safety and livestock and wildlife protection where needed. Chain link

fencing has been recommended in safety hazard and high risk areas in the Phoenix metropolitan area and around aqueduct control structures. Fencing will be considered for use along the remainder of the aqueducts especially at selected migration routes and in areas of high concentration of big-game. The recommendations of the Bureau of Land Management, the Bureau of Sport Fisheries and Wildlife, and the Arizona Game and Fish Department will be used in locating migration routes and areas of high incidence of mule deer and bighorn sheep. Other areas where specialized fencing may be required can be identified as construction progresses. After construction, a monitoring program will be initiated to evaluate the adequacy of fencing and to determine any problem areas.

Except in locations where special types of fencing are designated along the Granite Reef Aqueduct, the standard right-of-way fence will be a 4-strand barbed wire stock fence. This 4-foot-high fence will be placed on both sides of the canal along the right-of-way for the protection of range cattle in the area, and also to limit and control the unauthorized public use of the canal waterway and roadways. Stock fence will be equal to or better than required by Arizona Revised Statutes (Chapter 129, titles 23 and 24) for construction of a "Lawful Fence."

Special fencing will be provided in specific areas of bighorn sheep habitat in the Buckskin and Harquahala Mountains as recommended by the Arizona Game and Fish Department. The 5-foot-high sheep fence will be the woven wire type with 5 strands of barbed wire, and will be installed along the right-of-way on both sides of the canal.

b. Bridges

Bridges, culverts, and overchutes included in the project are part of Reclamation's standards for cross-drainage and continued access, and are not in themselves considered mitigating features. Plans are to design project bridges, overchutes, and culverts with natural settings and other enhancement features to be compatible with wildlife use. These structures near known migration routes will be made accessible for wildlife crossing. Additional wildlife crossings will be included in areas where access is shown to be inadequate.

Crossing structures on the Granite Reef Aqueduct will average about 1.5 per mile of total aqueduct length.

c. Escape Facilities

In conjunction with the location of bridges, siphons, checks, and overchutes, the open aqueducts will include escape facilities for public safety and wildlife protection. Escape facilities will be located above the entrance to each siphon, pumping plant, tunnel, or other structure where the potential for drowning exists. The exact design and frequency of placement of these devices will be in accordance with Bureau of Reclamation policy, the results of current studies, and

recommendations by the Arizona Game and Fish Department and the Bureau of Sport Fisheries and Wildlife. Safety ladders to protect against drownings will be placed on both sides of the aqueduct at intervals of about 750 feet. These will consist of ladder rungs embedded in the concrete sidewalls or lining.

d. Wildlife Water Sites

Water catchment sites will operate on the same principle as those now in use by the Arizona Game and Fish Department. These devices work on the principle of capturing precipitation and storing it in a covered polyurethane bag for controlled release in a limited area. Water sites will generally be located some distance away from the aqueduct. These sites will be selected for the purpose of drawing wildlife away from the aqueducts and to obtain a better distribution of deer and bighorn sheep.

The construction of 17 off-aqueduct watering holes for big game will mitigate big-game drowning losses in the Granite Reef Aqueduct. An increase in the number of big-game may occur in the areas adjacent to the aqueduct. The Bureau of Sport Fisheries and Wildlife and the Arizona Game and Fish Department did not recommend water catchment devices for the Salt-Gila Aqueduct.

"They would not require water from the aqueduct except during periods of drouth. During these periods, water could be transported by tank truck from the aqueduct to fill the catchment basins which would have capacities of 4,000 gallons each. Filling of all 17 basins would require less than one-quarter acre-foot of water." * * * "The exact locations would be determined through cooperative field studies by the interested agencies."

"The Arizona Game and Fish Department has standard specifications and plans for the catchment basins. Detailed plans can be made available during later project planning."[56]

e. Wildlife Oases

The Bureau of Reclamation, the Bureau of Sport Fisheries and Wildlife, and the Arizona Game and Fish Department concurrently recommend a number of small oasis-type watering stations along the aqueduct route. These oases will furnish a drinking source away from the aqueducts to minimize drowning of animals. The oases will provide a means for enhancing upland game along the aqueduct area with an estimated consumptive use of water for 35 stations at less than 35 acre-feet per year. If needed, these off-aqueduct watering facilities can be provided with specially designed fences to lead wildlife toward the watering sites and away from the open aqueduct. These stations will enhance the

distribution of wildlife by providing drinking water and the establishment of small areas of vegetation.

Each station will be located near the aqueduct. The watering stations will be connected to the aqueduct by a gravity-fed pipeline fitted with separate water and air valves. A flat structure having a minimum water holding capacity will be placed at the pipe outlet to dispense water.

"Overflow from the slab would disperse onto the surrounding land creating a small vegetated area which would be attractive to wildlife. Doves, quail, rabbits, and deer could be expected to make extensive use of these small oases, thus increasing wildlife numbers and improving hunting.

"The sites should be selected with attention to the need for sufficient gradient to assure an adequate head to maintain flow and improve periodic pipe flushing. Consideration also should be given to the possibility of extending the pipelines to create more than one station at some of the sites."[56]

Establishment of the 35 stations on the Granite Reef Aqueduct will provide wildlife benefits amounting to 900 man-days of big-game hunting and 3,600 man-days of upland-game hunting annually. A significant increase in hunting is not expected to accrue from mitigation on the Salt-Gila Aqueduct.

The costs will be about $2,400 per station for a total cost of $84,000 for all 35 stations. Annual operation, maintenance, and replacement costs will be $100 per station. Maintenance work will consist primarily of periodic cleaning of silt and algal growth from the pipelines by means of compressed air.

2. Reservoirs [23,33,34,38,39,47]

To maximize enhancement of environmental values, alternatives to individual project features have been and are continuing to be analyzed. The six biological studies, referred to above and cited throughout the statement, will aid in delineating required mitigation measures and desirable enhancement features for the four proposed reservoirs. Additional studies, either underway or planned, will incorporate more detailed analyses of possibilities for mitigation and enhancement, and will be included in the individual statements covering each of the reservoirs.

a. Fish Hatcheries [76]

The CAP plan includes one warm-water and two cold-water fish hatcheries. While these hatcheries will provide mitigation value,

considerable enhancement benefits will also accrue. The sites for the fish hatcheries have not yet been identified.

Major factors to be considered in the final selection of hatchery sites include consideration of the small fishing lake program proposed by Arizona Game and Fish Department, fish required in the proposed reservoirs and small lakes along the aqueducts, the exchange water lakes in upstream watershed areas, and the development of the fishery program on Fort McDowell Indian Reservation. Of the four damsites, the stream below Hooker Dam will provide the only reliable cold-water stream fishery. In order to prepare for the predicted 24,000 fisherman use-days of stream fishing below Hooker Dam and the 70,000 man-days of fishing for the cold-water species within the reservoir, a fish hatchery capable of producing approximately 100,000 pounds of trout annually will be necessary for Hooker Reservoir alone.

b. Orme

A portion of the Fort McDowell Indian Reservation will be inundated by Orme Reservoir. Mitigation to the Indians for these losses includes adding 2,500 acres to the reservation plus concessionaire rights on Orme Reservoir, and memorialization, protection, or relocation of the burial grounds. There is no known way to mitigate the Indians' cultural losses.

Facilities and management procedures will be included to mitigate the loss of the existing stream fishery in the reservoir area and to improve the potential of the future reservoir fishery. An estimated average of 352,000 fisherman-use days annually will occur. With proper management, an additional 115,000 fisherman-use days annually are anticipated. Management procedures should include segregating parts of the reservoir from speedboats so they will be compatible as fish and wildlife areas. Facilities include boat launching ramps, picnic tables, and campsites. Aside from the fishing, it is estimated that 100,000 recreation-use days annually will occur initially and 1,500,000 recreation-use days annually by the 10th year.

Loss of the Verde well field which provides water to the City of Phoenix will be mitigated by providing water from Orme Reservoir to the City to the extent of its legal rights and losses. Job losses to the Indians working in the well field should be fully mitigated by employment in the pumping plants, reservoir operations, and recreational development.

The inundated section of the Beeline Highway will be relocated and a bridge will be constructed at the Verde narrows.

Archeological resources will be salvaged to the extent feasible within the dam and reservoir areas.

c. Buttes 34,50,80-82

Portions of the Southern Pacific Railroad and county highway will be relocated. The Bureau of Sport Fisheries and Wildlife and the Arizona Game and Fish Department have indicated there are no significant fish and wildife values presently in the Buttes Reservoir site. Bottom lands will not be cleared above Elevation 1750 and a minimum pool in the reservoir will be maintained at not less than 200 surface acres, 8 feet in depth.

Buttes Reservoir will provide for about 30,000 fisherman-use days per year, plus an additional 55,000 recreation-use days annually of other water-oriented recreation.

Additional studies will determine the need and extent of work required to salvage any archeological, historical, or mineral values that may exist in the area.

d. Charleston 34,54

There will be no significant fish and wildlife losses due to the construction of Charleston Dam and Reservoir. Although it is recognized that the San Pedro River at Charleston once had a fishery, today there are only three native species of fish present. There have been no wildlife values identified that would be lost by inundation. There is a relatively thin border of riparian vegetation within the reservoir site that undoubtedly supports wildlife. That portion within the conservation pool will be lost to inundation. The portion in the flood control pool will not be removed.

After construction of the reservoir, fishing values will be increased. This reservoir will provide an estimated 180,000 fisherman-days per year. Including fishing activity, it is estimated that the dam and reservoir will provide about 270,000 recreation-use days per year initially, and about 435,000 recreation-use days annually by year 2000.

Additional archeological studies and salvage work will be required prior to construction. Thus far, 21 sites have been identified for further study and excavation.

e. Hooker 34,54,164

The New Mexico Game and Fish Department in its letter of March 7, 1972, listed several items that it would like to have considered as possible mitigation measures in the CAP. These include:

1) Potholes and marsh development along the Cliff-Gila area as habitat enhancement; 2) a gravitational flow structure to divert water from the Gila River through the Red Rock game pasture and back to the river to enhance upland and migratory bird habitat; and 3) development of small fishing and recreational reservoirs or enlargement of existing structures.

Discussions between the New Mexico Game and Fish Department and the Bureau of Reclamation have resulted in tentative identification of other conditions, resulting from the construction and operation of Hooker Dam, for which further mitigation measures may be required. A distinction will be made between mitigation measures and enhancement features after current and planned studies on the Hooker proposal are completed.

It is estimated that the reservoir will provide 70,000 fisherman-use days annually. Stream fishing below the dam will increase to about 24,000 fisherman-use days annually. Aside from fishing, about 11,000 recreation-use days per year will be provided initially, increasing to about 36,500 recreation-use days annually in later years.

C. Potential Enhancement Measures Not Authorized Under Public Law 90-537 14,54,61

In general, the policy of the Bureau of Reclamation has been to provide as part of the initial project construction, those mitigation features or facilities initially identified as falling under the provisions of the Fish and Wildlife Coordination Act (72 Stat. 563, P.L. 85-624). In the course of working with Federal and state agencies, additional features have been identified which cannot be classified in the mitigation category but are complementary to the project. These are defined as enhancement features, and are not required or designed to replace or substitute for a loss resulting from the project. Enhancement measures are considered as being in addition to, or as adding value to the project.

Although these features and recreational features associated with the proposed reservoirs may not be included in the present project plan authorized by Public Law 90-537, it appears that they would be important and beneficial to the project as enhancement features. Land and water conservation funds or Dingell-Johnson and Pittman-Robinson money may be available to state and local agencies for construction and/or operation and maintenance of these facilities. Federal and state agencies, counties, or certain municipalities may wish to participate in development, administration, and operation and maintenance of these facilities.

Due to the lack of complete data, full evaluation of the proposals discussed below is incomplete. The proposals are identified here so

that further evaluations by all appropriate agencies can be undertaken as a part of their on-going programs.

1. Other Wildlife Habitat Potential

In order to reduce the number of culverts and overchutes, training dikes will be used to concentrate drainage flows along certain sections of the aqueducts. Up to 100 acres of land behind each flood protection structure could be acquired by the project for temporary holding of floodflows. Periodic accumulation of water in these areas will result in increase of vegetation and enhancement of wildlife habitat. There may be other areas along the aqueducts where seepage or overflow may improve wildlife habitat. As the project develops and these areas occur, they may be acquired and included in the overall management program for the aqueduct system.

2. Parks-Recreation Potential 61

Cooperative studies are being made with Federal, State, and local recreation and fish and wildlife agencies to plan facilities for public use along the aqueduct in the Phoenix metropolitan area. In addition, and as recommended by the Arizona Water Sports Council in its letter of comment on October 20, 1971, the Arizona Highway Department will be consulted to coordinate the location of park sites at major highway crossings. It may be possible to develop greenbelt parks in conjunction with rest areas along Interstate Highway 10 between Blythe, California, and Tucson. Greenbelt parks with landscaped aqueduct slopes to improve the appearance of the aqueduct are envisioned within urban areas.

3. Fishing Lakes 55,56,61

The plan for a warm-water fishery to be developed in conjunction with the Granite Reef Aqueduct was formulated by the Bureau of Reclamation, the Bureau of Sport Fisheries and Wildlife, and the Arizona Game and Fish Department. This proposal provides for the impoundment of five unlined fishing lakes, each 10 acres in size, for a total area of 50 surface acres. The gravitational flow-through ponds can be constructed on acquired right-of-way lands or public lands.

"These lands and an additional 30 acres of peripheral lands would be necessary at each lakesite for the development of access, parking, and sanitary facilities. Fencing of approximately 40 acres at each site would be necessary.

"The aqueduct plus dikes to be constructed laterally would form the lake basins and impound the water. Natural runoff augmented

by water from the aqueduct would maintain water in the lakes. The annual water requirement for the five lakes is estimated at a diversion of 7,200 acre-feet of which 375 acre-feet would be annual consumptive use. For each lake, an inlet and outlet control structure in the aqueduct sidewall with connecting culverts would be needed to provide freshening flows and maintain the desired water levels needed for fishery management purposes. It is planned that water would be returned to the aqueduct by gravity flow. The inlet and outlet structures, capable of handling flows up to 5 second-feet, would be provided with removable screens. The lakes would be constructed to a water depth of 12 feet over 95 percent of the water areas.

"The lakes would be constructed to retain sufficient water to sustain fish during periods of low flow or closure of the aqueduct. The construction of these unlined lakes suitable for fishing is dependent upon the availability and location of a nonporous substratum. Specific lakesite locations would be determined through cooperative studies by the four interested agencies."[56]

Preliminary investigations suggest the location of a nonporous substrata may be difficult. In the absence of a suitable substratum the lakes would be lined to prevent seepage. Lining of the lakes would minimize seepage losses of water. The lined lakes would include a gradual slope of approximately 3 to 1 around the boundaries. The upper 3 to 5 feet of the lakes can be recessed, covered with fill, and revegetated in order to approximate a natural lake.

"The lakes would provide good quality warm-water fish habitat. The most suitable fish species for the lakes would be threadfin shad, largemouth bass, and channel catfish. Fishing on the five 10-acre lakes would total about 20,000 man-days for a benefit of $30,000 per year.

"Water to meet the 375 acre-foot annual consumptive use requirement on the (unlined) fishing lakes should be made available from the Central Arizona Project."[56] (Definition supplied.) In response to instructions received at a public meeting of prospective applicants for CAP water, held in Phoenix by the Secretary of the Interior on January 6, 1969, the Arizona Department of Game and Fish determined water requirements for fish and wildlife purposes. The Department prepared a resolution dated January 17, 1969, requesting an annual diversion of 60,000 acre-feet of water from the Colorado River under the CAP for use by the Arizona Game and Fish Department for creation of fishing lakes and wildlife management areas throughout the state. The resolution was sent to the Governor of Arizona, the Arizona Interstate Stream Commission, the Arizona Power Authority, and the Department of the Interior.

Estimated costs associated with construction of the five lake developments would amount to about $217,000 based on 1969 prices. Annual operation, maintenance, and replacement costs would be about $15,000. Estimated costs for the lakes are shown in Table 15.

Consideration will be given to construction of one or two of the highway park lakes in conjunction with rest areas to be built on Interstate Highway 10 where it traverses the aqueduct from Blythe to Tucson. The increase in size of these lakes, from the 5 acres outlined in the September 1971 draft statement, and the decrease in the number of lakes were also recommended by the Arizona Water Sports Council in its letter of comment on October 20, 1971.

The Bureau of Reclamation realizes there are many other enhancement undertakings associated with CAP which may be worthy of implementation. Additional features will be considered as they become fully identified and evaluated.

D. Historic and Archeological Sites 41-46,60,73,177,178,200

Pursuant to the National Historic Preservation Act of 1966 (80 Stat. 915, 16th U.S.C. 470), the Advisory Council on Historic Preservation and the National Park Service, Department of the Interior, have adopted procedures and criteria to further the Nation's historic preservation program, including the expansion of the National Register of Historic Places and initiating a grant in aid program for historic preservation. The National Register of Historic Places was consulted to determine if any properties identified in the Register would be affected by construction activities of the CAP. The Listing of National Register for Historic Places and Designated National Historic Landmarks, and National Registry of Natural Landmarks identified in the Federal Register through August 5, 1972, have been checked and no listed sites will be influenced or affected by project facilities. The Woodrow Ruin site in Grant County, New Mexico, is adjacent to the identified potential borrow site for Hooker Dam but is not within the borrow area.

Unlisted sites or areas of state historical interest that would be affected by development of CAP facilities are listed in Table 16. No sites have been identified at Hooker Reservoir site.

The National Park Service mentions three sites in its December 1, 1971, letter of comments on the CAP Draft of Environmental Statement: 1) Casa Grande National Monument, 2) Lehner Mammoth-Kill National Historic Landmark, and 3) Hohokam-Pima Irrigation Sites National Historic Landmark. Comments of the Historic Preservation offices in Arizona and New Mexico have been received and are included in this discussion.

The Casa Grande National Monument located in Section 16, T. 5 S., R. 8 E., GSRB&M is almost completely surrounded by irrigated lands of

TABLE 15
ESTIMATED COSTS FOR FISHING LAKES (UNLINED)[56]

Item	Costs
Development	
Embankments	$ 25,000
Inlets and Outlets	25,000
Concrete pipelines connecting aqueduct and lakes	25,000
Bank stabilization, beautification, fencing, and public use facilities	75,000
Engineering and Supervision	30,000
Contingencies	37,000
Total	$217,000
Annual O&M	$15,000

TABLE 16
UNLISTED SITES OF HISTORICAL INTEREST
THAT WILL BE AFFECTED BY THE CENTRAL ARIZONA PROJECT

Historical Feature	Project Feature	Remarks
Arizona and Swansea Railroad ROW	Granite Reef Aqueduct	Railroad alinement
Fort McDowell	Orme Reservoir	Inundate site
Lime Kilns	Orme Reservoir area	One above maximum water surface elevation and one at edge of conservation pool
Cochran	Buttes Reservoir	Inundate site
Riverside	Buttes Reservoir	Possible partial inundation
Kelvin	Buttes Reservoir	Most of area above maximum water surface elevation
Coke Ovens	Buttes Reservoir	Inundation
Kelvin Cemetery	Buttes Reservoir	Possible inundation at maximum water surface elevation under flood control operations
Charleston Area Ruins	Charleston Reservoir	Inundation

the San Carlos Indian Irrigation Project and the town of Coolidge. The existing Pima lateral of the San Carlos Project crosses the southern end of the monument area. This and other laterals will be concrete lined as part of the distribution system improvements authorized as part of the CAP. Distribution system lining is one of the water service contractual requirements established in the authorizing legislation. The nearest that any other portion of project facilities will come to the monument is about 7 miles southeast where the Salt-Gila Aqueduct will be constructed near the existing Florence-Casa Grande canal of the San Carlos Project. The supplemental water supplied to the San Carlos Project under the water allocations and contracts will not be in large enough magnitude to appreciably alter the present hydrologic regimen or the local surface and ground-water drafts. A lessening of the ground-water level decline may be expected but a long-term reversal and rise in the ground-water levels is not expected.

The Lehner Mammoth-Kill National Historic Landmark in the $N\frac{1}{2}$,$NW\frac{1}{4}$, $NW\frac{1}{4}$, $NE\frac{1}{4}$, Section 21, T. 23 S., R. 22 E., GSRB&M, at about elevation 4200 is about 120 feet higher in elevation and about 8 miles south of Charleston Reservoir. This landmark will not be affected by the project.

The Hohokam-Pima Irrigation Sites National Landmark in Maricopa and Pinal Counties and the Park of the Four Waters in Phoenix are located at distances varying from 4 to 20 miles downstream from the aqueducts and siphons crossing the Salt and Gila Rivers. The Orme Reservoir will provide flood control protection to the Maricopa sites. The location of potential construction material borrow sites in these same general downstream areas will be selected with respect to these landmarks. All construction activities of the CAP will be based on existing and final archeological surveys.

Initial archeological surveys by the National Park Service and the Arizona State Museum have been completed on the Buttes and Charleston damsites and reservoir areas, the Granite Reef Aqueduct from Lake Havasu to the Agua Fria River, the Granite Reef and Salt-Gila Aqueducts from the Agua Fria River to the Gila River, and the Tucson and San Pedro Aqueducts. A survey has been made of Orme Reservoir from the confluence of the Salt and Verde Rivers, and includes approximately 13 river miles of the Verde River.

There were six sites located in the Buttes survey. The National Park Service recommended that some excavation be conducted in the trash mounds and in search of houses. In addition, there are five other sites with potential as historical sites. These include: Cochran, Riverside, Kelvin, Coke Ovens, and Kelvin Cemetery. Further studies will develop recommendations for disposition of the features and any proposal for inclusion in the National Register of Historic Places.

The National Park Service recommended that all 12 of the sites located at the proposed Orme Dam site (formerly Maxwell and formerly McDowell) on the Verde River be excavated. No additional sites were identified on the Salt River. Future surveys will recommend disposition of the Lime Kilns listed in Table 16. Further studies and surveys are in progress for the Orme Dam and Reservoir site.

In a 1968 survey the National Park Service located an additional 113 sites bringing the total to 133 sites known to be at or in the vicinity of the proposed Charleston Dam and Reservoir area. Twenty-one of the sites within the survey area were recommended for further study and possible excavation. Refer to Chapter III for more detail.

In March 1968, the Prescott College Archeological Survey, under contract with the National Park Service, conducted a reconnaissance of that portion of the right-of-way of the proposed Granite Reef Aqueduct in west-central Arizona from Parker Dam on the Colorado River to the Agua Fria River northwest of Phoenix. Primary investigation was made by helicopter, supported by ground survey at key points. No prehistoric or historic sites were located.

In 1969, a survey (contracted to the Department of Anthropology, Arizona State University, by the National Park Service with funds provided by the Bureau of Reclamation) was completed on the Granite Reef-Salt-Gila Aqueduct from the Agua Fria River to the Gila River.[45] A few scattered tools were found along the Granite Reef Aqueduct alinement. Of the 12 sites located on the Salt-Gila Aqueduct route, eight were recommended for further testing and excavation. This study has since been supplemented by an extensive on the ground survey during June, July, and August 1972.

An agreement is being negotiated with the National Park Service for archeological surveys on the proposed Hooker Dam sites, for completion of surveys on the proposed Orme Dam site and Reservoir area, and for final surveys for the aqueducts, and Buttes and Charleston Reservoirs. Work included in the agreement will be a summary report of all the archeological work conducted in regard to the CAP since 1963. This summary will include a categorical listing of sites recommended for salvage and a cost analysis of funds required for work at each site and for the entire project. Recommendations received from the Advisory Council for Historic Preservation and the Arizona and New Mexico historical officers for proposed historical sites and places will be considered in the final recommendations. At that time a determination will be made in regard to mitigation measures that are to be accomplished as project costs and of other measures that would be considered enhancement.

A detailed archeological survey of the Havasu Intake Channel, Pumping Plant, and Buckskin Mountains area was made in April 1972. The only site found during this survey was Ariz. L:16:1, a lithic tool quarry. The site is

on the mesa at an elevation of 1,560 feet and is located on the tunnel right-of-way about 77 meters northwest of drill hole 114. A man-made trail crosses the eastern part of the site in a northeast-southwest direction, is generally faint, and is not currently being used by animals. The survey revealed little evidence of human activity within the limits of the project. Casual observance of the locality surrounding the survey area, and the general similarity of this locality to the right-of-way limits suggest that human utilization of the entire Buckskin Mountains area probably was limited. The only site located on the survey reflected sporadic use of the local resource and there was no evidence of permanent occupation in the immediate area.

The following recommendation was made concerning this site. Ariz. L:16:1 lies above the tunnel line and there is little danger that it will be disturbed by tunnel blasting or boring. Disturbance of the site would result primarily from establishing drill holes and constructing roads to these drill holes. Inasmuch as this aspect of the project has been carried out, further surface changes most likely will be negligible. Excavation of Ariz. L:16:1 is not feasible because of the character of the site. This particular archeological resource does not merit listing on the National Register of Historic Places, nor is it considered of major scientific importance. Thorough surface survey, collection and recording have been completed for the site and all pertinent information is on file in the Arizona State Museum. The survey, analysis of materials recovered, and this final report are considered sufficient to realistically mitigate potential future disturbance of the resources. In view of the limited access to the site, the improbability of major future project work in the area, and the complete recording of all features at the site, it is recommended that no further work be carried out on Ariz. L:16:1. On the basis of this report, the National Park Service will issue archeological clearance for all areas that were surveyed.

The 1972 study by the Arizona State Museum located a total of 33 sites over the entire reach of the Granite Reef Aqueduct from Lake Havasu to the Salt River. Five are historic and 28 are prehistoric. None of the sites was recommended for nomination to the National or State Registers of Historic Places. Excavation, intensive mapping or collection was recommended for 16 of the prehistoric sites. Of the 11 remaining prehistoric sites, one has been mapped, collected, and analyzed; another will be evaluated in the Orme Reservoir report; and the other nine were mapped, photographed, and recorded in detail. Data collected from these sites are considered sufficient to realistically mitigate future disturbance of the resources, and no further investigation or analysis was recommended. A few scattered "early man" artifacts have been found north and east of Phoenix along the Salt-Gila aqueduct system. All of these can be analyzed or salvaged prior to or during construction.

CHAPTER V

ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

V. ADVERSE IMPACTS WHICH CANNOT BE AVOIDED

In Chapter III, impacts whether beneficial or adverse were listed and discussed in detail. In Chapter IV, measures proposed to enhance, protect, and mitigate impacts on the environment were presented. This chapter is intended to outline the adverse impacts which cannot be avoided, i.e., adverse impacts discussed in Chapter III which will not be fully mitigated by measures presented in Chapter IV.

Several of the adverse impacts will be temporary, being associated with the construction of the project, while others will be relative to the operation, maintenance, or simply the existence of some of the features. A comprehensive review of the information presented in Chapters III and IV is considered a prerequisite to a complete understanding of the material presented below.

A. Impacts Related to Construction Activities

There will be some temporary disturbance of fish, wildlife, and vegetation in almost all of the immediate areas, although the best possible construction practices will be used in all phases of the CAP. Some flora protected and regulated by state law for control of wanton destruction or removal of plants without permit will be affected. Special measures will be taken during project construction to minimize the disturbance to protected species. Disturbance of the natural environment in some localized areas will have a detrimental effect. Impacts that may result, however, will not constitute a serious threat to environmental quality in the project area.

There will be additional sound and lighting, as well as the creation of dust and litter problems during the construction period. Insofar as possible, these will be controlled to avoid harmful effects, on wildlife and humans. Screening from public view will be accomplished to the extent possible to lessen the adverse impact.

Approximately 54,000 acres of right-of-way will be acquired for the project. This acquisition will involve Federal, state, Indian, and private land. Some adverse impacts will result from commitment of this land to the project, but these impacts will be small in relation to the lands remaining in the project area.

Roads will be needed in the project area for construction purposes. These will have some adverse impact on the existing environment. Roads not subsequently used for operation and maintenance of the project will be reshaped similar to natural conditions to minimize the adverse impact.

Some borrow areas will remain visible on the landscape for a long period after construction even with revegetation programs. Such areas will have reduced habitat and esthetic values and will be more susceptible to erosion than surrounding desert areas. This will create adverse impacts, which will only be partially mitigated by reshaping and replanting.

B. Impacts Associated with the Project [23,66,176-178]

The existence of the aqueducts and reservoirs and their attendant diversion works, transmission lines, and pumping stations, will have an esthetic impact on the environment. To some, this may be seen as an adverse impact, but to others a benefit. On the whole, it might best be assessed as a change rather than a negative aspect of the project.

Around the edges of the reservoirs between inactive and conservation water levels, there will be a permanent loss of terrestrial vegetation. Vegetation within the flood pool of the project reservoirs may be adversely affected. The extent of such impact will depend on flood frequency and severity. The overall loss of riparian vegetation from the areas of constant inundation, coupled with losses from flooding, is considered an adverse impact.

The reservoirs will have an adverse impact on native fish which are not able to adapt to reservoir conditions. Whether or not environmental conditions in the upstream and downstream areas will be suitable for these native fish is not known at this time. In general, however, there will be an unavoidable reduction in populations of native fish and some other species that have been introduced at the reservoir sites. There will also be reductions in the number of individuals in bird and other wildlife populations at the reservoirs due to inundation of habitat. Numbers of species will also be reduced. The reservoirs and attendant recreational uses may displace further use or visits to the area of the reservoirs by some species found on the Endangered Species List,[176] including the bald eagle, and certain mammals whose natural range makes them peripheral species in the project area.

The aqueduct system may cause the loss of some wildlife, especially small game which can enter through protective fencing and other systems designed for large mammals. The aqueducts will also provide some hindrance to movement and migration of wildlife in the area and this is an adverse impact, which although mitigated, may cause some loss of wildlife in the area.

The importation of Colorado River water will contribute salts to the central Arizona area. This may ultimately have an effect on soil fertility and ground-water quality in the area. This potentially adverse impact is not yet fully quantified, but analyses to date indicate that the impact will be small.

C. Impacts Associated with Key Features of the Central Arizona Project

Some of the features involved in the project will have a few unavoidable adverse impacts which are peculiar to that feature alone. They are discussed below.

1. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 70

The creation of large amounts of waste material from excavation of the tunnel will be unavoidable. It is planned to deposit this material near

Osborne Wash, assuming the main driving effort is from the outlet portal. This is considered an adverse impact both on the esthetic value of that area and on wildlife.

Some fish may pass through the intake channel into the pumping plant, with few surviving the impact of the pumps. Fish screens or other protective devices are being evaluated for installation ahead of the pumps to minimize the loss.

2. Granite Reef Aqueduct 166

The Granite Reef Aqueduct will cause some interruption of normal range and migrational movement of big-game animals, and present some drowning hazard. A small amount of vegetation now growing in the right-of-way will be removed, and the esthetic value of the area will be changed. In the area of metropolitan Phoenix, there will be a hazard of human drownings which will exist to a slight degree even if the facilities are completely fenced.

3. Salt-Gila Aqueduct

Minor impacts such as those described above and in Section B of this chapter may be found along this route.

4. Tucson and San Pedro Aqueducts

Apart from the permanent loss of some vegetation for the operation and maintenance roads on the right-of-way, the Tucson and San Pedro Aqueducts will have no significant unavoidable adverse impacts.

5. Orme Reservoir

Orme Reservoir will change the ecosystem of about 10 miles of the Salt River and about 10 miles of Verde River. A total of 24,000 acres of Indian and Forest Service land will be influenced by the project at maximum flood surcharge levels. However, only those areas below elevation 1437 (9,700 acres) will need to be cleared of existing vegetation. About 3,500 acres of riparian vegetation, which provides habitat for a relatively diverse terrestrial fauna, will thus be lost. A loss of 4,300 man-days of hunting will occur annually. Portions of the Salt and Verde Rivers which provide a stream recreation resource will be replaced by a reservoir-type recreation. To those who prefer the stream resource, the loss will be adverse.

By providing Orme Reservoir as a recreation resource, more people will use that area in the future. The impact of people on the area may adversely affect the stability of vegetation and wildlife surrounding the reservoir. An active bald eagle nest is located near Malpais Canyon about 3 miles from the reservoir area. Although the nest will not be affected by the reservoir itself, an increase in human activity due to the reservoir may adversely affect the birds.

Orme Reservoir will inundate 10 of the 12 identified archeological sites on the Verde River. Mitigation work prior to inundation will minimize the loss of values that might otherwise occur.

Some of the reservation lands of the Indian community of Fort McDowell, which consists of an area housing about 53 families and the tribal burial grounds, will be inundated by the reservoir. While measures will be taken to reduce adverse effects, intangible cultural disruptions may never be mitigated.

6. Buttes Reservoir [63,175]

Buttes Reservoir will inundate approximately 12 miles of the Gila River, influencing a total of about 6,200 acres at maximum flood surcharge elevation. Only those areas below elevation 1750 (4,000 acres) will need to be cleared, including about 1,500 acres which support riparian vegetation and its inhabiting wildlife. A loss of 200 man-days of big-game hunting and 100 man-days of quail hunting will occur annually. Inundation of the 12-mile reach of river will have little adverse effect on fishing and other recreation due to the limited use of the area today.

Some commercial grade copper ore may exist under the reservoir floor. Should the reservoir be completed prior to removal of the ore, inundation of the area would hamper removal activities. The extent of possible disturbance would depend on the type of excavation (underground or open-pit), depth of ore deposits, and criteria for reservoir operational levels.

7. Charleston Reservoir [177,178]

Charleston Reservoir will inundate about 9 miles of the San Pedro River, influencing about 5,600 acres of land at maximum flood storage level. Only those areas below elevation 4055 (4,000 acres) will need to be cleared. About 670 acres of this land is relatively sparse riparian type. Inundation of the 9-mile reach will have little effect on fishing, as essentially no fishing occurs on the San Pedro River.

Of the 21 archeological sites recommended for further study and possible excavation, 13 are above the maximum water surface elevation of the Charleston Reservoir. The extent to which unavoidable adverse impacts on archeological resources may occur will be dependent on excavation and/or salvage work prior to inundation and assessment of the findings.

8. Hooker Reservoir [51,184]

Hooker Reservoir will inundate about 10 miles of the upper Gila River influencing about 1,340 acres of land at maximum flood surcharge level. About 1,120 acres below the conservation level will need to be cleared, including 273 acres of riparian, 289 acres of pinyon-oak-juniper, and 502 acres of xeric shrub. The stream in the reservoir area only

provides about 500 visitor-use days annually for picnicking, fishing, camping, and other recreation activity. While most of these activities will be available with the reservoir, replacement of the 10-mile reach with reservoir-related recreational use will be adverse to some people who prefer present conditions.

The reservoir will influence about 90 acres of primitive and 180 acres of wilderness areas in the Gila National Forest during extreme flood conditions.

9. Transmission System

The unavoidable impacts of the CAP transmission system will be similar to those described in the Navajo Project environmental statement. Some right-of-way will be acquired for construction. Vegetation losses will be minimized by choice of route alinement. Clearing will generally be restricted to the tower footings, substations, switching station sites, and operation and maintenance roads. In view of the terrain involved, the area under the conductors will generally not require clearing. The presence of the system will have an esthetic impact, which should be relatively small in light of the use of existing right-of-way and the presence of existing facilities.

10. Distribution Systems

The lining of irrigation systems will conserve water by reducing seepage losses. At the same time, however, the reduction of seepage losses will reduce the ground-water recharge in some areas.

11. Drainage and Reuse Facilities

Depending upon the methods employed by the water contractors to effectuate reuse programs, the effect upon waste water flows will be to reduce and control such flows. This control may be to remove them from river channels and place them in lined canals or pipeline systems. This method would reduce streamside and swampy habitat conditions on the Salt and Gila Rivers such as presently exist between the Phoenix metropolitan area sewage treatment plants and the diversion dam of the Buckeye Irrigation District. The drainage facilities would maintain ground-water levels below the zone of crops in areas of poor ground-water drainage.

CHAPTER VI

THE RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

VI. THE RELATIONSHIP BETWEEN SHORT-TERM USE OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY 9

The CAP is a multipurpose project which will help achieve a better long-term water resource balance in the project area. It will reduce the present overdraft of ground water, improve the control and storage of surface flows (both normal and floodflows), increase the effectiveness of the irrigation systems of the service area by reducing the sediment transport in local surface waters, and provide water-oriented recreational facilities for man's use and enjoyment.

At the present time, demand for municipal, industrial, and agricultural water results in an overdraft of about 2.1 maf annually. This imbalance leads to excessive pumping of ground-water aquifers, which in turn results in land subsidence and cracking (discussed in Chapters I and II), higher pumping costs, and the loss of some types of vegetation used by wildlife.

Many of the impacts associated with the project will have only short-term effects on the environment of the area. Most of the disturbance to people and wildlife caused by construction activities will cease as the features are completed. Losses of riparian vegetation in the reservoir sites together with changes in the natural appearance of some areas will be more permanent. The long-range effect of the project on productivity of native vegetation for wildlife is considered minor. Impacts associated with individual features of the project will generally be local in scope and will have only minor impact on the total environmental quality of the project area.

Water users in New Mexico will receive long-term benefits from the CAP through water exchange by contracting with the Secretary of the Interior for water from the Gila River system in amounts that will permit consumptive use of water in New Mexico, not to exceed an annual average in any period of 10 consecutive years of 18,000 acre-feet, including reservoir evaporation, over and above the consumptive use provided for by Article IV of the March 9, 1964, decree of the Supreme Court in Arizona v. California.

The culture of the Fort McDowell Indian community will be modified by construction of the Orme Dam and Reservoir. The Indians' mode and standard of living will be changed and their burial ground will be inundated by the reservoir. These changes will have a long-term effect on the Indian community, especially as related to the cultural significance of the burial grounds. Memorialization or relocation of the burial ground may offset some of this long-term loss.

In accordance with plans approved by the Secretary, the Fort McDowell and the Salt River Pima-Maricopa Indian communities will have the right

to develop and operate recreation facilities along the part of the shoreline of the Orme Reservoir located on or adjacent to their reservations, including lands added to the Fort McDowell reservation. Long-term benefits will accrue to the Indian tribes as a whole from the new jobs that will be created by recreation, and operation and maintenance of Orme Dam and Reservoir.

Section 304(a) of Public Law 90-537 provides that CAP water will not be made available for the irrigation of lands unless the lands have a recent irrigation history. This restriction does not apply to Indian lands, National wildlife refuges, or, at the discretion of the Secretary, state-administered wildlife areas. Therefore, project water may be used to bring into production Indian lands which have not previously been irrigated. The converting of desert lands on Indian reservations into irrigated fields will have a long-term beneficial impact in those areas in terms of increased agricultural productivity. A corresponding long-term change in the wildlife habitat of these same areas may also occur.

Long-term productivity in central Arizona and elsewhere in the arid Southwest is tied to the availability of water in both sufficient quantity and quality to meet a variety of needs. As the project area has developed from a primarily agricultural economy to a diversified economy, problems associated with water supply have become more complex. The CAP will contribute additional flexibility to the existing water resource system in order to meet these problems. It will provide not only a delivery capability for Colorado River water, but also a capability for possible future delivery of other new water from sources technology is still developing, such as saline and geothermal water. The favorable climate, growth potential and other factors indicate long-term development for the central Arizona area in terms of industry, agriculture, and population. Water will be the key to this long-term productivity and water delivery and water management will be essential parts of any design to enhance such long-term productivity. The CAP will contribute in both these categories toward this end.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE CENTRAL ARIZONA PROJECT

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE CENTRAL ARIZONA PROJECT

Resource commitments for the project will take several forms. Water and land resource commitments will be made, as will commitments of electric power, construction materials, and public and private funds. In addition, there will be some commitments in terms of resources diminished by and therefore committed to the project, such as vegetative, wildlife, archeological, and mineral resources.

A. Water Resources [9]

The decision to divert the major portion of Arizona's remaining share of Colorado River water for use in the central service area is a water resource commitment. The long-term average diversion will be about 1.2 maf per year. The project's facilities will capture floodflows and further regulate runoff as well, which will constitute an additional water resource commitment to the central service area.

B. Land, Mineral, and Vegetative Resources [1,23,48-51,63,163,175]

Federal, state, Indian, and private land and associated vegetation will be committed to the project. About 54,000 acres of land will be committed for right-of-way for construction and operation of project reservoirs and aqueducts. There will be physical modification or inundation of natural topography and vegetation resulting from construction of project facilities. Some native vegetation and associated wildlife habitat will be lost. These losses, although minor in terms of statewide impact, will permanently alter the natural condition of the affected areas.

The Framework Study indicates there are about 18,963,000 acres of southern desert shrub in Cochise, Maricopa, Pima, Pinal, and Yuma Counties in Arizona. Of this total, the right-of-way required for project facilities is about one-fourth of 1 percent. Data available for a like comparison of riparian vegetation are conflicting due to differing definitions of vegetation classed as riparian.

Reaches of the Salt and Verde Rivers on the Salt River Indian Reservation and the Fort McDowell Indian Reservation will be inundated by Orme Reservoir. Inundation of lands up to the top of the conservation level of the reservoir will be frequent enough to prohibit other uses of these lands. Below the top of the conservation level, about 5,400, 900, and 3,400 acres will be on the Fort McDowell Indian Reservation, the Salt River Indian Reservation, and the Tonto National Forest, respectively. Lands above the top of the conservation pool, however, will not be cleared of vegetation and will be available for wildlife habitat, controlled leasing, and recreational opportunities.

As discussed in Chapter III, the construction of the proposed Hooker Dam and Reservoir on the Gila River will result in narrow penetrations of water into the Gila Wilderness Area in the Gila National Forest in

New Mexico, into the Gila Primitive Area on the Gila River, and into the Gila Primitive Area on Turkey Creek, a tributary to the Gila River. The encroachment on the primitive and wilderness areas will be about 90 and 180 acres of land, respectively, at maximum water level.

Buttes Reservoir will inundate lands which overlie mineralization not presently considered commercially attractive. Should this resource not be mined prior to construction of the reservoir, inundation will hinder but not prevent future recovery efforts.

No other feature is known to have any significant mineral resource.

C. Power Resources [69]

The Secretary of the Interior has contracted for power from the Navajo Generating Station to supply the energy requirements for project pumping stations. Thus, the project requires the commitment of a power resource, which will be 24.3 percent of the generating station capacity.

The commitment of coal resources and the associated changes in land form and esthetic value in connection with the construction and operation of the Navajo Generating Station is covered under the final Navajo environmental statement filed with the CEQ on February 4, 1972.

D. Wildlife and Recreation Resources and Esthetic Values [33,34,38,39,176,178]

Losses to wildlife will be minor in terms of total population of such resources. Special mitigation considerations and features as discussed in Chapter IV will reduce the loss of wildlife and thereby minimize the adverse effects.

Fish losses will be in terms of displacement of certain species from the reservoir areas. Most of the non-native species will proliferate in the reservoirs. In relation to the total native habitat available, the overall loss of habitat for the native species will be minor. Losses in terms of endangered species will be insignificant, primarily the possible disturbance of the bald eagle in the Orme Reservoir area.

Once the project recreation facilities have been constructed and placed into operation, there will be large public demand and expectation for their continued use. Previously unused or little-used areas will become more attractive to many people. This will cause a long-term change in the public use patterns of these areas.

A total of 10 miles each at normal reservoir levels of the Salt and Verde Rivers will be inundated by Orme Reservoir. The Salt River arm is now intensively used for recreation including sightseeing, innertubing, picnicking, fishing, and camping. The recreational and esthetic values associated with these rivers will be reduced in relation to reservoir conservation level.

About 10 miles of the upper Gila River in southwestern New Mexico will also be inundated by the proposed Hooker Dam and Reservoir. The recreational and esthetic values associated with this reach of river will also be an irreversible commitment.

Borrow areas will be graded and shaped and revegetation will be accomplished. Disturbed desert areas are slow to recover and these areas must be considered a resource commitment in terms of materials removed. Spoil deposition areas will also constitute a resource commitment, especially in the Lake Havasu area where the construction of Buckskin Mountains Tunnel will require deposition of about 723,000 cubic yards of material.

E. Historical and Archeological Sites 41-46,51,60,73,177,182,184,200

Preliminary archeological surveys have been made by the National Park Service under contract with the Bureau of Reclamation for the CAP aqueduct system and for Buttes, Charleston, and Orme Dam sites and reservoir areas. Also, preliminary archeological studies and surveys of Hooker Reservoir site have been made by the New Mexico State Museum. Final assessment of the Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel has been completed.

The culture and migration of the prehistoric Hohokam Indian and other early tribes to and from the Southwest have already been fairly well established. The remains of "early man" ruins are widespread throughout Arizona and the Southwest.

Studies by the Arizona State Museum in 1972 located a total of 33 sites over the entire reach of the Granite Reef Aqueduct from Lake Havasu to the Salt River. Five are historic and 28 are prehistoric. None of the sites were recommended for nomination to the National or State Registers of Historic Places. Excavation, intensive mapping or collection were recommended for 16 of the prehistoric sites. Of the 11 remaining prehistoric sites, one (S:6:5) has been mapped, collected, and analyzed. Another (V:6:8) will be evaluated in the Orme Reservoir Report. The other nine (L:16:3, L:16:4, L:16:6, L:16:7, S:1:2, S:1:3, S:6:4, S:8:1, and S:8:2) were mapped, photographed, and recorded in detail. Data collected from these sites are considered sufficient to realistically mitigate future disturbance of the resources, and no further investigation or analysis was recommended. These newly discovered sites will appreciably expand the anthropologists' understanding of the western desert areas. A few scattered "early man" artifacts have been found north and east of Phoenix along the Salt-Gila aqueduct system. All of these can be analyzed or salvaged prior to or during construction.

Some significant historic and prehistoric "early man" sites have been located in the San Pedro River valley in or near the area to be inundated by Charleston Reservoir. The Orme Reservoir area, especially on the Verde River arm, also has historic and prehistoric ruins. The extent of ruins at the Buttes, Orme, and Hooker sites is not fully known at this time.

A reevaluation of completed preliminary archeological studies is currently underway by the National Park Service. Additional field investigations will be completed on all features to identify significant findings which should be salvaged. Excavation and salvage work will be accomplished prior to or during construction. This will minimize the loss of historical and archeological data, artifacts, and other cultural evidence.

F. Indian Culture 67,125

The inundation of Indian lands for Orme Reservoir will flood burial grounds and require relocation of the Fort McDowell Indian community. The burial grounds will either be relocated or memorialized. The cultural loss associated therewith constitutes a human resource commitment to the project. Public and private funds will be used in financing the replacement housing.

G. Economic Resources

Millions of cubic yards of concrete, sand, gravel, and earth, and tons of metal, wood, and other materials will be used in the construction of the features of the project. Public Law 90-537 authorizes 832 million dollars to be spent on construction of project works. The act also authorizes escalation of that figure in response to general price increases in related construction activity. Project cost based on the 1972 cost index would be about 1.2 billion dollars.

Public funds have been and will be committed to the project. About 70 percent of the construction cost will be repaid to the Federal treasury by the water and power users who benefit directly from the project. By provisions of Public Law 89-72, the joint project costs and one-half of the separable construction costs for fish and wildlife and recreation purposes are nonreimbursable. Costs allocated to flood control in the National interest are also nonreimbursable.

CHAPTER VIII

ALTERNATIVES TO THE PROJECT

VIII. ALTERNATIVES TO THE PROJECT

This chapter discusses a number of different types of alternatives that have been considered during the 30-year history of specific planning for CAP. This discussion will include alternative routes for delivery of water from the Colorado River, alternative sources of water, the alternative of not augmenting existing water supplies in central Arizona, alternative sources of power for the project, alternative concepts of design, and alternatives to and alternative locations for major features of the project.

A. Alternative Diversion Routes to Central Arizona [7,64,65,74,198]

Initial conceptualization of diversion of Colorado River water to central Arizona occurred in 1894. Somewhat later studies began focusing on routes for delivery of Colorado River water to the central Arizona area. Preliminary field surveys, data collection, and analyses of alternative plans to deliver this water began in the early 1940's. These early studies considered numerous diversion routes. Three routes - Marble Canyon, Bridge Canyon, and Parker (Granite Reef) - were chosen to be analyzed in detail for comparative evaluation. The results of these studies were documented in two Bureau of Reclamation planning reports in 1945 and 1947. The 1945 report recommended against further consideration of the Marble Canyon route. The Parker alternative was determined to be the most favorable from an economic and construction standpoint. These primary routes were discussed and considered during the course of Congressional hearings on the authorization of CAP. All three routes were designed to deliver water to a reservoir in central Arizona approximating the present concept of Orme Reservoir.

The Parker route, is the route concept authorized for construction by Public Law 90-537 as the Granite Reef Aqueduct. This route as modified by updated designs and estimates, is described earlier in Chapter I of this environmental statement. It consists of the diversion works at Lake Havasu and the Granite Reef Aqueduct system. Besides their geographical differences, one salient difference between the route chosen and the alternatives rejected is that the Granite Reef route will not necessitate construction of another reservoir on the Colorado River. This is not true of the other two routes.

Section 301(a) of P.L. 90-537 provides that " . . . the Secretary shall construct, operate, and maintain the Central Arizona Project, consisting of the following principal works: (1) a system of main conduits and canals, including a main canal and pumping plants (Granite Reef aqueduct and pumping plants), for diverting and carrying water from Lake Havasu to Orme Dam or suitable alternative, . . ." Moreover, Section 303(a) of P.L. 90-537 provides that ". . . nothing in this section or in this Act contained shall be construed to authorize the study or construction of any dams on the main stream of the Colorado River between Hoover Dam and Glen Canyon Dam." Thus, the authorizing legislation, by choosing the diversion route to be used and by proscribing the investigation or construction of any dams necessary to utilize either of the alternative

routes, renders academic any discussion here of alternative routes to the project as presented. However, in the interest of more fully disclosing the decisionmaking processes involved in selection of the Granite Reef route, a discussion of the 2 major alternatives to it follows.

1. Marble Canyon (Verde River) Route [64]

The Marble Canyon route, an all-gravity route, was designed to allow for the diversion of about 2,000,000 acre-feet per year of Colorado River water into central Arizona through a 143-mile tunnel. This tunnel would divert water from the potential Marble Canyon Reservoir and discharge into the Verde River. From the tunnel outlet, the water would flow down the natural channel of the Verde River through a series of reservoirs and powerplants to a regulating reservoir on the Salt River near Granite Reef.

The construction of a 143-mile tunnel would have adverse impacts on the environment at the portals and service control centers. Aggregate required for finishing the tunnel would necessitate extensive borrow areas along the tunnel route. Reestablishment of natural vegetation and biota in the borrow areas would require several years due to climatic conditions and the slow successional processes natural to this area. In order to carry 2 million acre-feet of water per year, the tunnel would be about 21 feet in diameter. There would be about 15 million cubic yards of spoil from the 143-mile-long tunnel. Even if placed in the aggregate borrow areas, the remaining spoil would require more than 8,000 acres of open land if deposited at an average depth of 1 foot. The quality of soil resulting from spoil deposition could further lengthen the time for establishment of an environment compatible with natural surroundings.

The long tunnel route would pass through geologic formations with differences in water content and water-yielding capabilities. Several of these formations are saturated and permeable and would present difficulty in tunnel construction. Drainage into the tunnel from these saturated formations would result in lowering the water table in the rocks and this could reduce or eliminate spring flows influenced by the tunnel line. This could influence the water resources that are relied upon by native vegetation, range cattle operations, and municipal systems in certain areas of northern Arizona.

Temporary powerlines required to furnish electricity during construction would be removed and their paths obliterated. Power requirements for structures and monitoring control could be placed underground from several main points of high voltage power supply.

The Marble Canyon route would require the construction of Marble Canyon Dam on the Colorado River near the north boundary of the Grand Canyon National Park. This dam was subject to much criticism by environmental groups during Congresional hearings. The impact of the dam on canyon areas and its effect on the flow of the Colorado River were principal reasons this proposal was dropped from the project. The streamflow regimen of the Colorado and Verde Rivers would be changed, and esthetic

values and ecological aspects would be altered by reservoir construction. Species of stream fish and invertebrates would be displaced or eliminated and replaced by those common to mainstream reservoirs. Vegetation and wildlife endemic to the Marble Canyon area would be destroyed or displaced from the area of inundation. Fisherman and recreation-use days would increase on the reservoir over those formerly provided by the river.

The generation of hydropower would neither pollute the air, nor deplete fossil fuel supplies. Power transmission lines to the project features and to power market centers would have esthetic and physical impacts on the environment.

The remainder of the project features including Orme, Buttes, Charleston, and Hooker Dams and the aqueducts from Orme and Charleston Dams to Tucson would be the same as in the authorized plan and would present the same environmental impact as described in this statement.

2. Bridge Canyon (Big Sandy) Route 64

The Bridge Canyon route would divert Colorado River water into central Arizona by gravity through a system of tunnels, canals, and siphons. The aqueduct would begin at the reservoir formed by constructing a dam at the Hualapai site (Bridge Canyon damsite) on the Colorado River and traverse generally southward through a 78.5-mile tunnel and subsequent canal structure to Cunningham Wash. From this point eastward, it would continue by canal to its terminus at the potential Orme Reservoir. The environmental impact of the tunnel section would be similar to the Marble Canyon route. Borrow pits and spoil deposition sites for tunnel construction would require only about one-half the area as that of the Marble Canyon route.

The tunnel for the Bridge Canyon route could influence the water resources on the Hualapai Indian Reservation and adjoining range cattle operations in the same manner as discussed under the Marble Canyon route.

Construction of the canal section for the remainder of this route would have impacts similar to those associated with canal construction described in this statement. Mitigation of most of these losses could be accomplished. Adverse impacts would include disturbance of natural terrain within the right-of-way, alteration of esthetics, interference in migration patterns and movement of big game, permanent loss of some native vegetation, and possible loss of some upland and big-game hunting.

A dam would be constructed on the Colorado River at the Hualapai Dam site near the headwaters of Lake Mead. Construction of Hualapai Dam likewise did not receive Congressional approval as a result of testimony from individuals and organizations opposing its construction based on alleged adverse environmental effects in the reservoir area. The construction of the dam would result in the loss of riparian habitat and animal communities within the area of inundation, alteration of the esthetic values

of the river, changes in downstream flow patterns, and displacement of stream-dwelling vertebrates and invertebrates by reservoir conditions and by those species more adapted to reservoir environment. The limited recreational use and stream fishing days on the river would be replaced with a greatly increased number of reservoir use days. The values associated with river use within the inundated area would be lost.

The generation of hydropower would not pollute the air, nor deplete fossil fuel supplies. However, the physical intrusion of the reservoir, dam, and powerplant, and surface power transmission lines would be an alteration of the natural terrain and environment.

Selection of the Bridge Canyon route (or the Marble Canyon route presented earlier) would necessitate construction of a mainstream reservoir on the Colorado River that would be in addition to the four holding and regulating reservoirs described in the CAP. Therefore, reservoir impacts on the Colorado River would be in addition to those described in this statement.

B. Alternative Water Sources

As part of overall planning for the CAP, several sources of water and ways and means of conserving present supplies of water were evaluated and examined for viable alternatives. None of these alternatives appear to be feasible project alternatives, but they could enhance the long-range success of the CAP, or serve as a second stage of development. One problem common to all these alternatives is that they would only provide sources of water and without the proposed dams and reservoirs would not provide flood control, sediment control, recreation, and water exchange, which are major objectives of the project. Regardless of the source of water, the distribution and storage facilities similar to those of the CAP would still be required to effectively manage the water supplies in central Arizona. The environmental impacts of the facilities needed to accomplish the overall objectives of the project would be similar to those presented in this statement. Additionally, most of the alternatives evaluated would not supply the quantity of water that the Colorado River will provide.

1. Use of Recycled Water Produced in the Area[59,93]

Water reclamation projects provide great promise for increasing the efficiency of waste water reuse. Research and pilot studies are underway in Phoenix at the "Flushing Meadows Project" and in Tucson at the "Waste Water Reclamation Project," where municipal waste water is being reclaimed for irrigation, recreation, and possibly mining and other industrial uses. Under the Tucson plan, all wastes are treated to an equivalent secondary level after which the treated effluent is applied to the land for removal of additional impurities by infiltration through the soil. Water is thus made available by ground-water recharge and is available for unrestricted irrigation and recreation uses. In addition, mining and other industrial uses are being studied. Potential health

hazards and other possible adverse environmental consequences resulting from utilizing soil for further impurity removal by filtration have not been fully evaluated. Studies regarding pathogen and/or other bacterial responses, the effects on the soil fertility, percolation rates, and long-term ground-water recharge will require further investigation and analysis before total health and other environmental effects can be predicted in the central service area. In the meantime, recycled sewage water is now being successfully used only for lower priority needs such as greenbelt park irrigation and certain nonfood crops. Reclaimed sewage water is generally not presently considered acceptable for direct domestic water supply.

Future projected water requirements in the CAP service area greatly exceed the quantity of waste water potentially available for reuse. Satisfaction of these water requirements will necessitate the availability of another water supply in addition to the supply of waste water to augment existing surface and underground sources. Thus, recycling is not a practical or viable alternative but is a necessary supplement to the CAP water supply.

2. Precipitation Management[83-86,100,134]

The subject of precipitation management, or weather modification, has been under intensive investigation for about 25 years. Since 1966, the bulk of precipitation management research has been conducted or sponsored by the Bureau of Reclamation. The program is known as "Project Skywater," and is a coordinated multidisciplinary effort with the goal of putting together various sytems to manage the amount and distribution of precipitation in an efficient, economic, socially acceptable manner. About 90 percent of Project Skywater activities are conducted through contracts with colleges and universities, private organizations, state, and other Federal agencies. In addition, the National Water Commission is evaluating studies of the effects of precipitation management experiments.

A number of studies have been conducted in various places in the West, including selected locations in the Colorado River basin. These include selected sites in Arizona, both in the mountainous regions and in the desert areas. The results of early experiments and studies were not uniform. Various techniques for seeding clouds were used, with effects that were not completely predictable. Under certain meteorological conditions, cloudseeding led to more precipitation. Under other conditions, cloudseeding led to less precipitation or had no measurable effect. Moreover, the effects of cloudseeding on precipitation were predictable for only a limited number of cloud systems. The meteorological conditions which may influence snowpack increases from cloudseeding of the storms over the western mountains have now been reasonably well identified. Recent progress in modification of precipitation from convective storms is promising. However, the effects of such modification cannot yet be reliably predicted.

Beneficial use of augmented runoff for water supply depends upon its capture. This depends on the timely availability of reservoir storage. As yet, there is very limited information as to the effectiveness of precipitation modification in increasing water supply during sustained or protracted drought periods. Results to date indicate that the potential during such periods, although positive, may not be great. In areas where substantial extra annual or carryover storage is available, the average annual water supply may be increased by seeding during wet periods.

Precipitation management represents a potential source of new or additional water for a basin by producing runoff from precipitation that normally would not have fallen on the basin. Probable low operational costs, program flexibility, and the high quality of water produced, make precipitation management a desirable method for increasing the water supply where seeding conditions are suitable. However, within the Colorado River Basin most of the potential for water created would be found in the upper basin. In addition, more research is needed to develop a better understanding of the physical mechanisms of precipitation and the statistical effects of cloudseeding operations, and to improve existing seeding techniques. The legal ramifications and environmental consequences also need clarification. A firm annual increase in snowpack may have a direct effect on game and nongame species composition and behavioral patterns, and on vegetation associations. Increased precipitation in the form of rain would need to be scrutinized in respect to similar impacts. Other considerations would be directed to erosion potential, nesting habits of the avifauna, and the character of burrowing animals in the areas affected. Increased precipitation in a given area on a regular basis could increase the biological carrying capacity of the area. Without regularity of precipitation, flora and fauna populations would continue to fluctuate in response to available moisture. All of these considerations are now being studied by Project Skywater. Precipitation management is approaching practical application; but as an alternative for the CAP, it can be considered only a promising supplemental source of additional water.

3. Conservation of Irrigation Water [87,88,91,139]

The long history of the scarcity of water and the increasing cost of pumping water have made the agricultural industry in the lower Colorado region of the Colorado River basin look critically at water management. Even though the full potential has not yet been realized, much has been accomplished in efficient use of water supplies within the lower Colorado region, especially in the Gila subregion, which in essence comprises the project area.

Irrigation facilities and conservation measures that have been installed on the land include about 6,394 miles of irrigation ditch lining, canal lining, and irrigation pipelines that have been installed to reduce seepage losses. More than 146,000 water-control facilities have been installed in the project service area, including major storage

reservoirs, diversion dams, tailwater recovery facilities, pumping plants, and other water-control structures designed for better water management. In several areas where ground water and surface water are incorporated in the same system, pumps can be regulated to minimize system waste and assist in creating a flexible and reliable operation. This and other advanced water management techniques are being increasingly applied throughout the lower Colorado region and Gila subregion. Expansion of these practices can have a significant beneficial effect, but the resultant water savings will only be a supplement to CAP and therefore cannot be considered an alternative

4. Increased Watershed Runoff 89-100,137,142

Watershed management is directed at the use of land to improve the quantity and quality of water, to reduce erosion and sediment yield, and to maintain a productive watershed. Proper management must consider a number of factors, including past use of the land, ownership patterns, soils, vegetative types, climate, and physiography. Any well balanced watershed management program must consider the use and development of such resources as timber, forage, and wildlife, and such social values as recreation, esthetics, and population dispersal.

The need for increased watershed yields is greatest in the West. Studies in Arizona and watershed research in Colorado, the intermountain area, the Pacific Northwest, and California are providing valuable information for land managers. At this time, however, further study is needed before the effects of various watershed management programs can be reliably determined. Certain conclusions can be drawn and basic assumptions can be made from existing research. Generally, larger increases in yield are associated with high precipitation, and smaller increases occur when precipitation is low. The possibilities for increasing water yields in the West appear to be most favorable in areas of high elevation and greater precipitation. Research has shown that partial cutting in some types of forests can provide opportunities for increasing water yield through redistribution of the heavy snowfall and reduced evapotranspiration. Replacement of native vegetation with grasses in some areas has yielded inconclusive results.

The Salt River watershed offers a good example of problems associated with watershed management which need to be evaluated. It has been estimated that an additional yield of 145,000 acre-feet of water annually could be obtained by vegetative management on 710,000 acres in the Salt River watershed. Most of this work would involve modifying timber harvesting practices and conversion of chaparral and mountain brush to shallow-rooted grasses and forbs on watershed lands at higher elevations where precipitation is greater. One of the major environmental considerations associated with this alternative is the conversion of a large number of acres of native vegetation at higher elevations to that of grasses and forbs. Complete conversion of native vegetation to grasses and forbs could not be accomplished without almost total alteration of the associated fauna. The displacement and alteration of existing species may be followed by establishment of species adaptable to a grassland habitat or by creation of empty niches. The impact of such

displacement and alteration is not fully known. It would vary from place to place depending on the area being managed.

Water gained by watershed management has the potential of supplying additional water in the Gila River basin and reducing the requirements for imported water. To be of benefit to New Mexico, this alternative would probably involve a portion of the Gila Wilderness area. Further studies will be necessary in order to fully evaluate the contribution this program could have toward increasing water supply and the impact the program would have on all aspects of the environment. Present information indicates that water increases developed from watershed management programs would be supplemental to the importation of water by the CAP and not of sufficient quantity to be considered a suitable alternative to the project.

5. Import from Other Basins 94,105,186,187,192,195

Transfer of water from areas of surplus, such as Alaska or the Pacific Northwest, has been contemplated but legislative constraints have been imposed prohibiting current study of its potential. P.L. 90-537, Section 201, provides that "...for a period of ten years from the date of this Act, the Secretary shall not undertake reconnaissance studies of any plan for the importation of water into the Colorado River Basin from any other natural river drainage basin lying outside the States of Arizona, California, Colorado, New Mexico, and those portions of Nevada, Utah, and Wyoming which are in the natural drainage basin of the Colorado River." Since these studies have not and cannot be initiated for some time, interbasin transfer does not appear to be a presently available alternative water source in lieu of diversion of a portion of Arizona's present entitlement to Colorado River water. In addition, the normal lead time from start of planning through authorization and construction for interbasin transfer of water could require from 20 to 30 years or more. Moreover, were water available in the Colorado River system from interbasin transfer, some delivery system similar to CAP would have to be constructed if this water were to be used elsewhere within Arizona other than along the Colorado River itself. Environmental impacts from this delivery system would be similar to those of the present project. Additional impacts on the environment would be experienced outside the currently anticipated project area.

6. Geothermal Sources 106,109,194

Studies of the geothermal resources in Imperial Valley, California, indicate that substantial quantities of high salinity water with a high heat content may be stored in the deep ground-water basin. The area southeast of Yuma, Arizona, is also considered to have high potential for geothermal development. Utilizing the produced steam as an energy source for desalting this water may be an attractive source of new water for the possible augmentation of the Colorado River. If geothermal development is successful, the possibility for development of a relatively nonpolluting source would also exist.

Utilization of desalted geothermal water would require a transport and storage facility equal to or more elaborate than the one selected

for the CAP. The current state of technology and the insufficient knowledge relating to the quantities of water potentially available preclude geothermal sources as being a feasible or viable alternative to CAP.

The impact that geothermal development would have on environmental values is being considered in connection with geothermal resource investigations being conducted in Imperial Valley, California.

A final environmental statement on the Deep Geothermal Test Well, Geothermal Resource Investigations, Imperial Valley, California, FES 72-9, was filed with CEQ on April 28, 1972. The final environmental statement for the skid-mounted desalting unit and injection well (FES 72-21) was filed with CEQ on July 10, 1972. A brief summary of the environmental impacts of the geothermal investigations is provided below.

About 14 to 20 acres of desert land will be required for access roads and work areas during drilling and testing of the well. A minor impact on the overall esthetic value of the area will thus occur. The nature of the construction is such that it lends itself to restoration of the terrain's natural conditions at the completion of the work. The behavioral patterns of the few animals in the area might be temporarily altered by the presence of men and machinery. During operation and testing of the well, some noise could be expected during steam blowoff. Noise levels will be controlled by using silencers or other means to prevent injury to workmen. Accidents that could occur during drilling and testing of the well include leakage or spillage of geothermal brine, and inadvertent venting of noxious gases to the atmosphere. Stringent precautions will be enforced throughout the various operations to insure against such accidents. Certain amounts of objectionable gases, mostly hydrogen sulfide, might be encountered during investigations. These gases if encountered should disperse sufficiently within a short distance so as not to be objectionable. The presence of gases will be periodically monitored during the work. Temporary holding ponds for brines are designed to prevent escape of the brine into the surface or ground-water systems until disposal is effected.

A more detailed discussion of environmental consequences of geothermal development can be found in the subject environmental statements. The future of geothermal water as the by-product of production of electrical energy is dependent upon the success of the geothermal testing. The magnitude of the environmental impacts including subsidence effects of this alternative will be directly proportional to the amount of development that takes place in the future.

7. Desalting of Ocean or Other Brackish Waters [62,110-112]

The desalting of sea water has been considered as one of the alternative sources of water. It is not a feasible alternative to initial diversion of Colorado River water for three reasons: (1) large scale

desalting technology has not been proven; (2) the costs of desalting sea water and transporting it to a point on the Colorado River where it could be further transported to central Arizona are infinitely greater than the economic costs of diverting Arizona's remaining entitlement in the Colorado River, and (3) the lead time involved in relation to the need.

For the most part, facilities similar to those proposed for the CAP would be needed to convey and regulate the successive stages of desalinized water from the storage area on the Colorado River to the CAP area. Unless the imported sea water were introduced into Lake Mead where storage capacity is available, an additional regulatory reservoir would be required on the Colorado River or elsewhere.

Environmental impacts resulting from construction of an off-river storage reservoir would probably not adversely affect native fish fauna. Adverse impacts on esthetics, land-dwelling vertebrates, and invertebrates, vegetation communities, and recreational resources in open space would be similar to those encountered during construction of a reservoir on a stream. The species affected may be different, but the general impacts would be similar. Water quality improvements would be positive if the desalted water were refined to a better quality than that of the stream or the reservoir where desalted water is introduced.

Because of the developmental nature of desalting technology, a detailed evaluation of the impact that desalting of ocean water and the transportation of the desalted water inland would have on the environment was not made in this statement. Preliminary reviews indicate that impacts similar to those associated with the selected plan would occur in Arizona. In addition, there would be impacts associated with the desalination plant itself, and the conveyance system needed between the plant and the CAP facilities in Arizona. One of the major problems associated with desalting plants is disposal of the brine which is a by-product of desalinization. As a part of the conveyance system, pumping plants, aqueducts, siphons, bridges, roads, and transmission lines would be required. Environmental impacts of these structures would be similar to those described in this statement for the CAP aqueducts.

A detailed study of sea water desalinization will be part of the ongoing Western United States Water Plan studies for augmentation of the Colorado River. Desalting of ocean water is not considered a feasible alternative to the CAP at this time.

C. The Alternative of No Action [1,141]

The alternative of no action has been considered. In the case of the CAP, this would mean constructing none of the facilities which have been described in this statement, nor any of their alternatives. This

alternative would not accomplish any of the objectives of the project described in Chapter I, nor would it cause any of the impacts, described in Chapters III and IV, which are associated with the project.

It can be assumed that, if the water which the project will provide is not made available, those agencies which supply water to users in the service area would utilize any and all other sources which they could obtain.

If the project is not constructed, central Arizona's water supply would continue to come from local sources. At the present time, water consumption, all from local sources, exceeds the safe-yield supply by approximately 2.1 maf per year. As future consumption increases, overdraft of aquifers would continue, eventually exhausting some basins entirely. Water would have to be obtained from deeper or more distant aquifers or from some aquifers which are not presently used due to poor water quality. This would increase costs of delivery and treatment, raising consumer costs, and decrease the agricultural productivity. Land subsidence would continue in the central service area, causing increasing problems for agriculture and possibly threatening several of the small communities in the area.

In order to meet demands for water, some alternative facilities for some of the project features would undoubtedly be constructed for the control and storage of intermittent surface runoff waters on the Salt, Verde, Gila, San Pedro, and Santa Cruz Rivers. These facilities could also provide flood and sediment control for the municipal and agricultural areas of the region. Such facilities would have the same or similiar impacts on riparian flora and fauna as those described for the project reservoirs in Chapter III, as well as social and economic impacts. The seriousness of such impacts would depend largely on the sites selected and the size and type of facilities constructed.

Reversion to a fragmented or less than multiple-purpose approach would be counter to public interests, and would waste the opportunity to realize the economies of scale and the savings offered through the complementary nature of the several functions of a multipurpose project. Through the sharing of project elements such as rights-of-way, carriage losses, and management, efficiencies in the provision of the various services are effected. The results of sharing facilities become apparent when a typical cost allocation for the project is examined. There are six project functions to which cost is allocated under the existing planning process. It would cost some 50 percent more to provide the same services from these six project functions through single purpose undertakings.

While it is impossible to determine exactly where the impact of a restricted water supply without CAP would be felt, tests indicate that even under the most favorable and ideal conditions where reductions are limited to agricultural sectors, the economy would suffer a substantial

absolute loss. The realities of the water supply systems, water rights, and legal and institutional arrangements indicate that it is highly unlikely that such a limiting of reductions could be accomplished. Some sharing of the impact by both agriculture and other industries would occur.

Besides the conversion of agricultural lands to urban development, much agricultural land would eventually be abandoned from agricultural production due to lack of a water supply and would not be put to any other use. In most cases, desert vegetation would reestablish on abandoned agricultural lands through successional stages, although this may require many years. There would likely be limited numbers of wildlife associated with such lands due to the limited forage and shelter. Dust, erosion, and other associated problems would increase as a result of abandoned lands. Some abandoned agricultural land would probably be subdivided within the urbanized area of Phoenix or Tucson, or on the periphery of the smaller towns in the area.

The State of New Mexico would not be able to increase its consumption of Gila River waters if the project is not built, as the increased amount of water would not be available for the exchange in Arizona. This would have limiting effects on economic development and wildlife management in the southwestern portion of New Mexico.

The city of Phoenix, and the surrounding urban area, would not enjoy the protection from periodic, but severe, flooding that project dams will provide unless certain features were constructed independently. The lack of such protection would curtail the further development of certain areas and allow floods, such as the ones of January 1966 and June 1972, to cost residents millions of dollars, and prevent the improvement of transportation networks in the city of Phoenix, such as the river crossing roads and the runways at Sky Harbor International Airport. Control structures could be built on the Salt, Verde, and Gila Rivers but their impacts would be very similar to those of project reservoirs.

If the project were not built, sediment protection and unwarranted costly operations for dredging, sluicing, and clearing would still be needed by the operators of surface water distribution systems. Such protection could be included in independent flood control facilities, but again, environmental impacts of these facilities would be very similar to those described for CAP facilities.

Recreational opportunities provided by the reservoirs of the CAP (and to a lesser extent by the aqueducts) would also be denied. Streamside recreation would still be available as it is now. The number of water-based recreation days which can be provided by a reservoir far outnumbers that provided by a flowing stream, and thus, the projected deficit in water-based recreation days would not be met or reduced.

Archeological sites which have been identified in the CAP reservoir areas or along the aqueducts might remain intact. These identified sites, together with any unidentified sites, might eventually be excavated, or

they may simply be left to the vagaries of time and attendant pilferage, weathering, and later construction. Certainly, the impetus that the project gives to examination and salvage of these sites to increase man's knowledge of the past would be lost.

The continued overdrafting of the ground-water basins in the area would affect the riparian communities which depend upon ground-water levels. In some parts of the project service area, the decline of mesquite and some other riparian species (considered valuable for wildlife habitat) has been attributed to a rapid drop in ground-water levels. It is expected that even more of these areas would be lost by a continued drop in ground-water level.

The studies on the reservoir sites cited throughout this statement give information on the degree of riparian dependency associated with the fauna found at each site. Tables from these studies are included in the Appended Material.

The Colorado River would remain very similar to the conditions found today and those projected by the Framework Study. As the salinity of the river will not be affected by the project, no difference would be seen without it. The water allocated to the State of Arizona would undoubtedly continue to be used for the most part by the State of California in the absence of CAP or a similar project in Arizona. Flow patterns would be slightly different in the reach of the river between Hoover Dam and Lake Havasu, due to the lack of increased flows for CAP diversion. The Lake Havasu area would not have the minor impacts which will be associated with the Havasu feature of CAP.

D. Alternative Power Sources [10,62,68,69,75,76]

About 85 percent of the total CAP pumping power requirements will be used for the pump units on the Granite Reef Aqueduct system. The total at-plant power requirements are shown in Table 11 in Chapter I.

During the general planning stage of the project, several sources of power have been considered for meeting the aqueduct pumping requirement. Early studies and the 1947 Central Arizona Project planning report included a 750-megawatt Bridge Canyon (Hualapai) powerplant as the primary source of pumping power. The 1963 supplemental report included a 1,500-megawatt powerplant. The project at that time also included provisions for 17,500 kilowatts of installed capacity at Orme Dam (then McDowell-Maxwell Dam) and turnout locations where power head could be recovered.

During the formulation of the Pacific Southwest Water Plan, which incorporated the CAP as a unit into the plan for regional water resource development, power to meet project pumping requirements and to assist in repayment was obtained by combining the power units at Bridge Canyon and Marble Canyon Dams on the Colorado River. In January 1964, the Secretary of the Interior submitted the Pacific Southwest Water Plan to the Congress.

Because of objections to the Bridge Canyon and Marble Canyon Dams for environmental reasons, the Secretary of the Interior in 1966 directed the Bureau of Reclamation to analyze alternative plans to provide for the CAP pumping power requirement. The results of these studies were utilized in formulating a revised development program. This revised program was presented in a report entitled,"Summary Report--Central Arizona Project with Federal Prepayment Power Arrangements," dated February 1967. On March 2, 1967, this report was transmitted to the 90th Congress. The main difference in the revised program as outlined in the report was the replacement of the Marble Canyon and Bridge Canyon Dams and their hydroelectric units with a coal-fired thermal power unit. Public Law 90-537 directed the Secretary to find appropriate arrangements for supplying project energy requirements. This direction ultimately resulted in Federal participation in the Navajo powerplant project, located near Page, Arizona. Environmental analysis of that project is contained in the Navajo Project Final Environmental Statement, dated February 4, 1972.

E. Alternatives to Major Features of the Project

In the course of study involved in planning for the project, both before and since it was authorized by Congress, several alternatives for the major features of the project were examined and are continuing to be evaluated in some cases. The following discussion summarizes the studies made to date.

1. Havasu Intake Channel, Havasu Pumping Plant, and Buckskin Mountains Tunnel 70

Section 301(a) of P.L. 90-537, 82 Stat. 887, specifies that water for the CAP will be diverted from the Colorado River at Lake Havasu. For that reason, no other point of diversion will be discussed under this heading. (See Section A of this chapter for such discussion.)

a. Description of Alternatives 70,149

The proposed site and routing for the system of components designed to deliver water from Lake Havasu into the Granite Reef Aqueduct are considered most suitable based on a combination of engineering and geological studies of foundation conditions, location studies for discharge lines and tunnel, environmental considerations, and construction and operating costs. Of the numerous alternative pumping plant sites and conveyance routes studied for the present design concept, four of the more practicable and reasonable are described as follows:

Alternative Route No. 1 would skirt the north slope of the Buckskin Mountains along the Bill Williams River. It would continue along the Buckskin Mountains up the Mineral Wash drainage area following its eastern facing slopes and cross through a saddle between the Mineral Wash and Osborne Wash drainage areas, with delivery of water to the Osborne Wash area. Tunnels would be avoided wherever possible. Two pumping plants would be required with 300- and 482-foot lifts, respectively.

Alternative Route No. 2 would also follow the north slope of the Buckskin Mountains for about 4.6 miles and then enter a 3.3-mile tunnel and travel in a southerly direction to the Osborne Wash area. This route would require 2 miles of open canal, 4 tunnels having a total length of 5.6 miles, and 2 pumping plants with lifts of 396 and 399 feet, respectively.

Alternative Route No. 3 would follow the western slope of the Buckskin Mountains for about 3.5 miles and then enter a 3.9 mile tunnel and continue in a southeasterly direction to the Osborne Wash area. This route would require 1.7 miles of open canal, 2 tunnels having a total length of 5.3 miles, and 2 pumping plants with lifts of 396 and 397 feet, respectively.

Alternative Route No. 4 would eliminate the intake channel because the intake would be located near Parker Dam and away from the sediment delta. This route, like Alternative Route No. 3, would follow the western slope of the Buckskin Mountains but in a southerly direction for 7.5 miles, then through a 2.9-mile-long tunnel in a southeasterly direction to the Osborne Wash area. Approximately 5.1 miles of this route would be open canal, with 3 tunnels totaling 4.3 miles in length, and 2 pumping plants with lifts of 315 and 476 feet, respectively.

All alternative routes considered would provide for pumping to a common elevation of approximately 1225 feet. Selection of the proposed pumping plant site was further influenced by a geological study in the area completed in 1965. This study recommended that the pumping plant be located so as to provide a foundation entirely of gneiss, since location of the plant on a sandstone foundation north of the gneiss-sedimentary rock contact would be inadvisable due to the suspected low bearing strength and instability of the sandstone when saturated. This site also affords a discharge pipeline profile having little, if any, sidehill location and a shorter discharge line than any of the other sites and locations studied. In addition, the site and routing for the components of the system reflect the results of comparative studies that indicated that the Buckskin tunnel route is more desirable from esthetic, engineering, economic, and environmental considerations.

One alternative to the intake channel which was considered was the construction of a 10,000-acre-foot capacity sediment barrier dam on the Bill Williams arm about 1 mile upstream from the pumping plant site. This alternative was eliminated because of higher estimated construction costs, excessive evaporation losses, and the irreversible adverse effects on the Havasu National Wildlife Refuge. A major portion of the littoral zones associated with the productive shallow area within the refuge depends on the sediment delta and phreatophyte growth upstream from the site.

Studies of the alternative intake channels considered the impact on the environment and ecology of the area, impact on recreation facilities, both present and future, sediment deposition levels, and construction costs. The results and recommendations of these alternative studies include the

intake channel design recommended in this statement and 7 other alinements or variations contained in the "Report of Ad Hoc Committee on the Evaluation of Inlet Channel to the Havasu Pumping Plant - Central Arizona Project," dated October 23, 1970. A general layout of the selected and alternative intake channels is shown on Figure 29. Route A would be a channel which would pass through the Havasu Springs Resort marina where the lessee presently has docking facilities and a concrete block building housing a store, restaurant, and motel. This route would probably require at least partial cancellation of the lessee's concession. A second alternative considered was utilizing Route A and replacing the marina facilities by excavating a new cove on the west side of the peninsula and rebuilding the marina and other service facilities equal to those now existing. Alternate Route B would be an open cut immediately south of the marina facilities which would receive water from a cove located immediately west of the marina entrance. Route C would consist of a tunnel about 24 feet in diameter with approximately the same alinement as Route B. Route D would be a buried conduit directly across the peninsula with its intake on the north side of the peninsula. Route E would utilize a tunnel in approximately the same location as Route D. A channel which would terminate between the east side of the Havasu Springs peninsula and the adjacent island was designated as Route F.

Three pumping plant locations were considered. The two locations that were rejected were west of the presently planned site. Two designs for the pumping plant, one standard and one low profile, were investigated for the pumping plant. The alternatives in the discharge line design were above or below ground. Three tunnel locations were evaluated. The selected tunnel alinement is west of the 2 other locations. Two bridge designs were considered for Highway 95. One was a concrete-beam design and the other a steel design. Two schemes for the cut slopes were evaluated. One was a steep slope scheme (slope 1/2:1) and the other a more gradual slope (1:1).

b. Description of the Present Environment 42,46,70,73,146,177,178

The climate, topography, and geology of the area which would be affected by any of the alternative routes would be similar to those described in Chapter II of this statement and in the draft statement on the Havasu feature. The rock types along the lakeshore change from gneiss, a hard metamorphic rock, to a much softer, less stable sedimentary rock. One of the alternative pumping plant sites would be near the sediment delta of the Bill Williams River and would require the construction of a barrier dam, which would alter the pattern of waterflows and sediment deposition in the upper end of the Bill Williams arm of the lake.

The Buckskin Mountains are a rugged, sparsely vegetated range which trend northeast-southwest along the shore of the Bill Williams arm of Lake Havasu. Several intermittent washes form small alluvial fans at the base of the range. Osborne Wash is on the southeast side of the range where the open canal section of the Granite Reef Aqueduct will receive the water for conveyance to central Arizona.

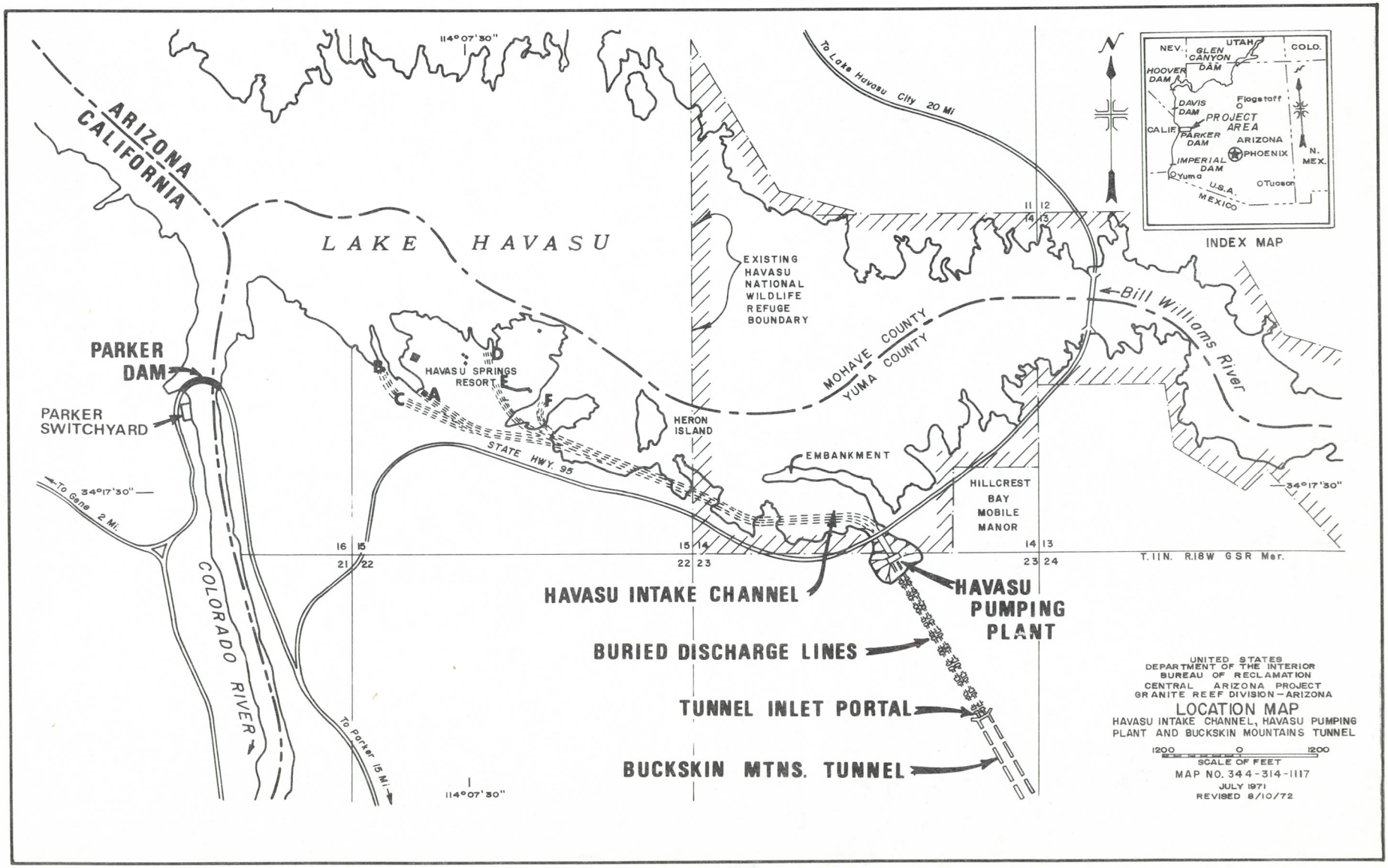

ARIZONA
CALIFORNIA
LAKE HAVASU
114°07'30"
To Lake Havasu City 20 Mi
EXISTING HAVASU NATIONAL WILDLIFE REFUGE BOUNDARY
MOHAVE COUNTY
YUMA COUNTY
Bill Williams River
PARKER DAM
PARKER SWITCHYARD
HAVASU SPRINGS RESORT
HERON ISLAND
STATE HWY. 95
EMBANKMENT
HILLCREST
BAY
MOBILE
MANOR
34°17'30"
To Gene 2 Mi.
COLORADO RIVER
To Parker 15 Mi.
T. 11 N. R. 18 W. G.S.R. Mer.
HAVASU INTAKE CHANNEL
HAVASU PUMPING PLANT
BURIED DISCHARGE LINES
TUNNEL INLET PORTAL
BUCKSKIN MTNS. TUNNEL
INDEX MAP
NEV.
UTAH
COLO.
GLEN CANYON DAM
HOOVER DAM
DAVIS DAM
Flagstaff
PROJECT AREA
CALIF.
PARKER DAM
ARIZONA
PHOENIX
N. MEX.
IMPERIAL DAM
Yuma
Tucson
U.S.A.
MEXICO
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
GRANITE REEF DIVISION - ARIZONA
LOCATION MAP
HAVASU INTAKE CHANNEL, HAVASU PUMPING PLANT AND BUCKSKIN MOUNTAINS TUNNEL
1200 0 1200
SCALE OF FEET
MAP NO. 344-314-1117
JULY 1971
REVISED 8/10/72

Figure 29

Native vegetation in this area generally is very sparse and limited to desert species such as cacti, catclaw, cholla, creosote bush, and paloverde, and in some of the washes, mesquite and ironwood. Much of the land along the south and east shores of the Bill Williams arm of Lake Havasu is included in the Havasu National Wildlife Refuge. The refuge contains marsh and delta habitat areas which are used by migratory waterfowl. A rookery of the great blue heron is found on Heron Island outside the refuge. A small herd of deer uses the area and a small band of desert bighorn sheep is in the Buckskin Mountains. Vegetation density increases and the type changes to marsh-riparian stream along the Bill Williams River and constitutes the primary wildlife habitat in the area. The lake itself supports a warm-water fishery. Many species of small mammals and birds are found around the lake.

The Colorado River has been significantly altered by the construction of dams like Parker and Hoover, and subsequent inundation of large areas of desert lands. Recreational and other developments have also changed the natural environment of this area. While most of this human disturbance has been water oriented along the immediate shoreline, the surrounding mountain and desert areas until recently were largely undisturbed by off-road vehicles. Archeological surveys in this area have not discovered any major sites.

c. Impacts of the Alternatives 70

Of the 4 alternative route designs for this feature, discussed above, the first 2 would have a more significant impact on the Havasu National Wildlife Refuge in that these 2 routes would involve more work along the Bill Williams River and more impact on the attendant riparian growth and wildlife habitat. This same impact is not present in the latter 2 alternative routes, which were rejected on engineering grounds and cumulative analysis of each of the components of the feature. The route that was selected is a combination of the most advantageous components from an environmental, engineering, and geologic standpoint.

The selected intake channel design, with its landform embankment and attendant recreational potentialities will be constructed from excavated materials available from the pumping plant site and other features of the Havasu complex. The advantages of the selected intake channel design over Alternate F and the other alternatives include decreased construction costs, more adaptability to land-form design, incorporation of recreational facilities, less harmful impact on aquatic life created by construction and operational activities, utilization of spoil materials from other segments of the feature, and enclosure of a smaller surface area of the Bill Williams arm of Lake Havasu. Three disadvantages of the selected design are: a minor increase in the quantity of suspended sediment passing through the Havasu Pumping Plant and into the aqueduct system; lack of land-based access to all areas of the intake channel for maintenance purposes; and the possible need for dredging and disposition of sediment deposits encroaching within the intake channel during the life of the project.

The impacts associated with the first 1,500 feet of the alternative routes would be similar to those of the selected design. Route A would provide for greater than 100-year sediment protection. However, Route A would fail to utilize material from necessary excavation; greatly reduce the available surface acres of water for recreation; create a more extensive loss of aquatic habitat; interfere with the natural continuity of the shoreline and adjacent islands; displace existing concession facilities; and have a greater visual impact on the esthetic value of the overall area. The impacts on the variation of Route A would be similar to those described above. In addition, there would be increased disruption of the shoreline resulting from cove excavation and complete relocation of the marina. This alternative was rejected because of the extensive space required to develop an equivalent marina area.

The impacts of Route B would be similiar to those of Route A. Additionally, there would be more significant impact on esthetic values and a greater potential loss of wildlife from drowning in the open intake channel. This route was eliminated because of safety hazards to the public due to the size of the cut required, esthetic considerations, and greater cost.

Route C was eliminated because of environmental impacts similar to those for Route A, plus a need for additional spoil deposit areas, and an increased cost of approximately five million dollars.

Route D would entail less environmental impact than Routes A or B since the structure would be underground. However, Route D would have a higher adverse impact than Routes C, E, or F. It would necessitate a larger area for spoil deposition and would disrupt existing resort concessions. The cost would be greater than Routes A, B, or F.

Route E would have impacts similar to those associated with Route D but would be about 3 times as costly as Route F. Route F was initially recommended by the Ad Hoc committee. Route F closely parallels the existing shoreline and requires surface, as well as subaqueous, excavation. The embankment is essentially linear except in the general inlet area. This embankment would use construction materials from the pumping plant site excavation as well as materials from required excavation along the channel alinement. There would be an adequate quantity of construction materials for the Route F embankment. However, following extensive evaluation of the environmental, economic, recreational, and sedimentation factors, Route F was rejected in favor of the selected landform embankment.

The two pumping plant locations that were rejected involved extensive cuts into the rock hills as well as a cofferdam in Lake Havasu that the selected site did not require. In addition, both of the respective discharge line locations would be more expensive, have greater visual impacts, and involve more difficult rerouting of State Highway 95 than the chosen alinement. The standard design for the pumping plant was rejected in favor of the low profile design on the basis of esthetic considerations and the development of more efficient pumps. The below ground design for the discharge lines was selected because of difficulty in anchoring the lines, potential interference with wildlife movement, and a lesser visual

impact than the above-ground lines. The present tunnel location was chosen on the basis of geologic and economic investigations and a resultant lessening in environmental impact from construction and operation of this component. The selected concrete-beam design for the bridge on Highway 95 was chosen to be compatible with the pumping plant design and surrounding area, and to comply with the specifications of the Arizona State Highway Department. A steel design was rejected due to its incompatibility with the improved appearance plan for this feature of the CAP. The steep slope scheme for cuts involved in site preparation was rejected following evaluation of geological factors.

2. Granite Reef Aqueduct

The Granite Reef Aqueduct, originally known as the Parker Route, was one of the three major alternative route concepts which were analyzed in detail for comparative evaluation and have been discussed above. As early as 1945, the Granite Reef Aqueduct was found to be the most favorable alternative from an economic and construction standpoint and is essentially the route concept authorized for construction by P.L. 90-537. Additional alternative studies of segments of this route and resultant modifications were made between 1946 and 1968. Alinement studies, detailed topographic survey ground control, aerial photogrammetric mapping, and requirements of the terminal regulatory storage facility in the Phoenix area have all contributed to these modifications. Also, sprawling urbanization in the north Phoenix metropolitan area has necessitated location of the aqueduct on a higher-grade line through Deer and Paradise Valleys to minimize the acquisition of high cost right-of-way and adverse impact on man's environment.

a. Description of Alternatives 7,64,74

The original alinement for the Granite Reef Aqueduct utilized 4 high-head pumping plants for diversion of water from Lake Havasu as previously discussed. These pumping plants permitted location of the Granite Reef Aqueduct at a generally higher elevation across the Cactus and Ranegras Plains region. This original route was an all-gravity route from the Buckskin Mountains and required no relift pumping stations at Bouse Hills, the Little Harquahala Mountains, Belmont Mountain, and the Hassayampa River.

Between the Little Harquahala Mountains and the Belmont Mountains, the original alinement for the Granite Reef Aqueduct would have been essentially the same as that now proposed for construction. From the Belmont Mountains, the original alinement crossed the Hassayampa Plain and River at a much lower elevation, and continued around the southern tip and eastern edge of the White Tank Mountains for some 30 miles. The aqueduct route then turned in an easterly direction crossing the Agua Fria and New Rivers through low-head siphons. From these crossings, the canal alinement extended across Deer Valley south of the Hedgepeth Hills crossing the route of the present Interstate 17 near Bell Road, and then continuing in a southeasterly direction through Deer Valley south of Turf Paradise just north of the Sunnyslope community. It then turned east passing south of Squaw Peak and the Phoenix Mountains and continuing

generally east between Camelback and Mummy Mountains. From this area, the aqueduct would have turned north crossing through the southern end of Paradise Valley generally paralleling and north of the Arizona Canal to the terminal point near the Granite Reef Diversion Dam some 25 miles northeast of Phoenix, Arizona. This alinement would have required an excessive cut section behind Camelback Mountain and was rejected in 1961 because of excessive right-of-way costs and increasing urbanization of the north Phoenix area.

During studies in 1961, this alinement was relocated further north of the Phoenix area by providing for a pumping station at the Hassayampa River which would permit passage of the aqueduct north of the White Tank Mountains by means of a 6-mile tunnel. This alternative alinement would have continued from the White Tanks, generally paralleling the present proposed alinement, but at a location several miles south on its traverse north of the Phoenix area. In 1965, this alinement was again modified because of the increased pressure from urbanization and difficulty with routing around existing facilities in Deer and Paradise Valleys. This alinement also terminated in the Granite Reef Diversion Dam area and provided for recovery of head by the installation of power drops at major turnouts near the Agua Fria and Salt Rivers.

These two earlier alternatives were designed for a capacity of 1,800 cfs which would have utilized a concrete-lined canal having a bottom width of 22 feet, a depth of 15 feet, and a side slope of 1-1/2:1. Maximum diversion capability of these two early plans would have been about 1.2 maf a year.

These early layouts of the Granite Reef Aqueduct provided for direct terminal storage on the Salt River, which is also presently proposed by providing a connection to the proposed Orme Dam at the confluence of the Salt and Verde Rivers.

Final layout of the proposed alinement for the Granite Reef Aqueduct was started in the mid 1960's. This relocation again was due to increasing urbanization in the north Phoenix area, excessive right-of-way costs, and also to obtain a high elevation through the Phoenix area for connection to the proposed Orme Dam for terminal storage of Colorado River water. The present plan also dropped consideration of the canal powerplants because of the change in the market value of small quantities of energy generated by low-head, small volume releases within the Phoenix metropolitan area.

Several physical sizes of the aqueduct have been considered during the general planning period for the project. The primary alternative sizes studied in detail were 1,800, 2,500, and 3,000 second feet. Following is a tabulation showing the physical properties of the alternative canal sections which have been considered:

Q	b	d	S	H	SS
1,800	20.0	14.5	.00006	16.3	1-1/2:1
2,500	20.0	17.0	.00006	19.1	1-1/2:1
3,000	20.0	18.5	.00006	20.7	1-1/2:1
3,000*	24.0	16.4	.00008	18.6	1-1/2:1

*Approved typical section, see Chapter I.

Where:

Q = Capacity in second feet
b = Base width in feet
d = Water depth in feet
S = Slope of canal in feet per foot
H = Height of concrete in feet
SS = Side slope of canal section

The differences in capacity as shown reflect change in criteria concerning the cost of pumping energy, operational requirements and flexibility, and the project water supply. As shown, the physical differences in size between all alternative sections are small, with only a 4-foot difference between the base widths. Right-of-way requirements for all sections would be essentially the same and, therefore, the temporary and long-term environmental impacts would be the same for each canal cross section.

Studies have been made for placing the entire Granite Reef Aqueduct underground, and also for placing just the Paradise Reach (Reaches 11 and 12) underground. These studies conducted in 1963, 1968, and 1972, indicated that the construction costs for an underground pipeline would average about twice those for the open canal section. Based on the 1,800-cfs capacity, a pipe system was estimated at about $2.8 million per mile as compared to $1.4 million per mile for the open canal section. Recent estimates for the 3,000-cfs capacity indicated that pipe would average about $4.1 million per mile as compared to $2.8 million per mile for the open canal. Energy to overcome friction losses in a closed pipeline system would require about 10 times the energy required for an open canal. Economic and financial studies have also indicated that an all-pipeline system could not be justified in terms of benefit-cost ratio and repayment obligations. The underground pipeline system would have less adverse environmental impact in terms of esthetic values and big-game losses, and would also present less safety problems. The open canal section would have environmental and enhancement aspects and impacts as covered in Chapters III and IV of this statement.

b. Present Environment of Alternative Locations 135,200

The present environment of the routes which were considered for the Granite Reef Aqueduct are very similar to the selected route. There is minor variation in vegetation and wildlife found across the area between Lake Havasu and metropolitan Phoenix. The vegetative variations are

primarily due to elevation and precipitation differences. The wildlife variations are primarily in the larger mammals which are more influenced by the presence of man. Some of the earlier considered alinements would presently require placing the aqueduct in areas which are now residential. Phoenix has experienced rapid suburban growth in the last 20 years, and much land which was either desert shrub or agricultural land has now become urban in character. Even with the lack of any perennial streams along any of the proposed alinements of the aqueduct, evidence of prehistoric Indian cultures has been found by archeological surveys.

c. Environmental Impact of Alternatives

The environmental impacts of the major portion of the aqueduct alternatives would be essentially the same as discussed in Chapters III and IV regardless of the location across open, uninhabited desert lands. The alternative locations of the open canal which would place it closer to Phoenix in its last several miles would create a greater degree of visual impact, as well as increase the hazard of drownings and disruption of traffic within the suburban area. The alternative of placing the canal underground would result in fewer impacts on wildlife and humans, as well as water savings from reduced evaporation. The cost of such an alternative is prohibitive. Bureau of Reclamation statistics show that over a 100-year period, costs are approximately 50 percent higher for pipeline as opposed to open canal.

3. Orme Dam and Reservoir 7,75,190

During the course of planning, the Orme Dam has also been known successively as the McDowell and Maxwell Dams.

a. Description of Alternatives

The only multiple-purpose alternative to the selected Orme Dam site, which is located at the confluence of the Salt and Verde Rivers, would be a dam constructed at the location of the existing Granite Reef Diversion Dam. The estimated cost of a dam at the Granite Reef site is about twice the cost of a dam at the confluence site because of a deep buried channel in the right abutment and the increased length of the structure. The buried channel would require expensive remedial measures to reduce seepage under the dam. This buried or relic channel represents an older Salt River course that subsequently filled with coarse permeable alluvium. This would increase the overall CAP cost above the cost ceiling established by the authorizing legislation and approval of an increased ceiling would be required.

Waddell Dam, which forms Lake Pleasant on the Agua Fria River, was studied as a single-purpose alternative structure for regulation of the Granite Reef Aqueduct flows. This plan, which would provide approximately 50,000 acre-feet of additional storage, would require a 2-way feeder canal 6 miles in length, a pump lift of 65 feet, and raising of or replacement

of Waddell Dam. This plan was rejected on the basis of the economics of alternative storage capacity and the engineering design problems associated with increasing the height of the existing dam.

Another possibility considered as a regulatory storage single-purpose alternative for Orme Dam would be the construction of an earthfill dam on the Gila River east of Florence, Arizona. This dam would not replace the Gila River siphon but it would provide terminal storage for regulation of CAP flows. A slab and buttress spillway having a capacity of 251,000 cfs would be located near the right abutment. A pumping plant and forebay would be required immediately downstream of the dam. This plan would also require relocation of approximately 10.5 miles of railroad. The site would present a seepage problem, and the limited storage capacity and estimated high construction cost of this plan with the limited available storage for the single-purpose function provided were reasons for rejecting this plan. This site would not eliminate the requirement for Buttes Dam to provide flood control, sediment retention, and conservation.

A partial single-purpose alternative for Orme Dam would be raising Theodore Roosevelt Dam on the Salt River. Studies have been made under the Safety of Dams Program for raising the existing crest of Theodore Roosevelt Dam by various heights ranging from 3 to 20 feet. This plan presents promise for optimum resource utilization, but provides no opportunity for regulating CAP import flows. Additional studies and possible construction must be funded under a program other than the CAP.

b. Present Environment of the Alternatives

The Granite Reef site for an alternative dam to Orme would have essentially the same environment as that described for the Orme Dam and Reservoir. Geologically, however, the site is underlain by coarse alluvial gravels which, unless sealed, would permit seepage beneath the dam. Vegetation and wildlife would be quite similar, although the Granite Reef site is closer to metropolitan Phoenix and thus does, and would receive heavier recreational use. The northerly one-third of the Granite Reef Diversion Dam lies within the Salt River Indian Reservation.

The use of Lake Carl Pleasant for storage and regulation of the flows from the Granite Reef Aqueduct would require the enlargement of the existing reservoir at that site. At the present time, the environment is one of a large fluctuating reservoir set in a desert location on an intermittent desert river. Climate, topography, geology, and soils are all similar to those found at Orme. The vegetation and wildlife species which require a riparian habitat and cannot survive in a reservoir area have already been eliminated from the vicinity of this reservoir. Some species of fish, especially the non-native varieties which are enhanced by reservoir environments, are found in Lake Pleasant.

The construction of a dam on the Gila River near Florence would utilize an area with a climatic environment similar to that found at the Buttes site, which lies upstream. The dry river channel contains a thin fringe of mesquite and saltcedar. The flood plain level above the river

channel is developed as farmland for about 2 miles upstream of the damsite. The surrounding areas support typical desert vegetation. Wildlife would be typical of these vegetational communities. There are about 10 miles of railroad which run along the river at this site.

The climatic environment of the Theodore Roosevelt Dam and Reservoir, being at a higher elevation and at the junction of two valleys below high mountains, has influenced the vegetation to species capable of growing in areas with colder winters. The differences between Orme and Roosevelt are related to an existing reservoir and its attendant floral and faunal changes and climatic variations for a higher desert. Lake Roosevelt receives heavy recreational use despite its distance from the Phoenix metropolitan area. The reservoir lies in the Tonto National Forest.

c. Environmental Impacts of the Alternatives

The use of the Granite Reef site would cause the flooding of a larger portion of the Salt River Indian Reservation and a portion of the Fort McDowell Reservation. A portion of the Bush Highway would have to be relocated. More land in the Tonto National Forest would also be inundated. The effects of this reservoir on fish and wildlife would be similar to those discussed in detail for Orme Reservoir in Chapter III. Heavy recreational use would be expected, causing some degradation of local vegetation and wildlife.

The environmental impacts of both the Waddell site and the Roosevelt site would be very similar since both involve the raising of existing dams and enlargement of the reservoirs behind them. An increased land area would be inundated,and this would have an adverse effect on the local vegetation and wildlife within the new area of reservoir fluctuation. Many of those animals or birds which are disturbed by the construction or operation of a reservoir have already left the area. Increasing the capacity of either of these reservoirs would increase the available fishery, as well as the recreational capacity of the area. More fishing, boating, and swimming areas would be available. The Roosevelt site would add partial flood control on the Salt River for the benefit of Phoenix, but would provide no control for Verde River or lower tributary flooding and would provide no sediment control. The Waddell site is on a river that does not affect Phoenix.

The use of a site on the Gila River would inundate irrigated farmland, riparian vegetation, and wildlife, and would create a small reservoir fishery. However, the use of the Gila River site would not fulfill one of the major objectives of the Orme site, which is to provide storage and conservation of floodwaters for the protection of and later use by the city of Phoenix and the surrounding suburban communities. This facility could provide minor flood protection to the people of Florence, and storage of surface runoff, but other facilities would be needed to provide this service to metropolitan Phoenix. The Buttes Dam which will be located not far upstream from this site will adequately provide flood control on the Gila River above Florence.

4. Salt-Gila Aqueduct

a. Description of Alternatives [7,75]

Several alternative routes for the Salt-Gila Aqueduct have been considered since the 1947 report. The alinement of the Salt-Gila Aqueduct used in the 1947 report started at Stewart Mountain Dam on the Salt River and ended at the Santa Cruz Flats in the vicinity of Eloy. This routing and concept were modified by the 1961 design due to water right, economic, and quality of water mixing factors. In the 1961 design, the aqueduct started at a turnout structure at the end of the Granite Reef Aqueduct near the Granite Reef Diversion Dam, with the flows from the Colorado River carried across the Salt River in a siphon to the Salt-Gila pumping plant. The present alinement is easterly from and at a higher elevation than the 1961 alinement to take advantage of protective flood works constructed or planned by the Soil Conservation Service and to bypass areas experiencing land subsidence and accompanying earth fissures which are evident at the lower elevation.

b. Present Environment of the Alternatives

The environment which was described in Chapter II for the selected route is essentially identical to that which is found along the routes of the alternatives. All of the alternative routes would cross creeks, washes, or rivers which periodically carry storm runoff or floodflows from summer thunderstorms or winter rains and snowmelt. Occasional mixing of turbid runoff with Colorado River water may occur from reservoir releases at Orme or Buttes.

c. Environmental Impacts of the Alternatives

The impact associated with the alternative canal routes would be similar in most respects to that of the present route discussed in Chapter III. The introduction into the aqueduct of floodflows controlled by the Soil Conservation Service dikes is not contemplated.

5. Buttes Dam and Reservoir [7,75]

a. Description of Alternatives [82,170-172]

Studies of alternative plans at the present site and at other sites have been conducted by the U.S. Geological Survey, U.S. Indian Irrigation Service, U.S. Corps of Engineers, Soil Conservation Service, and the Bureau of Reclamation. The first study started in 1895 and subsequent studies have, in addition to the Buttes Reservoir site, considered the Queen Creek, Riverside, Christmas, Coolidge, Camelback, Alma, Conner, Red Rock, Upper Red Rock, Lower Red Rock, Quail Spring, Tres Alamos, Cascabel, Charleston, and Aravaipa sites.

Studies for the Buttes site examined a low concrete gravity dam providing storage for sediment control and irrigation, and a higher structure that would add the flood control function. The height above the streambed of the lower and higher structures would be about 187 feet and 217 feet, respectively.

The Buttes site was considered to be superior overall to the Riverside site which is located 6 miles downstream from Kelvin. A Gila River mainstream stream structure below the mouth of the San Pedro River would be superior to a structure on the San Pedro River.

The farthest downstream site on the San Pedro River is the Aravaipa site. This site would be the most viable for controlling San Pedro riverflows entering the Gila River. The average yield of Aravaipa reservoir would be about 75 percent of that of Buttes Reservoir while the estimated construction costs would be approximately equal. Since construction of a dam and reservoir at the Aravaipa site would provide less benefits than the Buttes site and environmental consequences would be similar, it was eliminated from further consideration.

b. Present Environment of the Alternatives

The present environment for a high or low dam at the Buttes site is the same as described in Chapter II. The Aravaipa site on the San Pedro River is upstream from the Buttes site, at a slightly higher elevation. Its vegetation and wildlife are similar to those found at the Buttes site. The San Pedro River through the Aravaipa site is an intermittent stream with no resident fish. There is some riparian vegetation and irrigated farmland along the San Pedro River above and below the confluence of Aravaipa Creek. There are two gypsum mines shown on the Geological Survey map of this area. The potential of the site for development of other minerals is not known. No towns or communities would be influenced by this alternative site, although, as with all riverbank areas in this section, there may be some archeological sites of significance.

c. Impacts of the Alternatives

The Aravaipa alternative would inundate an area at the confluence of the San Pedro River and Aravaipa Creek. Two mines would probably be inundated, as would a moderate acreage of riparian vegetation and farmland. State Highway 77 would have to be relocated. Data are incomplete with regard to possible relocation of the San Manuel Railroad. Other impacts, related to the construction, operation and maintenance of the dam at this site would be similar to those described under section C, Chapter III covering Buttes Dam.

6. Tucson Aqueduct [7,75]

a. Description of Alternatives

The route selected for the Tucson Aqueduct is an alternative to the route considered in 1961 and 1962. For the same water quantity, the previous route considered a pipeline system and three pumping plants. The initial lift would be in the vicinity of Picacho Reservoir. The pipeline route would be southerly to Picacho Pass and then parallel to

Interstate 10 and the Southern Pacific Railroad to Tucson. Two additional pumping plants would be required to overcome the elevation difference and the friction loss of the 56-mile-long pipeline. The total pump lift would be 920 feet. As the magnitude of the subsidence and cracking increased along the alinement east of the community of Picacho, the desirability of using an alternative alinement to avoid the problem became vital.

b. Description of the Present Environment

The most significant difference between the present environment of the initial routing of the aqueduct and the present routing is the amount of land subsidence and cracking which has occurred on the former route. For the most part, the route crosses open desert lands, near existing highways and railroads.

c. Impacts of the Alternatives

The construction impacts which would be associated with this type of a pipeline system are discussed in Chapters III and IV. Maintenance and operation of the alternative pipeline would have encountered serious problems because of severe subsidence and fissuring of the land. Any esthetic disturbance caused by the construction and visible from the highway or railroad would have been temporary, and mitigated by successional revegetation and careful construction practices. As the proposed alternative pipeline would be buried, no long-term disturbance of wildlife would occur.

7. San Pedro Aqueduct 7,75

There are several alternative locations and designs and environmental considerations that have been explored for the San Pedro Aqueduct. The more notable ones are discussed below.

a. Description of Alternatives

The present design for the aqueduct calls for an all pipeline system originating at Charleston Reservoir on the San Pedro River. Water will be carried in a pipeline to a pumping plant 4 miles downstream and then raised about 320 feet in elevation through a 5-1/2-mile-long pipeline traveling westerly. From that point, the water will flow northwesterly by gravity to the vicinity of Tucson.

One alternative to the present system would be a pipeline route at a higher elevation from the pumping plant to Tucson. Such a system would require more energy for pumping and a longer section of higher strength pressure pipe for the discharge lines. Both factors would add considerably to the cost of delivery of the water. If the route were at a lower elevation, the pipeline would be longer in order to follow the ground contours around ridges and would require larger diameter pipes to reduce friction losses. This, too, would add considerably to the cost of delivery of water. Another alternative would be an open concrete canal and

buried pipeline combination. Under this system, water would be released through a controlled outlet through the dam into an 18-cfs open concrete canal which would convey it 20 miles downstream to the vicinity of St. David. A pumping plant installed at this point would pump the water across the river to a higher elevation from whence it would flow by gravity to the Tucson municipal water system through a concrete pipeline. A variation of this alternative would be to use a larger capacity canal to carry water to the St. David and Pomerene areas for irrigation, in addition to the 18-cfs capacity for Tucson. Under this variation, the river crossing siphon would be north of Benson and the pumping plant would be located west of the river. This alternative has been considered in relation to methods of handling reservoir releases to satisfy downstream water rights.

b. Present Environment of the Alternatives

The present environment along the alternative pipeline routes would include areas or riparian vegetation along the banks of the San Pedro River. These areas have a variety of wildlife, and there are possibly undiscovered archeological and historical sites along the river itself. In general the area is similar to that described in Chapter II on the San Pedro Aqueduct.

c. Impacts of the Alternatives

The impacts of the various alternative buried pipeline routes would be quite similar. The right-of-way needed for any possible route to Tucson would vary with the length of pipeline.

As with the proposed route discussed in Chapter I, the pipelines would be buried in each instance, allowing restoration of the area as nearly as possible to its original condition, consistent with the need for continued access to the pipeline right-of-way for maintenance purposes. The right-of-way would pass mostly through unimproved land. The alternatives of using an open canal to deliver water from the dam to the vicinity of the pumping plant would require the permanent alteration of riparian areas along the river, and would also have as yet unquantified effects on the river in this vicinity due to the fact that water releases for both municipal use in Tucson and irrigation uses in the St. David and Pomerene areas would be through the canal and not through the natural riverbed.

8. Charleston Dam and Reservoir 7,44,46,63,75,135,172,177,178

a. Description of the Alternatives 172

Three alternative designs for the Charleston Dam have been considered to provide the same multipurpose functions. One of the alternative designs was an earthfill structure. The second was a concrete gravity structure with an earthfill dike to close a topographic saddle. Each of these was rejected in favor of the third (or selected) alternative which provides a more economical concrete, thin arch design concept.

A single-purpose alternative for the Charleston Dam site was also investigated to provide a single-purpose municipal and industrial supply function. This alternative was not given further consideration due to the limited service provided.

b. Present Environment of Alternatives

The environment would be comparable to that described in Chapter II. No significant deviations in the natural conditions found at the Charleston site would be expected.

c. Impacts of the Alternatives

Construction impacts would be essentially identical to those described in Chapters III and IV. The final appearance of the dam would have been different if the alternatives were constructed, but the overall impact of the dam and the reservoir on the biota and archeological sites in the reservoir area would remain the same.

9. Hooker Dam and Reservoir 7,23,33,34,37-39,45,51,60,66,108,142, 159,164,177-179,181,182,184,189

Due to environmental effects attributed to infringement by the proposed Hooker Reservoir on a portion of the Gila Wilderness Area, alternatives to Hooker Dam are being investigated to determine their suitability. The alternatives to Hooker Dam which could be located on the Gila River include the Conner, Telegraph, and Gila-Mangas sites. There are also two sites on the San Francisco River which could be used for alternatives or supplements to a Gila River mainstream alternative. These are the Alma and Reserve sites. As indicated in its letter of comment on the draft statement, the New Mexico Interstate Stream Commission has continually and consistently expressed its preference for the Hooker site as compared to either of the alternatives on the San Francisco River. The New Mexico Department of Game and Fish, in its letters of comment on the draft statement, also expressed a preference for the Hooker site, subject to further study of the alternatives. The New Mexico Environmental Improvement Agency likewise requested further study of alternatives to Hooker. Each alternative is discussed below.

a. Description of the Alternatives 169,171,172,181

The Conner Dam site is located in the lower end of the "Gila Middle Box," a narrow, precipitous canyon extending about 10 river miles downstream before opening into Red Rock Valley. This site on the Gila River is about 7 miles upstream from the community of Red Rock, New Mexico in the SE1/4, SW1/4, Section 13, T. 18 S., R. 18 W., NMPB&M. Because of its rock foundation and topographic configuration, the Conner site is considered ideal for a thin concrete arch dam structure. The reservoir, when full, would extend about 15 miles on the Gila River above the damsite. The major portion of the reservoir would be located in the Gila National Forest. The lower half of the reservoir would be in a narrow, precipitous canyon with very little riparian vegetation. This site was investigated by the Bureau of Reclamation in 1930.

The Telegraph Dam site is located on the Gila River at the opening of the "Gila Middle Box." The site is suitable for an earthfill dam. There are about four possibilities for the axis location. However, the best axis is located in the NE$\frac{1}{2}$, Section 28, T. 17 S., R. 17 W., NMPB&M, about 14 river miles downstream from the communities of Cliff and Gila, New Mexico. The reservoir, when full, would extend upstream about 8 miles. The inundation would affect Gila National Forest land and private land that has been purchased by mining interests and retired from irrigated agriculture in order to transfer the water rights to mining uses at Tyrone.

The Gila-Mangas site is located on the Gila River approximately 9 river miles below the communities of Cliff and Gila, New Mexico, in Section 3, T. 17 S., R. 17 W., NMPB&M. The site is about a mile below the mouth of Mangas Creek. The reservoir would inundate an area up to 8 miles above the dam or almost to the communities of Cliff and Gila. In this area, the Gila River Valley is similar to the Telegraph site, but with broader flood plains supporting more riparian vegetation. Private lands which would be inundated have been withdrawn from irrigated agriculture by mining interests for water right purposes, the same as at the Telegraph site.

The Alma site is located on the San Francisco River in Section 9, T. 11 S., R. 20 W., NMPB&M, about 1-1/2 miles downstream from the community of Alma and 7 miles north of Glenwood in Catron County, New Mexico. Other suitable sites are available within 3 or 4 miles below this site. The Alma Dam site is suitable for a thin arch concrete dam. The reservoir created would inundate about 1,700 acres of private irrigated grazing land and some Gila National Forest land. Construction of the dam and reservoir would require relocation of approximately 5-1/2 miles of U.S. Highway 180. The community of Glenwood would not be affected by flood releases from reservoir operations. This site was first investigated by the Bureau of Reclamation in 1920 as part of the San Carlos project.

The Reserve site is located on the San Francisco River in Section 35, T. 6 N., R. 19 W., NMPB&M, about 6 miles northwest of the community of Reserve in Catron County, New Mexico. The site is suitable for a thin arch concrete structure. The reservoir created would require acquisition of several ranches with 750 acres of private land.

One possible hydrologic alternative to Hooker or the above mentioned alternative damsites would be the production of the 18,000 acre-feet of water per year specified by Section 304 of P.L. 90-537 for use in New Mexico by pumping ground water from the Cliff-Gila Valley. The water quality would not be suitable for domestic uses without expensive fluoride removal measures.

b. Present Environment of the Alternatives

Five sites have recently been considered as alternatives to the Hooker site: Gila-Mangas, Telegraph, Conner, Alma, and Reserve. The

Gila-Mangas, Telegraph, and Conner sites are located on the Gila River while the Alma and Reserve sites are located on the San Francisco River, a tributary to the Gila River.

(1) Conner Site [169]

(a) Geology and Topography [169]

Conner Dam site is located about 7 miles upstream from the community of Red Rock, New Mexico. The Conner site, much like the Hooker site, is located in a narrow canyon between the Red Rock Valley and the Cliff-Gila Valley, an area of complex faulting and vertical displacement. Generally, the foundation of the damsite is granite with tertiary volcanics and thin mantles of overlying alluvial materials.

(b) Mineralization [136]

No significant mineral deposits have been located in the Conner site. The only deposits of importance in the area were fluorites further upstream above the Hooker site.

(c) Vegetation [23,135]

The northeasterly facing slopes of the Conner reservoir area are covered with dense juniper woodlands while the south facing slopes are covered with xerophytic shrubs and grasses.

(d) Invertebrates [33,

The invertebrate fauna of the Conner site is similar to the type found at the Hooker site.

(e) Fish [34,164]

The ichthyofauna of the Conner site include catfish, chubs, suckers, and minnows. Trout are planted in areas approximately 25 miles above the damsite. Water temperatures range from 32°F. to 80°F. Catfish can propagate within this temperature range, but the higher temperatures preclude most trout propagation. The extremes in streamflow, 3 cfs to 40,000 cfs, can be detrimental to the introduction of game fish. Water is diverted upstream and downstream for farming and industrial uses. Downstream water rights are assigned to fish or wildlife through retirement of irrigated lands.

(f) Amphibians and Reptiles [38]

The similarity in climate, elevation, and vegetation between the Conner and Hooker sites provides an indicator of the herpetofauna to be expected at the Conner site. The Hooker site herpetofauna are listed in Tables 5 and 6 of the Appended Material.

(g) Birds[39,164,176]

The game birds in the Conner Reservoir area include mourning dove, scaled quail and Gambel's quail. The avian fauna list for the Hooker site provides an extensive listing of the species, most of which may also be found at the Conner site (Tables 7 and 15 of the Appended Material). The Mexican duck, bald eagle, and peregrine falcon, as discussed in the section on birds for the Hooker site, may be found at the Conner site.

(h) Mammals [39,66,176]

Game species of the area include sonoran whitetail deer (locally called sonoran fantail deer) and mule deer. Common fur bearers such as beaver, weasel, fox, badger, raccoons, and muskrats, are present. The list of the mammals found at the Hooker site may be considered partially applicable for the Conner site (Tables 8 and 16 of the Appended Materials).

(i) Archeological [177,182]

No evidence of archeological surveys of the Conner site is available for this statement. Survey of the site will be necessary as a part of the alternative site determination.

(j) Land Use Patterns [135]

The mountain and hill areas of the upper Gila River are very rugged, wooded in parts, used some for grazing, but mainly are just open land. The major landowner in the area is the Federal Government. The river-bottom and valley lands have been used for farming and livestock range.

(2) Telegraph Site

(a) Geology and Topography[135]

The Telegraph Dam site is located at about 5,000 feet in elevation in a remote area on the upper Gila River, 14 miles below Cliff and Gila, New Mexico. The topography in the canyon is extremely rugged. The reservoir bottom areas contain farmland. The site lies within the Mexican highland section of the Basin and Range physiographic region near the boundary with the Colorado Plateau Province. The Telegraph site, like both the Hooker and Conner sites, is situated in an area of volcanic rock with some alluvial deposition along the tributary creeks and in the canyon bottom.

(b) Mineralization[136]

Although this site, like all of the others, is located within the most highly mineralized area of western New Mexico, no significant deposits have been reported within the reservoir area.

(c) Vegetation[23,135]

The vegetation on the Telegraph site has some similarity to that of the Hooker site. The south facing slopes are covered with xerophytic shrubs and grasses while the north facing slopes are covered with juniper woodlands.

(d) Invertebrates[33]

For the most part, the invertebrates for the Hooker site can be expected to be found at the Telegraph site. The similarities in elevation, climate, and some vertebrate fauna would indicate the similarities in invertebrate fauna.

(e) Fish [34,66,142,164,176]

The ichthyofauna of the Telegraph site include catfish, chubs, suckers, minnows, and speckled dace. The extremes in streamflow, 17 cfs to 25,500 cfs, are detrimental to introduced non-native fish. The low streamflows occur during seasonally dry periods when water is diverted for irrigation. Water temperatures during low flow are detrimental to the trout population. The Gila topminnow on the endangered species list (see section on fish at Hooker site) occurs in the Safford Valley and not at this site.

(f) Amphibians and Reptiles[38]

The similarities in climate, elevation, and vegetation between the Hooker and Telegraph sites would indicate some similarity in herpetofauna. The list of Hooker Reservoir site herpetofauna is included in Tables 5 and 6 of the Appended Material.

(g) Birds[39,66,164,176]

Game birds at the Telegraph site include mourning dove, Gambel's quail, bandtail pigeon, wild turkey, and scaled quail. Two hundred and twenty-six avian species are listed for the Hooker site (Table 15 of the Appended Material) and a similar number and species composition would be expected at the Telegraph site. The Mexican duck, bald eagle, and peregrine falcon, as described in the section on birds for the Hooker site, are included in the endangered species list.

(h) Mammals[164,176]

Whitetail deer, mule deer, black bear, and javelina are known to the area. Antelope inhabit the open areas west of the Gila River. Common fur bearers at the Telegraph site are beaver, weasel, fox, badger, raccoon, and muskrat. The listing of mammals in the Hooker site (Tables 8 and 16 of the Appended Material) represents an adequate listing of the probable species at the Telegraph site.

(i) Land Use Patterns [135]

This area, lying just above the Conner site on the Gila River, is similarly remote. It is surrounded by National Forest lands and is used to some extent for grazing.

(j) Archeological [177,182]

No survey is known to have been made at this site. A reconnaissance study will be made to assist in the evaluation of alternatives.

(3) Gila-Mangas Site

(a) Geology and Topography

The Gila-Mangas site is located on the Gila River about 9 miles below the communities of Cliff and Gila, New Mexico. This site is located in a canyon below the mouth of Mangas Creek, just above the Telegraph site. The topography is generally rugged and mountainous. The geology of this site is similar to that found at the Telegraph and Hooker sites.

(b) Mineralization

Patterns of mineralization in this area are similar to those of the Conner and Telegraph sites.

(c) Vegetation[23]

The riparian community along the Gila River above the Gila-Mangas site is in open terrain and is dominated by baccharis and galleries of cottonwood. The exposed hills in this open area have scattered small mesquite and one-seeded juniper with grasses, and other xerophytic shrubs. The south facing slopes in the reservoir area are covered with xerophytic shrubs and grasses while the north facing slopes are covered with juniper. The upper end of the reservoir site at the lower end of the Cliff-Gila Valley has marsh habitat.

(d) Invertebrates [33]

The invertebrates typically found at the Hooker Reservoir site are also likely to be found at the Gila-Mangas site due to the similarities in climate, elevation, and vertebrate species.

(e) Fish [34,66,164,176]

The ichthyofauna of the Gila-Mangas site include catfish, chubs, suckers, and speckled dace. The rainbow trout are seasonally stocked upstream from this site. The extremes in streamflow,

17 cfs to 25,500 cfs, can be detrimental to introduced game fish. The low streamflows occur during seasonally dry periods when water is also diverted from the river for irrigation. Water temperature during the low water period is not acceptable for salmonids. Downstream water rights are held in part for fish and wildlife through purchase and retirement of lands by the New Mexico Game and Fish Department for the operation of Roberts Lake on Sapillo Creek.

(f) Amphibians and Reptiles[38,164]

The herpetofauna for the Hooker Reservoir site have been inventoried (Tables 5 and 6 of the Appended Material). For the most part, the same species should be likely inhabitants of the Gila-Mangas site.

(g) Birds[37,39,66,164,176]

The Gila-Mangas Reservoir area is rich in avian fauna. Two hundred and twenty-six species are found at the relatively close Hooker site (Tables 7 and 15 of the Appended Material). A similar number and composition would be expected in the Gila-Mangas site. Game birds on the Gila-Mangas site include mourning dove, scaled quail, Gambel's quail, bandtail pigeon, and wild turkey. The Mexican duck, bald eagle, and peregrine falcon, as discussed in the bird section of the Hooker site description, are classified as endangered species.

(h) Mammals[37,39,66,164,176]

Common big-game and fur-bearing mammals are whitetail deer, mule deer, black bear, beaver, weasel, fox, badger, raccoon, and muskrat. Javelina and elk are present in small numbers and antelope are found in open areas west of the Gila River. Listings of the small mammals likely to be found at the Gila-Mangas site are included in Tables 8 and 16 of the Appended Material for the Hooker site.

(i) Archeological[177,182]

The Gila-Mangas site is similar in archeological potential to the Conner, Telegraph, and Hooker sites. There may be ruins, trash mounds, and other remains of archaic cultures in the area. Further investigations are programed to assist in the evaluation of alternatives.

(j) Land Use Patterns[135,169,181]

The Gila-Mangas area is remote and primarily in private ownership. Land uses include recreation, grazing, some farmland, and the pumping plant of Phelps Dodge Corporation for diverting water from the Gila River for use at the Tyrone mine operation. Very low population density exists in the area.

(4) Alma Site [181]

(a) Geology and Topography[135,169]

The Alma site is located on the San Francisco River about 1-1/2 river miles below the community of Alma, New Mexico. The San Francisco River runs through an open valley at about 5,000 feet in elevation. The area is partially similar to the climate and topography of the Hooker site. The river channel through the valley flows intermittently. Geologically, this area is part of the Mogollon Rim and is volcanic in origin. It is similar to the Hooker site in this respect.

(b) Mineralization [16]

Several gold mines are located at higher elevations (5500 feet) approximately 4 to 6 miles east of the site at the old mining town of Mogollon. These mines would not be affected by the dam or reservoir.

(c) Vegetation[23,135,164]

The native vegetation at the Alma site is similar to that inventoried and listed for the Hooker Reservoir site. Both sites are similar in elevation, climate, and topography. Vegetative zones for this site include the upper sonoran and transition zones with their characteristic dominant species. The vegetation along the channel of the intermittent flowing river is less dense than that along the perennial flowing Gila River.

(d) Invertebrates [33,164]

The similarities in elevation, climate, and flora between the Hooker and Alma sites are also reflected in the invertebrate fauna. The invertebrate fauna for the Hooker Reservoir site may be applied for the most part to the Alma site.

(e) Fish [34,66,142,164,176]

When the riverbed contains water, the ichthyofauna of the Alma area includes channel catfish, suckers, and dace. Approximately 2 miles below the damsite, springs feed the river and the fishery is year-round. At the damsite, the flow varies from 0 cfs to 7,000 cfs with frequent dry periods. The frequent dry conditions are unsuitable for all fish species. No water rights are designated for fish.

(f) Amphibians and Reptiles [38,176]

To the extent that similar conditions are found, the list of herpetofauna inventoried for the Hooker Reservoir site may

reasonably be applied to the Alma site (Tables 5 and 6 of the Appended Material).

(g) Birds[39,66,164,176]

The extensive avian list for the Hooker Reservoir site (Tables 7 and 15 of the Appended Material) may be considered partially applicable to the Alma site. Major game species include the scaled quail, Gambel's quail, bandtail pigeon, wild turkey, and mourning dove. The bald eagle and peregrine falcon, included on the endangered species list, may occasionally be found in the general vicinity of the Alma site.

(h) Mammals[39,66,164,176]

The inventory and listing (Tables 8 and 16 of the Appended Material) of mammals for the Hooker Reservoir site should be similar to those species expected to be found at the Alma site. Major game and fur-bearing species are: whitetail deer, mule deer, black bear, beaver, weasel, fox, badger, raccoon, and muskrat.

(i) Archeological [177,182]

The remains of cultures similar to those described in the archeological section on the Hooker site may be found in this area, although the dam and reservoir area has not been surveyed in any detail. A reconnaissance survey will be made of this site to assist in evaluation of alternatives.

(j) Land Use Patterns [135,181]

The settlement of Alma, New Mexico, would be inundated by the reservoir. Several miles of U.S. Highway 180 would also be flooded. The ranches in the reservoir area have some irrigated land to supplement the range forage supplies. Ground water provides a portion of the irrigation water that cannot be provided by surface diversion.

(5) Reserve Site [181]

(a) Geology and Topography

The Reserve site lies in the northwestern Mogollon Mountains about 6 miles northwest of Reserve, New Mexico. The San Francisco River valley in the area of the damsite is in a steep walled canyon surrounded by rolling hills. The 6,000-foot elevation and relief are different from the Alma site downstream.

Geologically, the Reserve site lies within the volcanic Mogollon Rim. Typical rock types are volcanic, with some overlying alluvial fill.

(b) Mineralization

At present, there is no mining activity in this vicinity. Southwestern New Mexico has known resources of many minerals, but no survey of the Reserve site has been made to determine if economically recoverable resources of any minerals are present.

(c) Vegetation[164]

The elevation of 6100 to 6300 feet, climate, and general topography of the Reserve site are somewhat similar to those of the Alma site. The vegetative life zones for the Reserve site include the upper sonoran and the transition life zones. The upper sonoran zone is dominated by oaks and the transition zone by ponderosa pine.

(d) Invertebrates[33]

The dissimilarities in elevation, climate, flora, and vertebrate fauna between the Reserve and Hooker sites would be reflected in the differences in invertebrate fauna. The inventory of invertebrate fauna of the Hooker Reservoir site can only be considered partially applicable to the Reserve site.

(e) Fish [34,66,142,164,176]

The riverflow at the Reserve site is seasonally variable with water being stored upstream in Luna Reservoir and released for diversion at Luna for irrigation. The Tularosa River supplements the flow of the river below the Reserve site. Ichthyofauna include catfish, suckers, rainbow trout, minnows, chubs, and possibly smallmouth bass. The lack of water during the summer is detrimental to fish. Water rights for fish and wildlife in the San Francisco River drainage have been acquired by transfer of water rights from agricultural lands purchased and retired from productivity.

(f) Amphibians and Reptiles [38,164,176]

The extensive listing for the Hooker Reservoir site (Tables 5 and 6 of the Appended Material) can be only partially used for this site due to differences in elevation, climate, and vegetation between the Hooker and Reserve sites.

(g) Birds[39,66,164,176]

A large portion of the 226 avian species inventoried and listed for the Hooker site may be found at the Reserve site with a few additional species more suited to the higher elevation and attendant type of habitat. Major game species include the scaled quail, mourning dove, Gambel's quail, bandtail pigeon, and wild turkey. The bald eagle and peregrine falcon listed on the endangered species list may occasionally be found in the area.

(h) Mammals 39,66,164,176

A listing of the mammalian fauna of this site may be partially inferred from the Hooker site list. Major game and fur-bearing species include whitetail deer, mule deer, black bear, elk, beaver, weasel, fox, badger, raccoon, and muskrat.

(i) Archeological 177,182

Past studies of the Cochise, Mogollon, Mimbres, and Cibola cultures and excavation of the Luna and other village sites as reported in publications in 1907, 1919, 1936, 1938, 1940, 1943, 1947, and 1949, together with more recent work, provide some archeological knowledge of the area. Additional reconnaissance surveys of the specific area involved may be necessary during evaluation of alternatives.

(j) Land Use Patterns 135

The Reserve site within the Gila National Forest lies in a remote portion of the mountainous country of western New Mexico. The small town of Reserve lies about 6 miles southeast of the damsite, and the small town of Luna is upstream from the damsite about 10 miles west. There are many small ranches in the area. Most of the land used for grazing of livestock is under Forest Service permit. The forest is also managed for timber production.

c. Impacts of the Alternatives

The acres of vegetation which would be inundated by the alternative sites on the Gila River are as follows:

Reservoir Site	Riparian Shrub	Riparian Woodland	Pinyon-Oak & Juniper	Xeric Shrub	Agriculture	Total
Conner	119.0	158.9	354.5	699.6	140.7	1,472.7
Telegraph	109.2	171.3	251.2	448.8	518.8	1,499.3
Gila-Mangas	135.6	462.8	414.8	488.0	876.6	2,377.8
Hooker	112	161	289	502	---	1,064

The Conner Reservoir would extend or influence about 15 miles of scenic Gila River upstream from the damsite. The greater part of the reservoir would be located in the Gila National Forest. The lower half of the reservoir would be in a narrow, precipitous canyon. The riparian vegetation in the area has a high proportion of baccharis. Under extreme flood conditions, the reservoir could affect about 5 miles of riparian vegetation in the lower reaches of the Cliff-Gila Valley. Operation of the reservoir would probably affect fewer plants and animals both in species diversity and biomass than any of the upstream alternatives considered.

The Telegraph Reservoir would affect about 8 miles of the river upstream from the damsite. Four vegetative types occur along this

part of the river, with about 519 acres of agricultural land located in the upper extreme reaches of the reservoir area. Several fine stands of Arizona walnut, sycamore, cottonwood, and willow occur in this area and provide nesting habitat for many species of birds. A wide variety of wildlife inhabit the riparian brush and ecotone surrounding the wood communities of this site.

The Gila-Mangas Reservoir would inundate an area up to 8 miles above the dam or almost to the communities of Cliff and Gila. This reservoir would inundate more riparian shrub, riparian woodland, pinyon, juniper-oak, and agricultural areas than the other three reservoirs on the Gila River. The most important loss would be the riparian woodland communities (463 acres) which provide excellent wildlife habitat. This portion of the Gila River valley is similar to the Telegraph Reservoir area, but with broader flood plains supporting more riparian vegetation. The lower portion of the Cliff-Gila valley also has some marshy habitat that has developed as a result of irrigation return flows and a high ground-water level.

The Alma Reservoir, located on the San Francisco River, would inundate about 1,700 acres of private irrigated and grazing land and some Gila National Forest land. The settlement of Alma, New Mexico would also be inundated. Though aquatic life occurs in the river reach affected by a potential reservoir, no fishing has established itself as the riverbed frequently goes dry. Very little riparian vegetation exists in this stretch of the river. The site is upstream from the general area of the introduced Rocky Mountain bighorn sheep.

The Reserve Reservoir would also be located on the San Francisco River. It would inundate about 750 acres, including some 600 acres of grazing land, and require the acquisition of several ranches in the area. Flood control protection would be afforded to the town of Reserve. The reservoir would provide some additional reservoir fishery and scheduled releases would enhance the almost nonexistent downstream cold water stream fishery in the San Francisco River.

CHAPTER IX

CONSULTATION AND COORDINATION

IX. CONSULTATION AND COORDINATION

A. Consultation and Coordination during Development of the Proposal and during the Preparation of the Draft of Environmental Statement

1. Public Participation Leading to Project Authorization 7,8,10,173, 174

The general public has been actively aware of the proposal for the CAP at least since December 1947 when the Central Arizona Project Report was submitted to the Secretary of the Interior. As a result of the favorable report, the Secretary submitted the proposal to Congress in 1948. The well-publicized court decision in Arizona v. California was the result of this first submission to Congress. This decision was followed by additional versions of the CAP bills being introduced into the House and Senate in 1963, 1964, 1965, and 1967, and a compromise version being approved by the House and Senate and signed by the President in 1968.

During the long legislative history of the CAP, many persons and groups were able to present their views to the Congress on the environmental consequences of the project. Among the persons providing testimony on the impact of the CAP to Congressional committees were:

Individual	Organization
Mr. David Brower	Executive Director, Sierra Club
Miss Joy Coombs	Grand Canyon Workshop of the Colorado Open Space Coordinating Council
Dr. Robert Dennis	Izaak Walton League of America
Dr. Alfred Etter	Defenders of Wildlife
Mr. Jeffery Ingram	Southwest Representative, Sierra Club
Mr. Thomas Kimball	Executive Director, National Wildlife Federation
Mr. D. B. Luten	Federation of Western Outdoor Clubs
Mr. Michael McClosky	Conservation Director, Sierra Club
Mr. Stephen Raushenbush	Consultant to National Parks Association
Dr. Spenser Smith, Jr.	Citizens Committee on Natural Resources
Dr. Ruth Weiner	Grand Canyon Workshop of the Colorado Open Space Coordinating Council

As a result of opposition by environmental groups and the determination that other sources of electric power should be authorized (see Chapters I and VIII), the Bridge and Marble Canyon Dams were deleted from the project. Awareness of and response to environmental issues also resulted in language in the authorizing legislation which provided for further study of alternatives for Orme and Hooker Dams. These concerns are listed in more detail in Chapters III, IV, and VIII of this final statement.

2. Federal and State Studies Associated with Development of Project Proposals 1,14,16,18,19,41-46,48-52,54-57,60,61,63,73, 76-82,130-146,162-166,175,181,184,188-196,201, 202

The Colorado River Comprehensive Framework Study for the Lower Colorado Region was completed and published in 1971. The main report and 16 supporting appendices were compiled by 16 Federal and five state agencies from 1967 to 1971. The study involved comprehensive economic and social research and resource planning in the region. A major portion of the study was concerned with the Gila River subregion, which in essence encompasses central Arizona. The report outlined a consensus of these different agencies on the needs of the people as associated with growth in the Southwest, including central Arizona.

The Bureau of Sport Fisheries and Wildlife, working cooperatively with the Arizona and New Mexico Game and Fish Departments, completed nine reports on the fish and wildlife resources in relation to the CAP between 1959 and 1969. The National Park Service under contract with the Bureau of Reclamation completed four field archeological surveys of sites for the individual features of the CAP during 1968 and 1969. Two of the project reservoir sites included in CAP were examined by Arizona State Museum under contract with the National Park Service for the Corps of Engineers. The Bureau of Outdoor Recreation completed three reports on recreation aspects of the project between 1967 and 1970. The Bureau of Mines completed five reports on mineral aspects between 1963 and 1972. The Arizona Game and Fish Department provided three reports, the Museum of New Mexico furnished one report, and the Arizona State Museum developed two reports. Three reports of the U.S. Forest Service were also utilized.

The results of all of these reports and numerous other studies such as the Bureau of Reclamation's Report on Buttes Dam and Reservoir, Middle Gila River Project, Arizona, 1961, and the Pacific Southwest Water Plan of the Department of the Interior, as modified in 1964, were used in the development of many of the environmental considerations for the project.

3. Involvement of Advisory Group and Public Entities in Environmental Concerns

In August 1971, the CAP Environmental Advisory Group was established by the Commissioner of the Bureau of Reclamation for the purpose of affording the general public an opportunity to actively participate

with Reclamation in an advisory capacity on environmental planning of the CAP. Appointments to the Advisory Group were intended to obtain a broad cross section of the public in Arizona. This diversity is evidenced by the fact that the current members are individually associated with such different organizations as the Arizona Wildlife Federation, the Arizona League of Women Voters, the Arizona State Reclamation Association, the Central Arizona Water Conservation District, the Advisory Commission on Arizona Environment, the Department of Economic Planning and Development for the State of Arizona, and the Bureau of Reclamation. Meetings are held with this group and the members are participating in overall environmental concerns for the CAP.

4. Dissemination of CAP Information through News Media

Frequent Departmental news releases are made concerning the CAP. Most of the news coverage is in Phoenix, Tucson, and central Arizona. However, newspapers, radio, and television in Colorado, Wyoming, Utah, California, and New Mexico often give extensive coverage to items concerning the CAP. National coverage has been given in such publications as the Sierra Club Bulletin, Christian Science Monitor, Wall Street Journal, and the Engineering News Record.

B. Coordination during Review of the Draft of Environmental Statement

1. Distribution of the Draft of Environmental Statement

The Draft of Environmental Statement on the CAP was filed with CEQ on September 27, 1971, and a notification was published in the Federal Register on October 2, 1971. A news release was issued simultaneously with the notification of availability as published in the Federal Register. The original distribution of the draft statement was made from the Washington Office of the Bureau of Reclamation and the Regional Office in Boulder City, Nevada. Three hundred copies of the draft were sent initially to 120 Federal, state, and local governmental agencies, public groups, and interested individuals. Following publication in the Federal Register, 150 additional copies were mailed upon request. A partial distribution list for the draft appears at the beginning of this statement immediately following the Summary Sheet. All responses and comments received are noted. Copies of this final statement have been furnished to those individuals who responded to the draft with written comments or who subsequently requested a copy of the final statement. A notice of availability of the final environmental statement has been made in the Federal Register. News media coverage has been accomplished and individual requests for the final statement are now being filled.

2. Special Consultation during Draft Review Period

Following the distribution of the Draft of Environmental Statement on the CAP, separate meetings were held to discuss the draft with representatives of the Arizona and New Mexico Game and Fish Departments, Bureau of Sport Fisheries and Wildlife, the CAP Environmental Advisory Group, and the Arizona Water Commission. Numerous other meetings and discussions have been held by public and civic groups where the CAP was the subject topic.

The official review period started on September 24, 1971, and continued until October 24, 1971. However, several agencies requested and were granted an extension of time. Official review comments on the draft statement received through April 27, 1972, a period of some 7 months, have been considered in the preparation of the final statement.

3. Responses to the Draft of Environmental Statement

During the time period from September 24, 1971, to April 27, 1972, 53 responses were received after distribution of the Draft of Environmental Statement from 45 separate entities. Multiple responses were received from some entities. The last of these letters was dated April 7, 1972.

The draft statement resulted in many questions being raised by individuals and groups. Some of those commenting requested additional detail on the project, which was provided. At least seven such information letters were prepared for the Sierra Club.

An analysis of the letters of comments at that time was prepared and reviewed with the CAP Environmental Advisory Group and the Arizona Water Commission on November 18, 1971.

In December 1971, the environmental consulting firm of Jones and Stokes Associates, Inc., in Sacramento, California, was retained by the Central Arizona Project Association to work with the Association on environmental matters related to CAP. The firm was also made available to the Bureau of Reclamation for researching basic literature, presentation of suggested outlines, and other assistance as needed.

C. Recent Studies Reflected in Final Statement [73,165,166,200]

In December 1971, the Bureau of Reclamation contracted with four professors at Arizona State University for information studies on the biota of the four proposed dam and reservoir sites. The resulting six reports included a discussion of the ecological relationships of the biota, past and present, and the impact the CAP will have on the ecology of these areas. Much of these data are included in this statement. Negotiations are continuing with the National Park Service for completion of archeological studies of major individual features of the CAP. Two such studies involving detailed surveys on the Havasu Intake Channel, Pumping Plant, and Buckskin Mountains Tunnel, and the Granite Reef Aqueduct, have been completed. Field archeological surveys on the Salt-Gila Aqueduct are scheduled to be completed in early fall of 1972. These and future studies will include firm recommendations for salvage and preservation of these resources. A program has been initiated for comprehensive evaluations of the impact on the life systems of all the proposed features of the CAP. An example is the study by the Arizona Game and Fish Department, discussed in Chapter III, concerning fish screen protection in the Havasu Intake Channel. Another phase of this work is a study of the estimated wildlife losses along Granite Reef Aqueduct. In addition, the study report included a progress report on

an aquatic impact study on Lake Havasu that was initiated by the Bureau of Reclamation in cooperation with the Arizona Game and Fish Department, California Department of Fish and Game, Bureau of Sport Fisheries and Wildlife, U. S. Coast Guard, and The University of Nevada at Las Vegas.

D. Disposition of Comments Received by Official Letter or Obtained through Meetings with Agencies and Individuals

The list of agencies, groups, and individuals included with the Summary Sheet in the front of this statement reflects (by an asterisk) all those who furnished written comments on the draft statement to the Bureau of Reclamation. Copies of all of the letters of comments are included in the Appended Material of this final statement. The originals of these letters are on file in the Bureau of Reclamation's Washington, D. C., Office or the Regional Environmental Clearinghouse in Boulder City, Nevada.

All of the review comments received by the Bureau of Reclamation have been considered in the preparation of this Final Environmental Statement. Some of the letters of comments have been specifically referenced and discussed in the text. On others, the questions raised have been answered in the text by extended discussion. In many instances, five or more letters of comments raised the same or a very similar question. These are considered collectively in responses to comments, answered in the text, and discussed below.

1. The coordinated letter on the Sierra Club's position stated that the Club's "...basic reaction to the draft is that it is inadequate in the information presented and does not meet the requirements or the intent of the National Environmental Policy Act of 1969." It further stated "...we realize that it is now only in draft form and that it will undoubtedly be much altered in the rewriting for the final version." The draft statement, released on September 24, 1971, was prepared in accordance with the National Environmental Policy Act of 1969, with the intent of providing an accurate and objective assessment of all the environmental impacts associated with the project. The draft was prepared following the outline of the Act, the Council on Environmental Quality Guidelines of April 23, 1971, Departmental Manual guidelines of September 17, 1970, the Bureau of Reclamation interim instructions on the flow process for preparation of environmental statements, dated April 22, 1971, and other directives and guidelines thereto. Subsequent to the issuance of the draft statement, new Departmental guidelines were published in the Federal Register on October 2, 1971. Bureau of Reclamation Instructions, Part 376, Environmental Quality - Preservation and Enhancement, were subsequently released on January 12, 1972.

This final environmental statement on the CAP was prepared in accordance with NEPA and the succeeding Departmental guidelines and Reclamation Instructions. The detail in the final statement has been expanded to be responsive to the Department's and Bureau's more comprehensive guidelines, the review comments received, and to more fully describe the environmental impact.

2. The Arizona State Reclamation Association, the Resources Agency of California, and others suggested a broadening of the discussion on the history of the project, clarification of water allocation language, and a more complete discussion of legislative actions related to the project. These suggestions have been incorporated in the legislative history in Chapter I, which provides a sequence of events from the time of the Colorado River Compact of 1922 through legislative requirements included in Public Law 90-537, passed in 1968. Overall requests for water are also presented in Chapter I, showing a total of more than 5.3 million acre-feet.

3. Mr. Francis J. Welsh, P.E., questioned both the wisdom of further subsidization of agriculture and whether there is an overall water shortage in the area. The Sierra Club repeatedly referred to the CAP as a dubious project, and Mr. Harry S. Coblentz and others raised the question - is the CAP necessary? Background information and the specific need for the project have been included in the discussion in Chapter I on "Problems in Central Arizona and Western New Mexico Related to the Project." That section includes the present and future need for recreational, agricultural, and municipal and industrial water, information on ground-water pumping and land subsidence, flood and sediment control, water needs on Indian lands, deterioration of the quality of ground water, and the demands for water existing in the State of New Mexico. A further description of the need for the CAP and the methods to be employed in attempting to satisfy these needs are outlined in Chapter I on "Objectives of the Central Arizona Project."

4. It has been suggested that a public hearing should be held. Some 450 copies of the draft statement were furnished to about 200 Federal, state, and local governmental agencies, public groups, and interested individuals. Written response was received from only about 22 percent of these entities. Following original distribution and publication in the Federal Register, news releases, and numerous reviews in the news media, only 15 private groups and 15 individuals requested copies of the statement. Of these, only three groups and no individuals responded with letters of comment.

The CAP has been the subject of lengthy Congressional hearings and Congressional testimony (discussed in Chapter I and at the beginning of this chapter), daily public exposure of the project, continuous coordination with the advisory group, and broad distribution of the draft and final statements. This background and the degree of response to distribution of the draft contributed to the decision not to hold further public hearings.

5. The Native American Rights Fund, the Natural Resources Defense Council, Inc., and the Arizona Game and Fish Department raised the question regarding inclusion of the effects of the Navajo powerplant in the CAP environmental statement. A final environmental statement for the Navajo Project, authorized under Section 303 of P.L. 90-537, was filed with CEQ on February 4, 1972, and is referenced in this statement.

6. Concern for the protection of the Indian communities whose lands will be partly inundated by Orme Reservoir and for water allocation

provisions affecting Indian tribes in the central service area was expressed by: Mr. Robert Hilgendorf, DNA; Native American Rights Fund; Mr. Harry S. Coblentz; the Sierra Club; and others. These matters are discussed in Chapters I and III. Briefly, Section 302 of P.L. 90-537 delineates the conditions which must be met relative to obtaining Indian lands for project use. In addition to monetary compensation for Indian lands obtained for project use, the Secretary must transfer to the Indians 2,500 acres of nearby and suitable land so that a reasonable land base will be maintained for a reservation. The Indians also retain the right to use or lease some of the reservation land taken for project purposes so long as such use is not inconsistent with the project. The affected Indian communities shall have the right to develop and operate recreational facilities at Orme Reservoir located on or adjacent to their communities. Under the provision regarding irrigation of lands and irrigation systems, project water will be made available for irrigation of Indian lands not previously irrigated.

7. In an effort to more fully explain the status of the present conditions and the impact of the project in relation to ground water, surface water, and salinity in the area influenced by the CAP, and in an attempt to consider questions regarding these subjects as raised by the Environmental Protection Agency, the Arizona Game and Fish Department, the Native American Rights Fund, the Natural Resources Defense Council, Inc., and others, a discussion is included in Chapter III. The average total dissolved solids for all the wells tested in the service area is 955 ppm as pumped. In most sections of the Salt River Valley, the imported Colorado River water will be better in quality than the pumped water now being used, but inferior to existing surface supplies. Using TDS as an index to quality, Colorado River water at Lake Havasu had an average of about 726 ppm for the period 1965-1968.

Due to the increased flow of water from Lake Mead (with CAP), the water above Parker Dam should experience a freshening effect over that of recent years. Water quality below Parker Dam should not deteriorate as a result of diversion to the CAP. The volume of releases through Parker Dam will remain the same with CAP except for the infrequent occurrence of excessive floodwaters and increased flows for use on the Colorado River Indian Reservation. Floodwaters resulting in surplus releases from Parker Dam have not occurred since 1963. The frequency of surplus floodwater will decrease as more of the Upper Basin States' entitlement is utilized.

8. The National Park Service, Department of Agriculture, Environmental Protection Agency, Native American Rights Fund, and others suggested a more thorough review of endangered species of fish and wildlife in areas influenced by project features. The Sierra Club suggested the entire discussions concerning the biota should be broadened and improved. Since the draft statement was issued in September 1971, additional data have been obtained for incorporation into the final statement. Much of the data was provided by Drs. Minckley, Patten, Cazier, and Ohmart of Arizona State University; reports and personal contacts with biologists of the Bureau of Sport Fisheries and Wildlife and the Arizona Game and Fish

Department; and from professional life scientists employed by the Bureau of Reclamation. An extensive explanation of the present life systems is included in Chapter II. Impacts of the project and mitigation measures are presented in Chapters III and IV. Endangered species possibly affected are discussed, their habitats identified, and impacts are discussed. Pertinent discussions of the ecological relationships and the impacts of the project on all biota are likewise expanded. Further studies are underway and planned which will continue to assess the life systems of the project area. The information obtained will be considered in the preparation of the individual statements on major features.

9. The Environmental Protection Agency, Sierra Club, Bureau of Land Management, and others offered recommendations regarding power and powerlines necessary to operate the CAP. Some suggest all powerlines be buried. As explained in Chapter I, conductors from the Parker Switchyard for 1-1/2 miles will be aboveground to a 230-kv terminal structure, and the 1/2 mile of line to the Havasu Pumping Plant will be placed underground. Undergrounding all high voltage transmission lines is not feasible due to excessive cost of initial installation and the required number of expensive reactor stations necessary to cancel out the capacitive effect of the cable after installation. Westinghouse Electric Corporation has estimated that to underground a 345,000-volt transmission line for more than 300 or 400 miles would require an expenditure of at least 26 times the cost of conventional overhead construction.

10. The Bureau of Sport Fisheries and Wildlife, Sierra Club, Arizona Outdoor Recreation Coordinating Commission, Arizona Game and Fish Department, Environmental Protection Agency, Bureau of Land Management, Bureau of Indian Affairs, and others raised questions concerning land-use patterns, land ownership, total acreage involved in the construction of all the features of the project, and lack of description of the present environment. A detailed description of present land-use patterns is a part of Chapter II. Impacts on these patterns are discussed in Chapter III. The total acreage required for right-of-way and construction sites for the aqueducts and reservoirs is approximately 54,000 acres. Amount and type of acreage required for each of the features are discussed in Chapters I through V, and VII. The projected future environment without the project is discussed in Chapters II and VIII.

11. The National Park Service, the State Planning Office of New Mexico, Native American Rights Fund, Arizona State Parks Board, the Advisory Council on Historic Preservation, and others suggested a more detailed description of the impact of the project on archeological resources and National historic places. The National Register of Historic Places and Designated National Historic Landmarks, and the National Registry of Natural Landmarks were reviewed, and current information was obtained from the departments in the States of New Mexico and Arizona concerned with the management of these resources. A discussion of archeological and historical resources and impacts is presented in Chapters II and III. This includes a description of Woodrow Ruin located in the general vicinity of the proposed Hooker Dam in New Mexico, and Casa Grande National Monument, Lehner Mammoth-Kill National Historic

Landmark and the Hohokam-Pima Irrigation Sites National Landmark located in Arizona. Other potential nominations to the National Register are also discussed. The National Park Service, Arizona Archeological Center (formerly Southwest Archeological Center) has conducted surveys of aqueduct routes and reservoir sites to appraise the archeological and historical sites and structures. The results of these studies are a part of the general description of archeological resources in Chapters II, III, and IV. Certain of these studies are considered preliminary. Negotiations have been undertaken with the National Park Service for more detailed surveys of the archeological resources of the sites for proposed features, and two such studies have been completed. The results of the more refined studies will be included in statements on individual project features. These new studies will include firm recommendations for preservation, salvage, and mitigation of archeological resources.

12. The Bureau of Outdoor Recreation, Sierra Club, Native American Rights Fund, Bureau of Sport Fisheries and Wildlife, New Mexico Department of Game and Fish, State of New Mexico Environmental Improvement Agency, Associate Professor Bruce J. Hayward of Silver City, New Mexico, and others expressed concern for a broader discussion of infringement of the proposed Hooker Dam site and Reservoir on the Gila Wilderness Area, the possibilities of alternatives to Hooker, and the effect of the proposed dams on riparian vegetation. The Sierra Club also states that infringement on this area would violate the Wilderness Act. Under Section 4(d)(4) of P.L. 88-577, water resource projects can be established in wilderness areas within National forests upon the determination that such use of the area would be in the best interest of the people. Hooker Reservoir will inundate 140 acres of the Gila Wilderness and 80 acres of primitive area at maximum conservation level. A description of the impacts of the proposed Hooker site and alternatives on the wilderness area and on riparian vegetation is included in Chapters III and VIII, respectively. The alternatives to the Hooker site, as well as other features of the project, are discussed separately from the overall alternatives to the CAP. The effect of the proposed dams on riparian vegetation is discussed in Chapter III.

13. The Bureau of Mines believes that the draft environmental statement was inadequate in its treatment of mineral occurrences, mining claims, and exploration and development potential in the areas of the proposed reservoirs. However, it was suggested that increased water availability due to the project could locally benefit the mineral industry. The proposed Orme Reservoir area has no known remaining mining potential. Although about 300,000 tons of barite have been removed from a deposit immediately downstream from the left abutment saddle, the mine has been abandoned for many years, and the deposits apparently do not extend into the reservoir area. Foundation drilling conducted for the damsite did not show any barite mineralization. The abandoned open shaft has recently been filled to reduce the safety hazard to recreationists using the area. The Buttes site is recognized as possibly having low-grade copper-ore deposits on withdrawn lands in or adjacent to the proposed reservoir area. Tentative plans are presently being formulated for commercial exploration of

the potential mineralized areas with the possibility of allowing mineral extraction if compatible with the plans and construction schedules of the CAP. Historically, the Charleston Mining District, which is partly within the proposed Charleston Reservoir area, was active in lead and silver mining. The mineralized area could mostly be protected by a dike across a small arm of the reservoir, as recommended by the Bureau of Mines. The desirability of a dike will be evaluated during the design stage, following further appraisal of the mineral value to be salvaged. The Hooker reservoir area is adjacent to areas mineralized with copper, lead, and zinc, but the only known mineral deposits within the reservoir area are non-commercial veins of fluorite. A few small fluorite mines in the area were operated during World War II, but are not economical under present conditions. More details of the impact of the CAP on the mining potential are included in the sections on mineralization in Chapter III.

14. The Arizona Game and Fish Department, Arizona Wildlife Federation, Bureau of Sport Fisheries and Wildlife, Arizona Outdoor Recreation Coordinating Commission, Arizona Water Sports Council, Sierra Club, New Mexico Department of Game and Fish, Bureau of Land Management, Museum of Northern Arizona, and others raised questions concerning structures for fish and wildlife and other mitigation and enhancement features of the project. Chapter IV deals extensively with these subjects. In that chapter, the discussion is outlined under three major categories: 1) Standard Reclamation Rules for Design and Construction; 2) Protective Measures and Mitigation Features Included as a Part of the Project; and 3) Proposed Enhancement Measures not Authorized under Public Law 90-537. Mitigation measures are defined as those being funded by the project. Enhancement features are defined as those being desirable, but not included as part of the original authorization. Mitigation is considered as replacement or substitution for losses incurred as a result of project construction. Proposed enhancement not yet authorized includes additional features that are recommended by cooperating land-use agencies as being desirable, beneficial, and important additions to the project, but which were not included in the project during Congressional authorization. Protective measures, mitigation features, and enhancement are not limited to fish and wildlife. Reports prepared by the Bureau of Sport Fisheries and Wildlife and concurred in by the Arizona Game and Fish Department are quoted extensively. Backwater fingers listed in the draft statement are not now considered feasible and have been replaced with other watering devices. Off-aqueduct flow through side ponds and wildlife watering sites has been modified to coincide with recommendations of the Arizona Game and Fish Department and Bureau of Sport Fisheries and Wildlife. Safety features included as a part of the project are designed for both wildlife and humans.

15. The Museum of Northern Arizona, Sierra Club, Environmental Protection Agency, Arizona Game and Fish Department, and others raised questions regarding water salvage from phreatophyte control. Pursuant to Section 306 of P.L. 90-537, the water salvage program along and adjacent to the mainstream of the lower Colorado River was a part of the Colorado River Basin Project authorization. However, the intent of this program

in part has already been accomplished. Further research for management of phreatophytes will be pursued as a separate vegetative management program. The program is intended to be multiple-purpose in scope, including water salvage, recreation, and fish and wildlife aspects. In response to the inquiry from the New Mexico Department of Game and Fish, channelization, channel modification, or phreatophyte control along the Gila River in New Mexico are not proposed as part of the CAP.

16. Mr. Joseph J. Brecher of the Native American Rights Fund indicated a defect in failing to discuss the environmental impacts regarding construction of fishing lakes by the Arizona Game and Fish Department. This comment stems from the January 17, 1969 request of the Arizona Game and Fish Department for 60,000 acre-feet of water to develop 50 new fishing lakes in the mountains. This request is discussed in Chapter IV of this statement. In its November 19, 1971 reply to the draft statement, the Arizona Game and Fish Department stated "Appropriation of water to the users has not been made at this time. This makes it difficult if not impossible to accurately assess the environmental impact of the project." This quotation is still appropriate. As stated in the draft, construction would be over a period of 25 years, thus making total assessment at the present time even more difficult. Discussion with representatives of the Arizona Game and Fish Department indicates that plans for the fishing lakes are not finite. However, the Department and the Bureau of Reclamation are aware of most environmental impacts that would be generated by a program for construction of fishing lakes including direct impacts from construction and access, increased use of an area, and changes in or losses of habitat.

17. The Museum of Northern Arizona, Sierra Club, Native American Rights Fund, Arizona Game and Fish Department, National Park Service, Department of Agriculture, and others suggest a broader discussion of the impacts of increased use of the recreational facilities provided by the project and of the population growth potential of the service area. The implication is that a drastic increase in recreational use of an area will result in adverse environmental impacts or unnatural conditions. With increased or new use of an area, i.e., a new reservoir, there will be indirect and direct impacts associated with use as well as direct and indirect impacts of construction. Impacts associated with increased recreational use are discussed in numerous sections of Chapters III and IV. Considerations for secondary impacts such as trampling, expanding use beyond buffer or fringe zones surrounding a facility, access roads, provision of sanitary facilities, campgrounds, picnic areas, boat launching ramps, and other use facilities are recognized. Recreational development will conform to master planning criteria to be developed for the area as directed in the authorizing legislation and with the necessary approval by the Secretary of the Interior. The population growth potential of the service area is discussed in Chapter III.

18. The State Planning Office of New Mexico indicated that the East Fork of the Gila River is presently being considered for inclusion

in the State Wild and Scenic River System and that CAP should not interfere with this proposal. Neither the Hooker Reservoir nor its five alternate sites that have been under evaluation (Chapter VIII) will affect that area. There are no plans in CAP for investigation or use of areas that would influence the East Fork of the Gila River.

19. The Native American Rights Fund and the Department of Health, Education and Welfare commented on the use of pesticides and herbicides. This environmental statement recognizes the potential for an increase in the number of vectors, such as mosquitoes, and the presence of potential waterborne diseases. The statement also recognizes that bacteriological quality of water supplies at some recreational areas does not meet USPHS standards. Health guidelines employed during the development of recreational areas will follow the criteria of the PHS publication, Environmental Health Practices in Recreational Areas. The use of chemicals to protect domestic water supplies, control vectors, maintain acceptable bacteriological standards or to limit unchecked growth of aquatic vegetation will be in strict compliance with the Department of the Interior and the Environmental Protection Agency guidelines and regulations. These items are listed in Chapter II and discussed in Chapter III.

20. The March 7, 1972 letter from New Mexico Game and Fish Department acknowledges the project authorization of 18,000 acre-feet annually of additional uses in New Mexico. The letter further states that an additional 20,000 acre-feet annually for future wildlife and recreational projects would contribute to the State's economy as a whole and to the Gila Valley in particular. This additional 20,000 acre-feet is greater than the Type I Framework Study estimated fish, wildlife, and recreation requirement for the Gila River basin portion of New Mexico. It is, however, less than the additional 30,000 acre-feet annually provided for New Mexico in the authorizing legislation to be made available following augmentation of the Colorado River.

The New Mexico Game and Fish Department had previously submitted an Expression of Interest form for project water as requested by the Secretary of the Interior for those entities interested in contracting for project water. This Expression of Interest in project water, dated March 2, 1971, was for 3,000 acre-feet. No revised Expression of Interest for contracting for project water has been submitted. With the total of Expression of Interest from New Mexico entities totaling in excess of 65,000 acre-feet (see Chapter I, Table 2), the recommendations of the New Mexico Interstate Stream Commission to the Secretary of the Interior will provide guidance with regard to allocating New Mexico's initial 18,000 acre-feet allotment and the potential subsequent 30,000 acre-feet allotment after augmentation. Fully meeting the current New Mexico expressions of Interest and the apparent increase desired by the New Mexico Game and Fish Department will on the basis of planning studies require additional facilities appreciably beyond the scope of the authorized CAP.

21. The Environmental Protection Agency and the Sierra Club raised questions about evaporation losses of water and their effects. The impact of evaporation losses of Colorado River water in transit is discussed in Chapter III. The 18,000 surface acres referred to by the Sierra Club represent the approximate total area of the four reservoirs at their conservation levels. However, the average operating levels in the reservoirs during the year will be below the conservation levels. Therefore, the estimated total evaporation from the four reservoirs and open aqueducts in the CAP will average approximately 72,000 acre-feet per year. This figure is based on a 6-foot-per-year evaporation rate.

22. There were a number of comments regarding alternatives to the CAP and the alternatives of individual features of the project, in particular the proposed Hooker Dam site and Reservoir. A distinction is made in this final statement between alternatives to a feature of the project and alternatives to the project itself. Alternatives to the Havasu feature and its components and to the proposed Hooker site are examples of alternatives to individual features. Both types of alternatives are discussed in Chapters IV and VIII. Chapter VIII on alternatives presents alternative routes for the importation of Colorado River water to central Arizona, alternative water sources, the alternative of no action, alternative power sources, and alternatives to major features of the project. Environmental impacts of the alternatives are included in the discussion.

23. Most letters of comment suggested a more detailed and expanded description of the features of the project. This was accomplished in keeping with the intent of this statement, which is to describe the general overall impacts of the CAP. Individual statements on major project features will be prepared at a later date. The recommendations for additional holding reservoirs, ponds, and pumped-storage power generation system suggested by the Arizona Water Sports Council have been considered in the planning process and were found not to be feasible or did not meet the project objectives.

24. Some of the comments and questions dealt either directly or indirectly with the question of the control of population growth. Population factors and possible impacts on growth and development of the project area are discussed in Chapters II and III.

25. Every effort was made in this statement to quantify the environmental effects of CAP. There are, however, a few unresolved questions that cannot be answered at this time. Unquantified impacts include the cumulative social and economic effects of Orme Reservoir on the Fort McDowell Indian community; the emotional effect of using a small portion of the wilderness and primitive areas for Hooker Reservoir; the effect of reservoirs and aqueducts on some species of mammals; and others as described in Chapter III. It is recognized in this statement that methods and procedures need to be developed to better understand, study, and evaluate them.

APPENDIX A OF APPENDED MATERIAL

DEFINITIONS FOR TABLES

The following definitions apply to the tables found in this Appended Material:

Endangered: An endangered species or subspecies is one whose prospects of survival and reproduction are in immediate jeopardy. Its peril may result from one or many causes - loss of habitat or change in habitat, overexploitation, predation, competition, disease. An endangered species must have help, or extinction will probably follow.

Rare: A rare species or subspecies is one that, although not presently threatened with extinction, is in such small numbers throughout its range that it may be endangered if its environment worsens. Close watch of its status is necessary.

Peripheral: A peripheral species or subspecies is one whose occurrence in this country is at the margin of its natural range. Special attention may be needed to retain them in the United States.

Status Undetermined: A species or subspecies which has been suggested for rare or endangered classification, but about which further information is needed to clarify its status.

Where predicted effect on number of individuals is noted on the tables, this pertains only to the inundated reservoir areas.

For an explanation of how to use the tables, refer to pages 131 through 133 of the text of this statement.

Table 1

Native ichthyofauna of the Gila River system, emphasizing the Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico, ca. 1850, and at present (1970). Symbols: X = presence as documented by on-site or upstream literature, photographic, or specimen records; H = probable occurrence based on known ecology of the species and habitats in the area; and --- = absence. The column to the left for each site is for the 1850 period, and that to the right is for 1970.

Species	Reservoir Sites							
	Orme		Buttes		Charleston		Hooker	
SALMONIDAE, TROUTS AND SALMONS								
E *Salmo* sp., Apache trout	---	---	---	---	---	---	---	---
E *S. gilae*, Gila trout	---	---	---	---	---	---	H	---
CYPRINIDAE, MINNOWS								
Gila elegans, bonytail chub	X	---	H	---	---	---	---	---
G. robusta robusta } roundtail	X	H	X	---	---	---	---	---
G. r. grahami } roundtail	---	---	---	---	X	---	X	---
G. intermedia, Gila chub	X	---	---	---	X	---	---	---
Meda fulgida, Gila spikedace	X	---	X	---	X	H[1/]	X	X
Plagopterus argentissimus, woundfin	X	---	---	---	---	---	---	---
E *Ptychocheilus lucius*, Colorado River squawfish	X	---	X	---	H	---	---	---
Agosia chrysogaster, longfin dace	X	X	X	X	X	X	X	X
Rhinichthys osculus, speckled dace	X	---	X	---	X	---	X	X
Tiaroga cobitis, loach minnow	X	---	X	---	H	---	X	X
CATOSTOMIDAE, SUCKERS								
Catostomus insignis, Gila sucker	X	X	X	---	X	---	X	X

Table 1. Concluded.

C. latipinnis, flannelmouth sucker	X	---	X	---	X	---	---	---
Pantosteus clarki, Gila mountain-sucker	X	X	X	X	X	X	X	X
Xyrauchen texanus, razorback sucker	X	---	X	---	X	---	---	---
CYPRINODONTIDAE, KILLIFISHES AND TOOTHCARPS								
Cyprinodon macularius subsp., Desert pupfish	X	---	H	---	X	---	---	---
POECILIIDAE, LIVEBEARERS								
E *Poeciliopsis occidentalis occidentalis*, Gila topminnow	X	---	H	---	H	---	H	---

1/ A single specimen of Gila spikedace was taken at Fairbank, Cochise County, Arizona, in 1965--the last record for this species from the San Pedro River that is known to me.

E Indicates endangered species as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

Table 2

Ecological relationships of native fishes of the Gila River basin, Arizona-New Mexico.

Symbols: X = "preferred;" 0 = avoided; and ? = qualified or inferred relationships.[1/]

Features of habitat		Fish species																
		Salmo sp., "Apache trout"	Salmo gilae, Gila trout	Gila elegans, bonytail chub	G. robusta, roundtail chub	G. intermedia, Gila chub	Meda fulgida, Gila spikedace	Plagopterus argentissmus, woundfin	Ptychocheilus lucius, squawfish	Agosia chrysogaster longfin dace	Rhinichthys osculus speckled dace	Tiaroga cobitis, loach minnow	Catostomus insignis, Gila sucker	C. latipinnis, flannelmouth sucker	Pantosteus clarki, mountain sucker	Xyrauchen texanus, razorback sucker	Cyprinodon macularius, pupfish	Poeciliopsis occidentalis, topminnow
Bottom type	organic	0?	0?	0	0	x	0	0	0	0	0	0	0	0	0	x	x	x?
	silt	x?	x?	0	0	x	0	x	0	0	0	0	0	0	0	x	x	x
	sand/gravel	x	x	x	x	0	x	x	x	x	x	x	x	x	x	0	0	x
	boulder/bedrock	x	x	x	x	0	0	0	x	0	x	0	0	x	x	0	0	0
Bottom stability	stable	x	x	0	0	x	0	0	0	0	0	0	0	0	0	x	x	x
	moderate	x	x	0	0	x	x	0	x	0	x	x	x	x	x	x	x	x
	laminar movement	0	0	x	x	0	x	x	x	x	0	x	x	x	x	0	0	0
	saltational	0	0	x	x	0	0	x	x	0	0	0	0	x	0	0	0	0
Stream type	ponded	x	x	0	0	x	0	0	0?	x	x	0	x?	0	0	x	x	x
	meandering	x	x	0	x	x	x	0	0?	x	x	0	x	0	x	x	x	x
	pool-riffle	x	x	x?	x?	x?	x	0	x?	x?	x?	x?	x	0?	x?	x?	?	?
	channelized	0	0	x	x?	0	0	x	x	0	x	x	0	x	0?	0	0	0
Velocity of flow	none	0?	0?	0	0	x	0	0	0	0	0	0	0	0	0	x	x	x
	slow	x	x	0	x?	x?	0	0	x?	x?	0	0	x?	0	0	x	x	x
	moderate	x	x	x?	x	0	x	x?	x	x	x	x?	x	x?	x	x?	0	0
	swift	0	0	x	x?	0	x?	x	x?	0	x?	x	0	x	x?	0	0	0

Table 2. Continued

Current 1/	none	0	0	0	0	x	0	0	0	0	0	0	0	0	0	x	x	x
	slow	x?	x?	0	0	x	0	0	x?	0	0	x?	0	0	x?	x	x	x
	moderate	x	x	x	x	0	x	x?	x	x	x	x	x	x	x	0?	0	0
	pronounced	0	0	x?	x?	0	x?	x	x?	0	x?	x?	0	x	x?	0	0	0
Stream size	brook	x	x	0	0	x	0	0	0	x	x	0	0	0	0	0	x	x
	creek	x	x	0	x	x	x	0	0	x	x	x	x?	0	x	0	x	x
	stream	x?	x?	x?	x	x?	x	x?	0	x	x?	x	x	x?	x	x?	x?	x?
	river	0	0	x	x	0?	0?	x	x	x?	0?	0	0?	x	0?	0?	0?	0?
Aquatic plants	absent	x	x	x	x	0	x	x	x	x	x	0	0	x	0	0	0	0
	sparse	x?	x?	x	x	0?	x	x	x	x	x?	0?	x?	x	x?	0	0?	0?
	common	0	0	0	0	x	0?	0	0	0?	x?	x	0	0	x	x	x	x
	abundant	0	0	0	0	x?	0	0	0	0?	0?	x?	0	0	0	x?	x?	x
Stability of waters	stable	x	x	0	0	x	0	0	0	0	x?	x?	0	0	0	x?	x?	x?
	moderate	x	x	0	0?	x?	0?	0	0	0	x?	x?	x?	0	x?	x	x	x
	seasonal	x	x	x	x	0?	x	x	x	x	x	x	x	x	x	x?	x?	x?
	erratic	0	0	x	x	0	0	x	x	x	0	0	x?	x	x?	0	0	0
Habits	bottom	0?	0?	0?	0?	0?	0	x	0?	0?	x?	x	x	x	x	x?	x	0
	open water	0?	0?	x	x	x?	x	0	0	x	x?	0	0	0	x?	x	0	0
	mid-water	x	x	x	x	x?	x	0	0?	x?	0	0	0	0	0	x	0	0
	near cover	x	x	0	0	x	0	0	x	0	x	x	x?	0?	x?	0	x	x
	surface	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0?	x
	deeps	x	x	x	x	x	0	0	x	0	0	0	x	x	x?	x	0	0
	moderate	x	x	x	x	x	x	x	x?	0?	0?	0?	x?	0	x?	x?	0?	x?
	shallows	0	0	0	0	0	0?	x	0	x	x	x	0?	0	0?	0	x	x
Foods	carnivorous	x	x	x	x	x	x	x	x	0?	x	x	x	x	0	x?	x?	x
	herbivorous	0	0	x?	x?	x	0	0	0	x	0	0	0?	0?	x	x?	x?	0?
	larvivorous	x	x	x	x	x	x	x	x	x	x	x	x	x	0?	x	x	x
	piscivorous	x	x	x	x	0?	x	x	x	0	x	0	0	0	0	0	0?	0
	terrestrial input	x	x	x	x	x	x	x?	x?	x	0	0	x?	x?	0	x?	x	x
	planktivorous	0	0	0	0	x	0	0	0	x?	0	0	0	0	0	x	0?	0?

Table 2. Concluded

1/ The ecological relations here indicated are for the adults of each species; larval ecology of these fishes is poorly, if at all, known.

2/ "Current" is defined as the sum of linear velocity plus turbulence (Deacon and Minckley, 1972).

Table 3

Estimates of past environmental features of Orme, Buttes, Charleston, and Hooker Reservoir sites as compared to present conditions within the sites. Symbols: 0 = least prevalent or absent; 1 = present, in small volume or amount; 2 = present, as at least half the parameter considered; and 3 = predominant. The first value is for the early estimate (ca. 1850), the last for present (1970).

Site	Bottom types							
	Organic		Silt		Sand/gravel		Boulder/bedrock	
ORME, Salt River arm	0	0	1	2-1	2	2	3	3
Verde River arm	3	0	2	2-1	1	3	0	1
BUTTES	0	0	1	2-1	2	3	3	2
CHARLESTON	2-3	0	2-3	1	1	2-3	0	0
HOOKER	0	0	0-1	1	1-2	2-3	3	2

	Stability of bottom							
	Stable		Moderate		Laminar movement		Saltational movement	
ORME, Salt River arm	0	3	1	1	1-2	0	3	2
Verde River arm	3	2	2	1	1-0	2	0	3
BUTTES	0	2	1	1	1-2	3	3	0
CHARLESTON	3	0	2	1	1-0	3	0	2
HOOKER	0	1	2	2	1-2	2	2-3	3-2

	Stream type							
	Ponded		Meandering		Pool-riffle		Channelized[1/]	
ORME, Salt River arm	0	0	1	0-1	1-2	1-2	2-3	3

Table 3, Continued

ORME (cont'ed)								
Verde River Arm	3	0	2	0-1	1-0	2-1	0-1	3
BUTTES	2-3	0	2-3	0	1-0	1-2	0-1	3
CHARLESTON	3	0	2-3	3[2/]	1?	0	0-1	3
HOOKER	0-1	0	1-0	0-1	3-2	3-2	2-3	3

Velocity of flow

	None		Slow		Moderate		Swift	
ORME, Salt River arm	0	0	1	0-1	2-3	1-2	3	3
Verde River arm	3	0	2-3	0-1	0-1	2-3	0-1	2
BUTTES	0	0	1	0-1	2-3	3-2	2-3	3
CHARLESTON	1-0	0	1	0-1	1-2	2-3	2	2
HOOKER	0	0	1	1	2-3	3-2	3	2

Current[3/]

	None		Slow		Moderate		Pronounced	
ORME, Salt River arm	0	0	1-0	1-0	2-3	3-2	3	3
Verde River arm	3	0	2	1-0	1	2-3	0	2
BUTTES	0	0	1-0	0-1	2-3	3-2	3	3
CHARLESTON	3	0	2-3	1-0	1-0	2-3	0	2
HOOKER	0	0	1	1	2	2-3	3	2

Aquatic vegetation

	Absent		Sparse		Common		Abundant	
ORME, Salt River arm	3	0	0-1	3	0	2	0	1
Verde River arm	0	0-1	1-2	3	3	1-2	2-3	1

Table 3, Continued

BUTTES	3	0	0-1	3	0	2	0	1
CHARLESTON	0	3	0-1	0-2	3	0-1	2-3	0
HOOKER	3	3	0-1	0-2	0	1-0	0	0-1

Stability of water levels[5/]

	Stable		Moderate		Seasonal		Erratic	
ORME, Salt River arm	0	2	1	3	2	0	2-3	0
Verde River arm	3	2	2-3	3	1	0	0	3
BUTTES	0	1	1	2	3	0	2-3	3
CHARLESTON	3	0	2	1	1	2	0-1	3
HOOKER	0	0	2	2	3	3	2-3	2-3

Ranges of water depths[4/]

	0 - 1 meter		0 - 2 meters		0 - 3 meters		0 - > 3 meters	
ORME, Salt River arm	0	0	1	1	3	3	2	2
Verde River arm	3	0	2	3	1	2	0	0-1
BUTTES	0	3	1	2	3	0-1	2	0
CHARLESTON	0	3	3	0-2	2	0	1	0
HOOKER	0	1	3	3	2	2	1	1

General water chemistry[5/]

	Stable		Moderately fluctuant		Seasonal		Erratic	
ORME, Salt River arm	0	3	2	2	1	0-1	3	0-1
Verde River arm	3	2-1	1	2	2-3	0-1	1	0-1
BUTTES	0	3-2	1	3	3	0-1	2-3	0-1
CHARLESTON	3	0	2	0-1	1	2-3	0	3

Table 3. Continued

HOOKER	0	0	1	1	3	3	2	2

	Food base for fishes[6/]							
	Plants and debris		Plankton		Bottom fauna[7/]		Fishes	
ORME, Salt River arm	0-1	0-1	0	2	1-2	2-3	2-3	1
Verde River arm	3	0-1	2	2	2-1	1	1-0	2
BUTTES	0-1	0-1	0	2	1-2	1	2-3	2
CHARLESTON	2-3	0-1	2-1	0	2-1	3-2	1-0	0
HOOKER	0-1	0-1	0	0	2-3	3	2-3	2

	Diversity of Fish populations[8/]							
	0 - 3 species		4 - 6 species		7 - 9 species		10 - 16 species	
ORME, Salt River arm	0	2-3	2	1	2-3	0	2-3	0
Verde River arm	3	3	3	2-3	2	0-1	0-2	0
BUTTES	3	1	3	0	2-3	0	2-3	0
CHARLESTON	3	2	3	0	2	0	0-1	0
HOOKER	3	3	3	2-3	3	2	0	0

1/Refers to the natural state of canyon walls, cut banks, or other features that constrict the stream and produce swift, turbulent conditions of flow.

2/Now represented by a shallow, often intermittent, braided channel flowing over sands and gravels between cut banks

3/Refer to footnote number 2, Table 2.

4/Excluding, in general, depths of water that might have occurred behind beaver dams or obstructions of man-made nature (e.g., diversions for irrigation).

5/Note that increased stability of chemistry and all other features of the habitats at Orme and Buttes

Table 3. Concluded.

Reservoir sites result from operations of upstream dams.

6/ Mountain-suckers (Pantosteus) feed by scraping plant (principally diatoms) and associated animal materials from stones or other solid surfaces, and they are present within all reservoir sites. This necessitated the "0-1" categorization of the food base at present under the "plants and debris" section.

7/ Included here are various allochthonous materials, principally terrestrial arthropods, that are exceedingly important in the food base of many desert streams, and especially at higher elevations where leaf-fall of deciduous riparian trees introduces a tremendous amount of organic material into the aquatic systems (to be utilized directly, or, in most instances, to be assimilated into the nutrient cycles and stimulate expansion of the bottom fauna).

8/ This refers only to the indigenous fauna, which at a maximum would be 16 species with all sites being considered and assuming that the Gila trout did, in fact, move at least seasonally as low in the Gila River as the Hooker Reservoir site. Comparisons of this section of Table 3 with species lists in Tables 2 and 4 will round out and define the present fauna at each of the sites under consideration.

Table 4

Non-native fishes within, or upstream from, Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico, with an estimate (X) of the probability of their establishment in the various reservoirs, or a lack of that probability (Y); the symbol "---" denotes their absence.

Reservoirs	Orme	Buttes	Charleston	Hooker
Fish species				
Dorosoma petenense, threadfin shad	X	X	---	---
Salmo spp.[1/]	Y	Y	---	Y
Salvelinus spp.[1/]	Y	Y	---	Y
Esox americanus, northern pike	X?	---	---	---
Cyprinus carpio, carp	X	X	X	X
Carassius auratus, goldfish	X	X	X	X
Notemigonus crysoleucus, golden shiner	X	X	---	X
Hybopsis gracilis, Plains chub	---	Y[2/]	---	Y[2/]
Notropis lutrensis, red shiner	X	---	---	---
Notropis formosus subspp.? beautiful shiner	X?[3/]	---	---	---
Pimephales promelas, fathead minnow	X	X	---	X
Ictiobus cyprinellus, bigmouth buffalo	X	---	---	---
I. niger, black buffalo	X	---	---	---
I. bubalus, smallmouth buffalo	X	---	---	---
Catostomus sp., Little Colorado River sucker	Y[4/]	---	---	---
Pantosteus plebeius, Rio Grande mountain-sucker	---	Y	---	Y
Pilodictis olivaris, flathead catfish	X	X	---	X

Table 4. Continued

Ictalurus punctatus, channel catfish	X	X	?	X
I. melas, black bullhead	X	X	X	X
I. natalis, yellow bullhead	X	X	X	X
Poecilia latipinna, sailfin molly	X	---	---	---
P. mexicana, Mexican molly	X?	---	---	---
Lebistes reticulatus, guppy	X?	---	---	---
Gambusia affinis, mosquitofish	X	X	X	X
Roccus mississippiensis, yellow bass	X	---	---	---
Micropterus dolomieui, smallmouth bass	Y?	Y?	---	X
M. salmoides, largemouth bass	X	X	X	X
Chaenobryttus gulosus, warmouth	X	---	---	?
Lepomis cyanellus, green sunfish	X	X	X	X
L. macrochirus, bluegill	X	X	X	X
L. microlophus, redear sunfish	X	---	---	---
L. gibbosus, pumpkinseed	---	X?[5/]	---	---
Ambloplites rupestris, rock bass	Y	---	---	---
Pomoxis annularis, white crappie	X	X	---	?
P. nigromaculatus, black crappie	X	X	---	X
Stizostedion vitreum, walleye	X	---	---	---
Perca flavescens, yellow perch	X	---	---	---
Tilapia mossambica, Mossambique tilapia	---	Y[6/]	---	---

1/ One native salmonid, the yet-undescribed "Apache trout" of the upper Salt and Gila drainages, and another, S. gilae, which is in the headwaters of the Gila and (formerly) the Verde River system, plus many other species of Salmo, Salvelinus (listed above), Pacific salmons (Oncorhynchus), and grayling

Table 4. Concluded

(Thymallus), live upstream from the Orme, Buttes, and Hooker sites. I know of no salmonids introduced in Sonora, Mexico, upstream from the Charleston Reservoir site. Of the two native trouts, S. gilae may have moved as low as the Hooker site in times past, but not at present. It seems unlikely that either native or introduced species will occur in any of the reservoirs (with the possible exception of Hooker), unless they are maintained below the dams in tailrace fisheries.

2/ This introduced, Plains species was apparently established for a short time in the upper Gila basin (Koster, 1957), at a locality(ies) unknown to me. The fish has not been taken for years, and presumably has failed to maintain populations.

3/ A form of this minnow, different from the native form which occurs in the Río Yaqui basin, southeastern Arizona (Minckley, 1971, 1972), has been caught in the Phoenix canal system, and may well occur in the Orme Reservoir area.

4/ This apparently undescribed sucker, in need of intensive study, has been introduced into the Salt River where it occurs sympatrically with C. latipinnis, the species with which it long has been identified.

5/ Pumpkinseed sunfish were present near Safford, Graham County, Arizona, in the period 1935-45, or so, but have not been identified in collections from Arizona since that time.

6/ Tilapia were introduced by U.S. Fish and Wildlife personnel at Warm Springs, San Carlos River, and reproduced successfully for a period of time. They appear to have been destroyed by flooding, most probably in winter 1965 (Minckley, 1972).

Table 5

Herpetofauna of the Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona-New Mexico.

Symbols: X = definite occurrence; --- = absence; ? = probable occurrence; and H = hypothetical occurrence.

Taxa	Common name	Reservoir Sites			
		Orme	Buttes	Charleston	Hooker
Ambystomidae[1/]	MOLE SALAMANDERS				
Ambystoma tigrinum nebulosum	Arizona tiger salamander	X	X	X	X
Pelobatidae	SPADEFOOT TOADS				
Scaphiophus bombifrons	Plains spadefoot	---	---	H	?
S. couchi	Couch's spadefoot	X	?	X	?
S. hammondi	Western spadefoot	X	X	X	X
Bufonidae	TRUE TOADS				
Bufo microscaphus microscaphus	Arizona toad	---	---	---	?
B. woodhousei australis	Southwestern Woodhouse's toad	X	X	X	X
B. cognatus	Great Plains toad	X	X	X	?
B. debilis insidior	Green toad	---	---	X	?
B. punctatus	Red-spotted toad	X	X	X	X
B. alvarius	Colorado River toad	X	X	X	---
Hylidae	TREEFROGS AND ALLIES				
Hyla arenicolor	Canyon treefrog	X	X	X	X
H. wrightorum	Arizona treefrog	---	---	---	H
Pseudacris triseriata triseriata	Western chorous frog	---	---	---	H

Table 5. Continued

Ranidae	TRUE FROGS				
Rana pipiens[1/]	Leopard frog	X	X	X	X
R. catesbeiana[2/]	Bull frog	X	X	X	?
Microhylidae	NARROW-MOUTHED TOADS				
Gastrophryne olivaceous mazatlanensis	Sinaloa narrow-mouthed toad	---	---	H	---
Chelydridae	SNAPPING, MUSK, AND MUD TURTLES				
Chelydra serpentina[2/]	Common snapping turtle	X	---	---	---
Kinosternon flavescens	Yellow mud turtle	---	---	?	---
K. sonoriense	Sonora mud turtle	X	X	X	X
Testudinidae	WATER AND BOX TURTLES, TORTOISES				
Terrapene ornata luteola[1/]	Yellow box turtle	---	---	X	?
SU[7/] Gopherus agassizi	Desert tortoise	X	X	H	---
Trionychidae	SOFTSHELLED TURTLES				
Trionyx spiniferus emoryi[2/]	Texas softshell	X	X	X	X
Gekkonidae	GECKOS				
Coleonyx variegatus variegatus	Desert banded gecko	X	?[3/]	---	---
C. v. bogerti	Tucson banded gecko	---	?[3/]	X	---
Iguanidae	IGUANIDS				
Sauromelas obesus obesus	Western chuckwalla	?[3/]	---	---	---
S. o. tumidus	Arizona chuckwalla	?[3/]	X	---	---

Table 5, Continued

Iguanidae (cont'ed)					
Dipsosaurus dorsalis dorsalis	Desert iguana	X	X	---	---
Holbrookia maculata	Lesser earless lizard	X	X	X	?
H. texana scitula	Southwestern earless lizard	X	X	X	?
Callisaurus draconoides	Zebra-tailed lizard	X	X	X	---
Crotaphytus collaris	Collared lizard	X	X	X	X
C. wislizeni wislizeni	Leopard lizard	X	X	X	X
Sceloporus scalaris	Bunch grass lizard	---	---	H	---
S. poinsetti	Crevice spiny lizard	---	---	---	?
S. magister magister	Desert spiny lizard	X	?[3]	---	---
S. m. bimaculosus	Twin-spotted spiny lizard	---	?[3]	X	?
S. clarki clarki	Sonora spiny lizard	X	X	X	X
S. undulatus tristichus	Southern plateau lizard	H	X	---	?[3]
S. u. consubrinus	Southern prairie lizard	---	---	---	?[3]
Urosaurus ornatus	Tree lizard	X	X	X	X
Uta stansburiana stejnegeri	Desert side-blotched lizard	X	X	X	X
Phrynosoma douglassi ornatissimum	Desert short-horned lizard	---	---	H	---
P. d. hernandesi	Mountain short-horned lizard	---	---	---	?
P. solare	Regal horned lizard	X	X	X	---
P. cornutum	Texas horned lizard	---	---	H[4]	---
P. modestum	Round-tailed horned lizard	---	---	?	?
Scincidae	SKINKS				
Eumeces obsoletus	Great Plains skink	H	X	X	X
E. multivirgatus epipleurotus	Southern many-lined skink	---	---	---	X

Table 5. Continued

Scincidae (cont'ed)					
E. callicephalus	Mountain skink	---	---	H	---
Teiidae[5/]	WHIPTAILED LIZARDS				
Cnemidophorus tigris gracilis	Southern whiptail	X	X	X	---
C. t. marmoratus	Marbled whiptail	---	---	---	X
C. uniparens	Desert-grassland whiptail	---	H	X	X
C. inornatus	Little striped whiptail	---	---	?	H
C. exanguis	Chiracahua whiptail	X	X	X	X
C. burti stictogrammus	Giant spotted whiptail	---	---	H	---
Anguidae	ALLIGATOR LIZARDS				
Gerrhonotus kingi nobilis	Arizona alligator lizard	H	H	X	X
Helodermatidae	VENEMOUS LIZARDS				
SU[7/] Heloderma suspectum suspectum	Reticulate Gila monster	X	X	X	---
Leptotyphlopidae	SLENDER BLIND SNAKES				
Leptotyphlops humilis	Western blind snake	X	X	X	---
L. dulcis	Texas blind snake	---	---	X	?
Colubridae	COLUBRIDS				
Diadophis punctatus regalis	Regal ringneck snake	X	X	X	X
Heterodon nasicus kennerlyi	Mexican hognose snake	---	---	X	?[3/]
H. n. nasicus	Plains hognose snake	---	---	---	?[3/]
Phyllorhynchus decurtatus: nubilus X perkinsi	Spotted leaf-nosed snake	X	---	---	---

Table 5. Continued

Colubridae (cont'ed)					
Masticophis flagellum piceus	Red racer	X	X	X	---
M. f. lineatulus	Lined whipsnake	---	---	---	X
M. t. taeniatus	Desert striped whip-snake	---	---	---	X
M. bilineatus bilineatus	Sonora whipsnake	X	X	X	---
Salvadora hexalepis hexalepis	Desert patch-nosed snake	X	?[3]	---	---
S. h. deserticola	Big Bend patch-nosed snake	---	?[3]	X	X
S. grahamiae grahamiae	Mountain patch-nosed snake	---	---	---	H
Elaphe triaspis intermedia	Green rat snake	---	---	H	---
Arizona elegans noctivaga	Arizona glossy snake	X	X	?[3]	---
A. e. philipi	Painted Desert glossy snake	---	---	?[3]	X
Pituophis melanoleucus affinis	Sonora gopher snake	X	X	X	X
Lampropeltis getulus yumensis	Yuma king snake	X	X	---	---
L. g. splendida	Sonora king snake	---	---	X	?
Rhinocheilus lecontei lecontei	Western long-nosed snake	X	X	X	---
R. l. tessellatus	Texas long-nosed snake	---	---	---	X
Thamnophis rufipunctatus	Narrow-headed garter snake	---	---	---	H
T. elegans vagrans	Wandering garter snake	---	H	---	?
T. cyrtopsis cyrtopsis	Western black-neck garter snake	X	X	X	X
T. eques megalops	Mexican Garter snake	X	X	X	?
T. marcianus	Checkered garter snake	X	X	X	X

Table 5. Continued

Chionactis occipitalis klauberi	Tucson shovel-nosed snake	X	---	---	---
Chilomeniscus cinctus	Banded sand snake	X	---	---	---
Ficimia cana	Western hook-nosed snake	---	---	X	X
Tantilla planiceps transmontana	Desert black-headed snake	X	X	?[3]	X
T. p. yaquia	Yaquia black-headed snake	---	---	?[3]	---
Tantilla nigriceps nigriceps	Plains black-headed snake	---	---	---	H
Trimorphodon lambda lambda[6]	Sonoran lyre snake	X	X	X	H
Hypsiglena torquata deserticola	Desert night snake	X	X	X	?[3]
H. t. texana	Texas night snake	---	---	---	?[3]
Elapidae	CORAL SNAKES				
Micruroides euryxanthus euryxanthus	Arizona coral snake	X	X	X	X
Viperidae	VIPERS				
Sistrurus catenatus edwardsi	Desert massasauga	---	---	X	?
Crotalus atrox	Western diamondback rattlesnake	X	X	X	X
C. mitchelli pyrrhus	Southwestern speckled rattlesnake	H	---	---	---
C. cerastes cercobombus	Sonoran sidewinder	X	---	---	---
C. molossus molossus	Northern black-tailed rattlesnake	X	X	X	X
C. tigris	Tiger rattlesnake	H	---	---	---
C. viridis cerberus	Arizona black rattlesnake	?	X	---	?[3]
C. v. viridis	Prairie rattlesnake	---	---	---	?[3]
C. scutulatus scutulatus	Mohave rattlesnake	X	X	X	---

Table 5. Concluded.

1/ Importation of "waterdogs," Ambystoma tigrinum, of other subspecies for use as fishing bait, and their introduction, may have essentially destroyed the native Arizona form through genetic swamping.

"Rana pipiens" in Arizona seemingly consists of two, or more, very similar species, under study by D. Platz of Arizona State University.

Box turtles of various species and subspecies have been introduced widely in Arizona by man, and the situation described before for Ambystoma may soon (or at present) apply here.

2/ The common snapping turtle has not yet been recorded from Arizona in the technical literature, but adults and juveniles of this species (plus a number of others) have appeared in the Phoenix canal system, with only the listed form yet taken in the area of the Orme site (from the Verde River).

3/ The symbol "?" is used with footnote 3 to denote zones of intergradation between subspecies at a given site, or of probable intergradation; it is therefore equivalent to an "X" in this usage.

4/ Extant literature indicates the absence of this species from the Charleston area; however it has been caught in numbers by Arizona State University personnel far north of its indicated range, near Bonita, Graham County, also far north of the Charleston Reservoir site.

5/ Numerous taxonomic problems exist in southwestern whiptail lizards, with conflicting reports and major arguments developing and continuing (note the papers by Wright, Lowe, and Maslin, in the bibliography). I have followed Conant (1966) in this listing.

6/ Gehlbach (1971) relegated this form to Trimorphodon biscutatus lambda.

7/ SU Indicates a status undetermined species as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

Table 6

Ecological relationships of the herpetofauna of Orme, Buttes, Charleston, and Hooker Reservoir sites, Arizona- New Mexico. Symbols: X = most typical; F = frequent; R = rare; ? = unknown; and --- = no known relationship or occurrence.

Species of animals 1/	Life Zones: Lower Sonoran	Upper Sonoran	Transition	Canadian	Physiography of Habitat: Aquatic, permanent	Aquatic, temporary	Aquatic, lentic	Aquatic, lotic	Cienega	Riparian boulders	Flat mesic	Flat xeric	Washes	Rolling hills, or bajada slopes	Rugged Montane, cliffs
Ambystoma tigrinum 2/	R	F	X	X											
larvae					X	R	X	R	R	---	---	---	---	---	---
adult					---	---	---	---	R	X	F	---	---	R	R
Scaphiophus bombifrons	---	X	---	---											
larvae					---	X	X	---	---	---	---	---	---	---	---
adult					R	R	R	---	---	R	F	F	F	F	---
S. couchi	X	F	---	---											
larvae					---	X	X	---	---	---	---	---	---	---	---
adult					R	R	R	---	---	R	F	F	F	F	F
S. hammondi	F	X	F	---											
larvae					R	X	X	R	---	---	---	---	---	---	---
adult					R	R	R	R	R	R	F	F	F	F	F
Bufo microscaphus	F	X	R	---											
larvae					F	R-F	X	F	R	---	---	---	---	---	---
adult					F	R-F	F	F	R	R	F	F	R	R	R
B. woodhousei	X	R	---	---											
larvae					F	F	F	F	F	---	---	---	---	---	---
adult					R	F	F	R	R	R	R	---	R	---	---
B. cognatus	X	X	---	---											
larvae					R	X	X	F	R	---	---	---	---	---	---
adult					R	R	R	R	R	R	R	F	F	---	---
B. debilis	---	X	---	---											
larvae					---	X	X	---	---	---	---	---	---	---	---
adult					R	R	R	R	R	---	---	F	F	---	---
B. punctatus	X	X	---	---											
larvae					R	X	F	R	R	---	---	---	---	---	---
adult					R	R	R	R	R	F	R	R	R	F	F
B. alvarius	X	F	---	---											
larvae					X	R	X	R	R	---	---	---	---	---	---
adult					R	R	R	R	R	X	X	X	X	X	---
Hyla arenicolor	X	X	F	---											
larvae					X	---	---	X	?	---	---	---	---	---	---
adult					X	R	---	X	?	X	R	---	---	---	---
H. wrightorum	---	R	X	R											
larvae					X	?	F	F	X	---	---	---	---	---	---
adult					X	?	F	F	X	X	X	---	---	---	---
Pseudacris triseriata	---	R	X	R											
larvae					X	X	X	---	---	---	---	---	---	---	---
adult					X	F	X	---	X	---	X	---	---	---	---
Rana pipiens 2/	X	X	F	R											
larvae					X	---	X	X	X	---	---	---	---	---	---
adult					X	---	X	X	X	R	R	---	---	---	---
Rana catesbeiana 3/	X	F	R	---											
larvae					X	---	X	X	X	---	---	---	---	---	---
adult					X	R	X	X	X	R	R	---	---	---	---
Gastrophryne olivacea	X	---	---	---											
larvae					---	X	X	---	---	---	---	---	---	---	---
adult					---	R	R	---	---	R	R	---	?	---	---

Species of animals 1/	Vegetation Aspect of Habitat: Aquatic	Cienega	Non-cienega riparian	Open grass	Closed grass	Open shrub	Closed shrub	Open forest	Closed forest	Habits: Aquatic	Semi-aquatic	Riparian	Arboreal	Terrestrial	Nocturnal	Crepuscular	Diurnal	Migratory for reproductive season	Migratory for hibernation in winter	Sedentary	Wide-ranging	Shallow burrower	Deep burrower	User of rodent burrows	User of rock, logs, pack-rat nests	Crevice dweller	Carnivorous	Herbivorous	Omnivorous
Ambystoma tigrinum 2/																													
larvae	X	R	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
adult	---	R	F	R	R	R	R	F	F	---	R	R	---	X	X	---	---	X	---	F	R	---	---	X	F	R	X	---	---
Scaphiophus bombifrons																													
larvae	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	X	F
adult	R	---	---	X	X	R	---	R	---	R	R	R	---	X	X	F	R	X	---	?	?	R	F	R	R	---	X	---	---
S. couchi																													
larvae	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	X	R
adult	R	---	---	X	F	X	R	R	---	R	R	R	---	X	X	R	---	X	---	?	?	R	F	R	R	R	X	---	---
S. hammondi																													
larvae	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	X	R
adult	R	R	R	X	R	F	R	R	R	R	R	R	---	X	X	R	---	X	---	?	?	R	F	R	R	R	X	---	---
Bufo microscaphus																													
larvae	X	---	---	---	---	---	---	R	R	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
adult	R	R	R	F	R	R	R	R	R	R	R	F	---	X	X	R	---	X	---	?	?	X	?	?	?	?	X	---	---
B. woodhousei																													
larvae	X	R	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
adult	R	R	R	F	F	R	---	---	---	R	R	F	---	X	X	F	R	X	?	?	?	F	?	X	R	---	X	---	---
B. cognatus																													
larvae	X	R	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
adult	R	R	R	F	F	F	---	---	---	R	R	R	---	X	X	---	---	X	?	?	?	R	F	R	R	---	X	---	---
B. debilis																													
larvae	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
adult	R	---	---	X	R	F	---	---	---	R	R	R	---	X	F	F	F	X	?	F	?	R	X	R	R	---	X	---	---
B. punctatus																													
larvae	X	---	---	---	---	---	---	---	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	X
adult	R	R	---	R	---	---	---	---	---	R	R	R	---	X	X	F	F	X	?	X	---	---	---	---	X	R	X	---	---
B. alvarius																													
larvae	X	R	---	---	---	---	---	R	R	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	X	R
adult	R	R	X	X	R	X	R	R	R	R	R	F	---	X	X	R	---	X	---	?	?	X	R	F	R	---	X	---	---
Hyla arenicolor																													
larvae	X	?	---	---	---	---	---	F	R	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	---	X
adult	X	?	X	R	---	---	---	F	R	F	X	X	R	F	X	X	X	---	?	F	R	?	?	?	?	X	X	---	---
H. wrightorum																													
larvae	X	X	---	---	---	---	---	F	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	?	?	?
adult	X	X	X	X	X	X	X	F	X	F	X	X	F	F	X	X	X	---	?	F	R	?	?	?	?	R	X	---	---
Pseudacris triseriata																													
larvae	X	R	---	---	---	---	---	F	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	?	?	?
adult	X	X	---	X	X	---	---	F	X	X	R	X	---	R	R	F	R	X	?	?	?	---	---	---	R	---	X	---	---
Rana pipiens 2/																													
larvae	X	X	---	---	---	---	---	X	X	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	---	X
adult	X	X	R	R-F	R	R	R	X	X	X	X	F	X	---	X	X	X	X	?	?	F	?	X	---	F	R	X	---	---
Rana catesbeiana 3/																													
larvae	X	X	---	---	---	---	---	R	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	---	X
adult	X	X	R	R	R	---	---	R	---	X	R	X	---	---	X	F	R	---	---	F	R	R	---	---	F	---	X	---	---
Gastrophryne olivacea																													
larvae	X	---	---	---	---	---	---	R	---	X	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	R	R	X
adult	R	---	R	R	R	R	R	R	---	R	R	R	---	X	X	R	---	X	?	?	?	X	---	X	X	R	X	---	---

Table 6 Continued

Chelydra serpentina[3]	X	R?	---	---	X	---	X	X	?	---	---	---	---	---	---	X	?	---	---	---	---	---	---	---	X	---	---	---	---	X	X	X	?	?	F	R	X	---	---	---	---	X	---	R
Kinosternon flavescens	?	X	---	---	X	X	X	X	X	F	F	R	R	---	---	X	F	F	F	F	R?	---	R	---	F	X	F	---	F	X	F	R	F	?	?	?	X	---	---	F	---	---	---	X
K. sonoriense	X	F	---	---	X	X	X	X	X	F	F	R	R	---	---	X	F	F	F	F	R?	---	R	---	F	X	F	---	F	X	F	R	F	?	?	?	X	---	---	F	---	---	---	X
SU[6] Terrapene ornata[2]	R?	X	R?	---	---	F	F	R?	R	R	F	X	X	R	---	---	R?	R	X	F	R	R	F	---	---	R	F	---	X	---	R	X	?	F	F	R	X	---	F	F	---	---	---	X
Gopherus agassizi	X	R-F	---	---	---	R	R	---	---	R	R	X	F	X	R	---	---	R	X	R	X	R	---	---	---	---	R	---	X	---	R	X	?	?	F	R	R	X	X	R	---	---	---	---
Trionyx spiniferus[3]	X	X	F	F	X	---	X	X	F	---	---	---	---	---	---	X	F	---	---	---	---	---	---	---	X	---	---	---	---	X	F	R	?	?	F	?	X	---	---	---	---	---	---	---
Coleonyx variegatus	X	F	R?	---	---	---	---	---	---	R	R	F	F	F	X	---	---	R	F	F	X	F	---	---	---	---	F	---	X	X	R	---	?	?	F	R	---	---	X	X	X	X	---	---
Sauromelas obesus	X	R	---	---	---	---	---	---	---	F	---	---	R	R	X	---	---	R	---	---	X	---	---	---	---	---	R	R	X	---	R	X	?	?	X	---	R	R	X	X	X	---	X	---
Dipsosaurus dorsalis	X	R?	---	---	---	---	---	---	---	---	---	X	X	R	R?	---	---	---	X	R?	F	---	---	---	---	---	R	F	X	---	R	X	?	?	---	X	X	---	F	F	R?	R?	X	---
Holbrookia maculata	R?	X	---	---	---	---	---	---	---	F	R	X	R	R	---	---	---	R?	X	R?	F	---	---	---	---	---	F	---	X	---	R	X	?	?	---	X	?	?	X	X	---	X	---	---
H. texana	F	X	R	---	---	---	---	---	---	X	---	R?	X	X	R	---	---	X	R?	---	R	---	---	---	---	---	F	R	X	---	---	X	?	?	R?	X	?	?	R-F	X	R	X	---	---
Callisaurus draconoides	X	R	---	---	---	---	---	---	---	R?	R	X	X	R?	---	---	---	R	X	R	F	R?	---	---	---	---	F	---	X	---	R?	X	?	?	R?	X	X	---	F	F	R	X	---	---
Crotaphytus collaris	F	X	X	R	---	---	---	---	---	F	R?	R	F	X	X	---	---	F	R	R?	F	R?	F	R	---	---	F	R	X	---	R	X	?	?	X	---	X	---	F	F	F	X	---	---
C. wizlizeni	X	F	---	---	---	---	---	---	---	R-F	---	R-F	R-F	X	R	---	---	R-F	F	R	X	R	---	---	---	---	R	R	X	---	---	X	?	?	---	X	X	?	F	F	R	X	---	---
Sceloporus scalaris	---	R	X	F	---	---	---	---	---	---	---	R	R	F	X	---	---	---	F	R	F	R?	F	?	---	---	F	F	X	---	?	X	?	?	X	---	?	?	R	F	R	X	---	---
S. poinsetti	---	---	---	F?	---	---	---	---	---	---	---	---	---	R?	X	---	---	---	---	---	F?	R?	F	R?	---	---	R	R	X	---	?	X	?	?	X	---	?	?	R	R	X	X	---	---
S. magister	X	X	F	---	---	---	---	---	---	R	R	F	X	X	X	---	---	R	F	R	F	R	---	---	---	---	F	F	X	---	R	X	?	?	R	X	X	---	X	X	X	X	---	---
S. clarki	R	X	R	---	---	---	---	---	---	R	---	---	R	F	X	---	---	R	---	---	F	R	F	R	---	---	F	X	F	---	?	X	?	?	X	R	?	?	F	F	X	X	---	---
S. undulatus	R?	X	F	R?	---	---	---	---	---	R	---	R	R	F	X	---	---	F	R	---	F	R?	X	F-R	---	---	F	X	F	---	---	X	?	?	X	---	?	?	X	X	X	X	---	---
Urosaurus ornatus	F	X	F	R?	---	---	---	---	---	R	---	---	F	X	X	---	R?	X	---	---	F	F?	X	F-R	---	---	F	X	R	---	R?	X	?	?	X	---	---	---	R	R	F	X	R	---
Uta stansburiana	X	F	R?	---	---	---	---	---	---	F	R?	F	F	X	F	---	---	R	X	R-F	F	R-F	---	---	---	---	F	R	X	---	R	X	?	?	X	---	?	?	X	X	R	X	R	---
Phrynosoma douglassi	---	F	X	F	---	---	---	---	---	R?	R?	X	X	X	F	---	---	R?	X	R	F	R?	F	F?	---	---	R	---	X	---	---	X	?	?	X?	---	X	---	X	X	R?	X	---	---
P. solare	X	F	---	---	---	---	---	---	---	R	---	X	X	F	R	---	---	R	X	R	X	R?	---	---	---	---	R	---	X	---	R	X	?	?	X?	---	X	?	X	X	R?	X	---	---
P. cornutum	F	X	---	---	---	---	---	---	---	---	---	X	X	X	---	---	---	---	X	R	X	R?	---	---	---	---	---	---	X	R?	R	X	?	?	X?	---	X	---	X	X	R?	X	---	---
P. modestum	X	F	---	---	---	---	---	---	---	---	---	X	X	X	R	---	---	---	X	R	X	R	---	---	---	---	F	R	X	R?	F	X	?	?	X?	?	X	---	X	X	F	X	R	---
Eumeces obsoletus	R?	X	F	---	---	---	---	---	R	X	R	---	R	R	R	---	---	X	R?	F	---	F	F	R?	---	---	F	---	X	R	F	F	?	?	?	F?	F	F	X	X	R	X	---	---
E. multivirgatus	---	X	F	---	---	---	---	---	R?	R?	R	R?	R?	X	---	---	R?	R?	X	F?	---	F?	F	?	---	---	F	?	X	?	?	X	?	?	?	?	?	?	?	X	?	X	---	---
E. callicephalus	---	X	F	---	---	---	---	---	R?	R?	R?	R?	R?	X	---	---	R?	R?	F	X	F?	?	F?	?	---	---	F	?	X	?	?	X	?	?	?	?	?	?	?	?	?	X	---	---
Cnemidophorus tigris	X	F	R	---	---	---	---	---	---	R	X	X	X	X	F	---	---	R	X	R	X	R	---	---	---	---	R	R	X	---	---	X	?	?	---	X	X	---	X	X	R	X	---	---
C. uniparens	---	X	R?	---	---	---	---	---	---	F	F	F	R	R	---	---	---	F	F	R	F	R?	R?	---	---	---	F	?	X	---	---	X	?	?	R	X	X	---	F	F	?	X	---	---
C. inornatus	---	X	---	---	---	---	---	---	---	F	F	X	X	F	R	---	---	F	X	R	F	R	R?	---	---	---	F	R?	X	---	---	X	?	?	R	X	F	---	X	X	?	X	---	---
C. exsanguis	F	X	F	---	---	---	---	---	---	X	X	F	F	R	---	---	---	F	X	F	X	R	R	R?	---	---	F	?	X	---	R	X	?	?	R	F	F	---	F	F	R	X	---	---
C. burti	X	F	---	---	---	---	---	---	R?	X	X	R-F	R	R	---	---	---	X	X	R	F	X	---	---	---	---	X	---	X	---	---	X	?	?	R	F	X?	---	F	F	?	X	---	---
Gerrhonotus kingi	R	F	X	---	---	---	---	---	R?	X	X	R	R	R	R	---	---	X	R	F	R	F	F	F	---	---	R	---	X	X	F	R	?	?	X	---	---	X	X	X	F	X	R	---
SU[6] Heloderma suspectum	X	F?	---	---	---	---	---	---	---	F	R	F	F	X	F	---	---	F	F	R	X	R	---	---	---	---	R	---	X	X	F	R	?	?	X	---	---	X	X	X	F	X	R	---
Leptotyphlops humilis	X	R?	---	---	---	---	---	---	R?	F	F	R	R	R?	--?	---	R?	F	F	F	R	R	?	?	---	---	F	---	X	?	?	?[5]	?	?	---	?	?	X	?	?	?	X	---	---
L. dulcis	F	X	---	---	---	---	---	---	R?	F	F	R	R	R?	--?	---	R?	F	F	F	R	R	?	?	---	---	F	---	X	?	?	?[5]	?	?	?	?	?	X	?	?	?	X	---	---
Diadophis punctatus	R	X	R	---	---	---	---	---	R?	F	R	---	R	F	R?	---	R?	F	R	F	F	R	F	R?	---	---	F	---	X	X	F	R?	?	X	?	?	?	?	X	X	?	X	---	---
Heterodon nasicus	---	X	R?	---	---	---	---	---	---	---	R	X	F	R	---	---	---	---	X	F?	F	R?	R	---	---	---	---	---	X	?	X	X	?	?	---	X	---	---	X	X	R	X	---	---
Phyllorhynchus decurtatus	X	---	---	---	---	---	---	---	---	R	---	R	X	R	---	---	---	R	X	R	F	?	---	---	---	---	---	---	X	X	R?	---	?	?	?	?	X	F?	R	R	?	X	---	---
Masticophis flagellum	X	F	R?	---	---	---	---	---	R	R	R	F	F	X	X	---	---	F	R	R	X	F	R	R	---	---	F	F	X	R	F	X	?	?	---	X	---	---	F	F	F	X	---	---
M. taeniatus	---	X	R?	---	---	---	---	---	---	R	F	F	F	F	R	---	---	F	F	R	X	F	F	R?	---	---	F	F	X	F	X	X	?	?	---	X	---	---	F	F	F	X	---	---
M. bilineatus	F	X	---	---	---	---	---	---	R?	F	R	R	F	F	R	---	---	F	F	R	F	F?	R	R?	---	---	F	X	F	X	X	?	?	?	---	X	---	---	F	F	F	X	---	---
Salvadora hexalepis	X	F	---	---	---	---	---	---	---	R	R	X	F	F	R	---	---	R	X	F	F	R	---	---	---	---	R	?	X	X	R	---	?	?	X	F?	F	R?	F	F	R	X	---	---
S. grahamiae	---	X	F	---	---	---	---	---	---	R	F	R	F	X	F	---	---	F	X	X	R	---	F	F?	---	---	R	?	X	X	R	---	?	?	X	?	F	F	F	F	R	X	---	---
Elaphe triaspis	---	X	---	---	---	---	---	---	---	F	---	---	F	F	F	---	---	F	---	---	R?	---	---	---	---	---	R	R	X	X	R	---	?	?	---	X	---	---	X	X	R	X	---	---
Arizona elegans	X	F	---	---	---	---	---	---	---	R	---	X	R	R?	---	---	---	R	X	R	X	R	---	---	---	---	R?	---	X	X	---	---	?	?	?	?	X	R?	F	F	R	X	---	---
Pituophis melanoleucus	X	X	X	F	---	---	---	---	R	X	F	X	X	X	X	---	---	F	X	X	X	X	F	F	---	---	F	F	F	X	X	X	?	X	---	X	---	---	X	X	X	X	---	---
Lampropeltis getulus	X	F	R?	---	---	---	---	---	R	F	F	R	F	X	R	---	---	F	F	R	X	R	F	R	---	---	F?	R	X	X	R	---	?	X	---	X	---	---	X	X	F	X	---	---
Rhinocheilus lecontei	X	F	---	---	---	---	---	---	---	F	R	F	X	X	R	---	---	F	F	X?	X	?	---	---	---	---	R	R?	X	X	R	---	?	?	R?	X	X	?	F	F	R	X	---	---
Thamnophis rufipunctatus	R?	X	F	---	X	---	X	X	X	R	R	---	---	---	---	X	X	R	R?	R?	---	---	R?	R?	F	X	F	---	---	?	?	X	X?	X	S?	---	---	---	---	F	---	X	---	---
T. elegans	---	X	F	R?	X	X	X	X	X	F	R	---	R	R	---	X	X	F	R	F?	---	---	F	R?	R	X	F	R	F	?	?	X	?	?	---	X	---	---	---	F	R	X	---	---
T. cyrtopsis	X	F	R	R?	X	X	X	X	X	F	R	---	R?	R?	---	X	X	F	R?	R	---	---	F	R	F	X	X	R	---	X	F	X	?	?	---	X	---	---	---	F	R	X	---	---
T. eques	F	X	R?	---	X	X	X	X	X	F	R	---	R?	R?	---	X	X	F	R?	F	R	---	F	R	F	X	X	R	---	X	F	X	?	?	---	F	---	---	---	F	R	X	---	---
T. marcianus	F	X	---	---	X	X	X	X	X	F	G	R	R	R	---	X	X	F	R	F	R	---	R?	---	R	F	F	R?	R	X	F	F	?	X	---	X	---	---	---	F	F	X	---	---
Chionactis occipitalis	X	---	---	---	---	---	---	---	---	---	---	F	X	X	R	---	---	R	X	X	X	F	---	---	---	---	R	---	X	X	?	---	?	?	?	?	X	F?	F	F	?	X	---	---
Chilomeniscus cinctus	X	---	---	---	---	---	---	---	---	---	R	X	X	F	F	---	---	R	X	X	F	R?	---	---	---	---	---	---	X	X	---	---	?	?	?	?	X	?	R	R	---	X	---	---
Ficimia cana	X	F	---	---	---	---	---	---	---	---	---	F	X	F	R	---	---	---	X	F	X	R	---	---	---	---	R?	---	X	X	---	---	?	?	?	?	X	X?	R	R	?	X	---	---
Tantilla planiceps	F	X	---	---	---	---	---	---	---	F	F	---	---	?	?	---	---	F	?	?	F	?	---	---	---	---	F	---	X	X	?	---	?	?	?	?	X	X?	F	F	---	X	---	---
Tantilla nigriceps	X	F	---	---	---	---	---	---	---	F	F	R?	R?	R?	?	---	---	F	?	?	?	?	---	---	---	---	F	---	X	X	?	---	?	?	?	?	X	?	F	R	---	X	---	---
Trimorphodon biscutatus[4]	X	F	R	---	---	---	---	---	---	R	---	---	R	F	F	---	---	R	R	?	X	?	R?	R?	---	---	R	R?	X	X	F	---	?	?	?	?	?	?	F	F	---	X	---	---
Hypsiglena torquata	X	F	---	---	---	---	---	---	---	---	---	R	F	X	F	---	---	---	X	?	F	?	R?	---	---	---	---	---	---	X	X	R	---	?	?	?	?	?	R	R	---	X	---	---

A-22

Table 6 Concluded

Micruroides euryxanthus	X	F	---	---	---	---	---	---	---	R	---	F	F	X	F	---	---	R	X	R	F	?	---	---	---	---	R	---	X	X	R	---	?	?	?	?	X	?	F	E	?	X	---	---
Sistrurus catenatus	---	X	---	---	---	---	---	---	?	?	?	X	---	---	---	---	?	?	?	?	?	?	R?	---	---	R?	D	E	X	X	R	R	X	F	---	---	---	---	X	X	---	X	---	---
Crotalus atrox	X	X	F	R?	---	---	---	---	R	F	F	X	X	X	X	---	---	F	X	X	X	X	---	---	---	---	F	R	X	X	C	R	X	X	---	X	---	---	X	X	X	X	---	---
C. mitchelli	X	---	---	---	---	---	---	---	---	---	---	---	R	R	X	---	---	---	---	---	R	---	---	---	---	---	---	---	X	X	R	R	?	X	?	?	---	---	R?	R?	X	X	---	---
C. cerastes	X	---	---	---	---	---	---	---	---	---	---	X	R	---	---	---	---	---	X	---	X	---	---	---	---	---	---	R?	X	X	R	R	?	?	?	?	X	---	F	F	R	X	---	---
C. molossus	X	X	F	R	---	---	---	---	R	F	F	F	F	F	X	---	R	F	F	F	X	F	F	R	---	---	F	R	X	X	F	F	?	X	?	F	---	---	R	F	X	X	---	---
C. tigris	X	---	---	---	---	---	---	---	---	---	---	---	R	R	X	---	---	---	---	---	---	---	---	---	---	---	---	---	X	X	R	R	?	X	X?	---	---	---	R	R	X	X	---	---
C. viridis	R?	F	X	X	---	---	---	---	F	F	F	F	F	X	X	---	F	F	F	?	F	?	F	F	---	R?	F	R	X	X	X	F	?	?	F	?	---	---	R	F	R	X	---	---
C. scutulatus	X	F?	---	---	---	---	---	---	---	---	---	R	X	F	R	---	---	---	F	?	F	?	---	---	---	---	R	---	X	X	F	R	?	X	F	?	---	---	F	F	X	X	---	---

1/ When altitudinal or life-zone intergrades are considered, their attributes are combined in this summary of ecological relationships of the *species* as a whole; *e.g.*, high- and low-altitude forms of *Crotalus viridis*, *etc*.

2/ See footnote number 1, Table 1.

3/ Introduced from eastern United States.

4/ See footnote number 6, Table 1.

5/ Because of the secretive nature of many snakes, exemplified here by the worm snakes that rarely move above ground, the habits, habitats, and so on of many species is speculative or unknown.

6/ SU Indicates status undetermined species as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of *Rare and Endangered Fish and Wildlife of the United States*.

Table 7

Composite list of birds with critical life history data and predicted effects following inundation in the Central Arizona Project dam construction.[1]

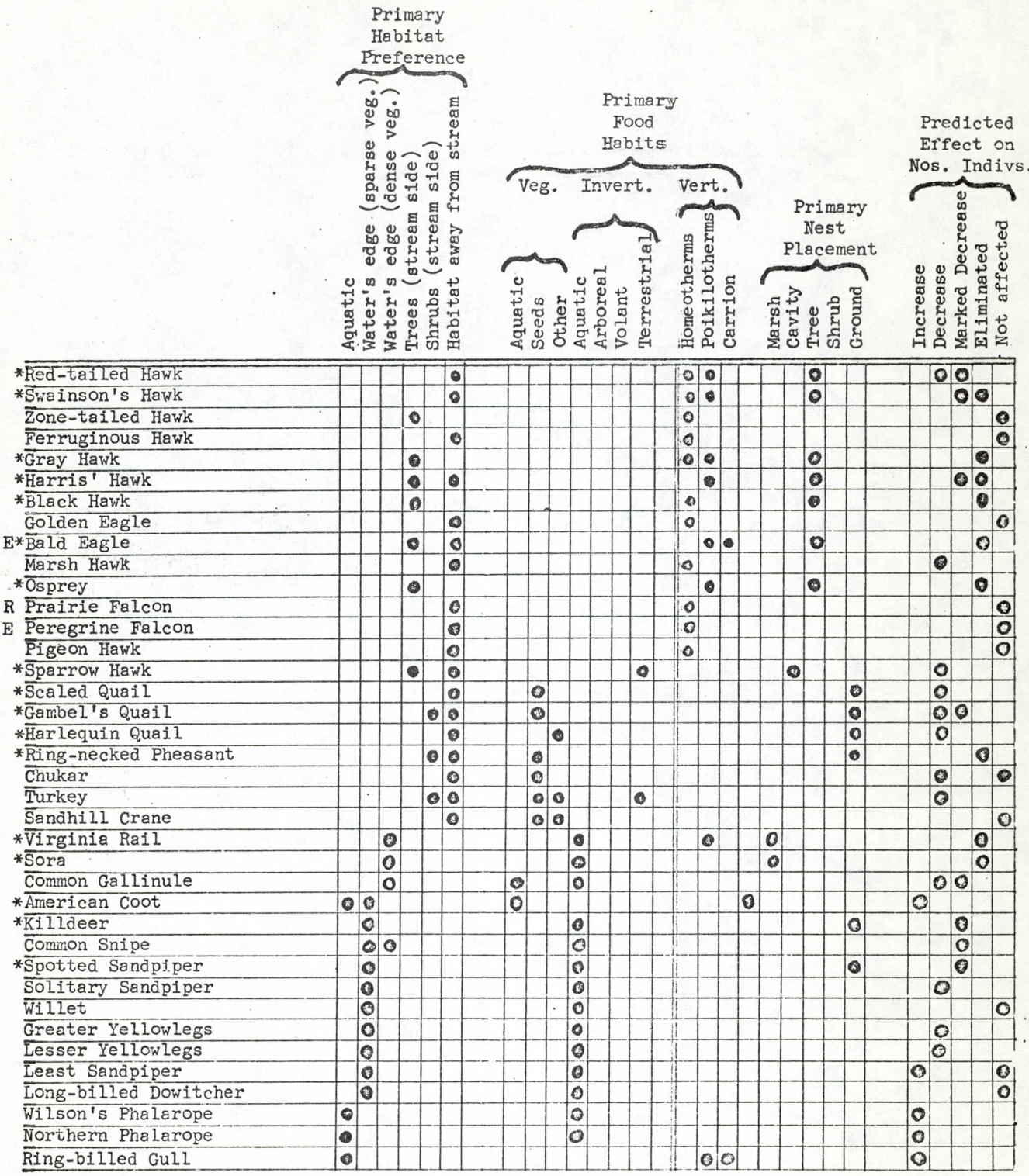
	Primary Habitat Preference						Primary Food Habits									Primary Nest Placement					Predicted Effect on Nos. Indivs.				
							Veg.			Invert.				Vert.											
	Aquatic	Water's edge (sparse veg.)	Water's edge (dense veg.)	Trees (stream side)	Shrubs (stream side)	Habitat away from stream	Aquatic	Seeds	Other	Aquatic	Arboreal	Volant	Terrestrial	Homeotherms	Poikilotherms	Carrion	Marsh	Cavity	Tree	Shrub	Ground	Increase	Decrease	Marked Decrease	Eliminated	Not affected
Eared Grebe	●									●					●							●				
Western Grebe	●									●					●							●				
*Pied-billed Grebe	●		●							●					●		●					●				●
Double-crested Cormorant	●														●											●
Olivaceous Cormorant	●														●											●
*Great Blue Heron		●													●				●	●				●		
*Green Heron			●												●				●	●				●	●	
Snowy Egret		●													●										●	
*Black-crowned Night Heron			●												●				●	●	●				●	
Yellow-crowned Night Heron			●												●										●	
*Least Bittern			●							●					●		●								●	
Wood Ibis		●								●					●										●	
White-faced Ibis		●								●					●										●	
Canada Goose	●					●		●														●				
Snow Goose	●							●														●				●
Black-bellied Tree Duck		●						●																		●
*Mallard	●	●						●		●							●					●				
E*Mexican Duck	●	●						●		●							●							●	●	
Gadwall	●	●						●		●												●				
Pintail	●	●						●		●												●				
Green-winged Teal	●	●						●		●												●				
*Blue-winged Teal	●	●						●		●							●								●	
Cinnamon Teal	●	●						●		●												●				
American Widgeon	●	●						●		●												●				
Shoveler	●	●						●		●												●				
Wood Duck	●	●						●		●																●
Redhead	●									●												●				
Ring-necked Duck																						●				
Canvasback	●									●												●				
Lesser Scaup	●									●												●				
Bufflehead	●									●												●				
Ruddy Duck	●							●		●												●				
Common Merganser	●														●							●				
Red-breasted Merganser	●														●											●
Turkey Vulture				●		●										●							●			●
Goshawk						●								●										●	●	
Sharp-shinned Hawk				●										●										●	●	
*Cooper's Hawk				●										●					●					●	●	

[1]Asterisk (*) indicates nesting.

E Indicates an endangered species, BSF&W's Rare and Endangered Fish and Wildlife of the U. S..

R Indicates a rare species, (as above)

Table 7 (continued)



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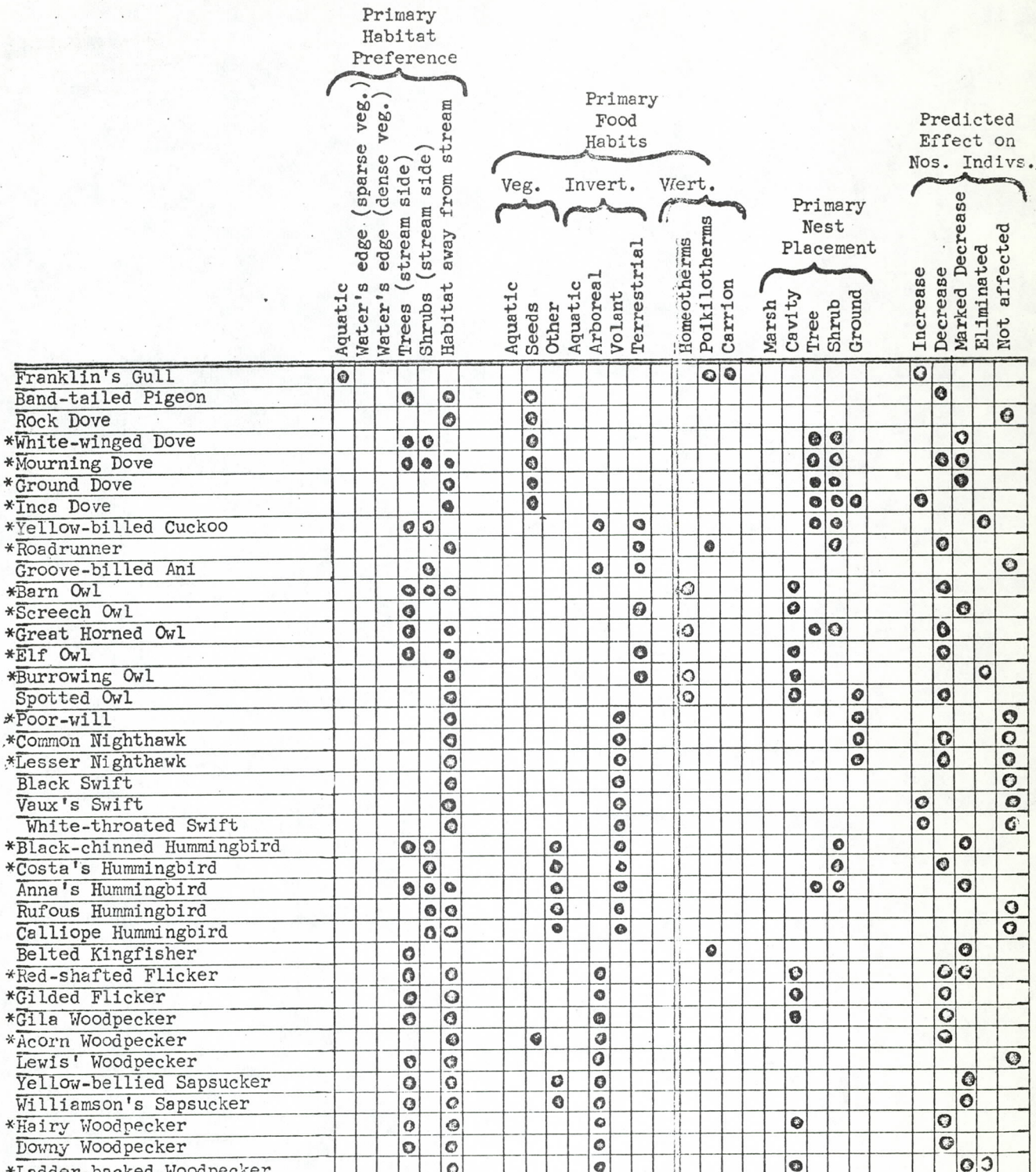

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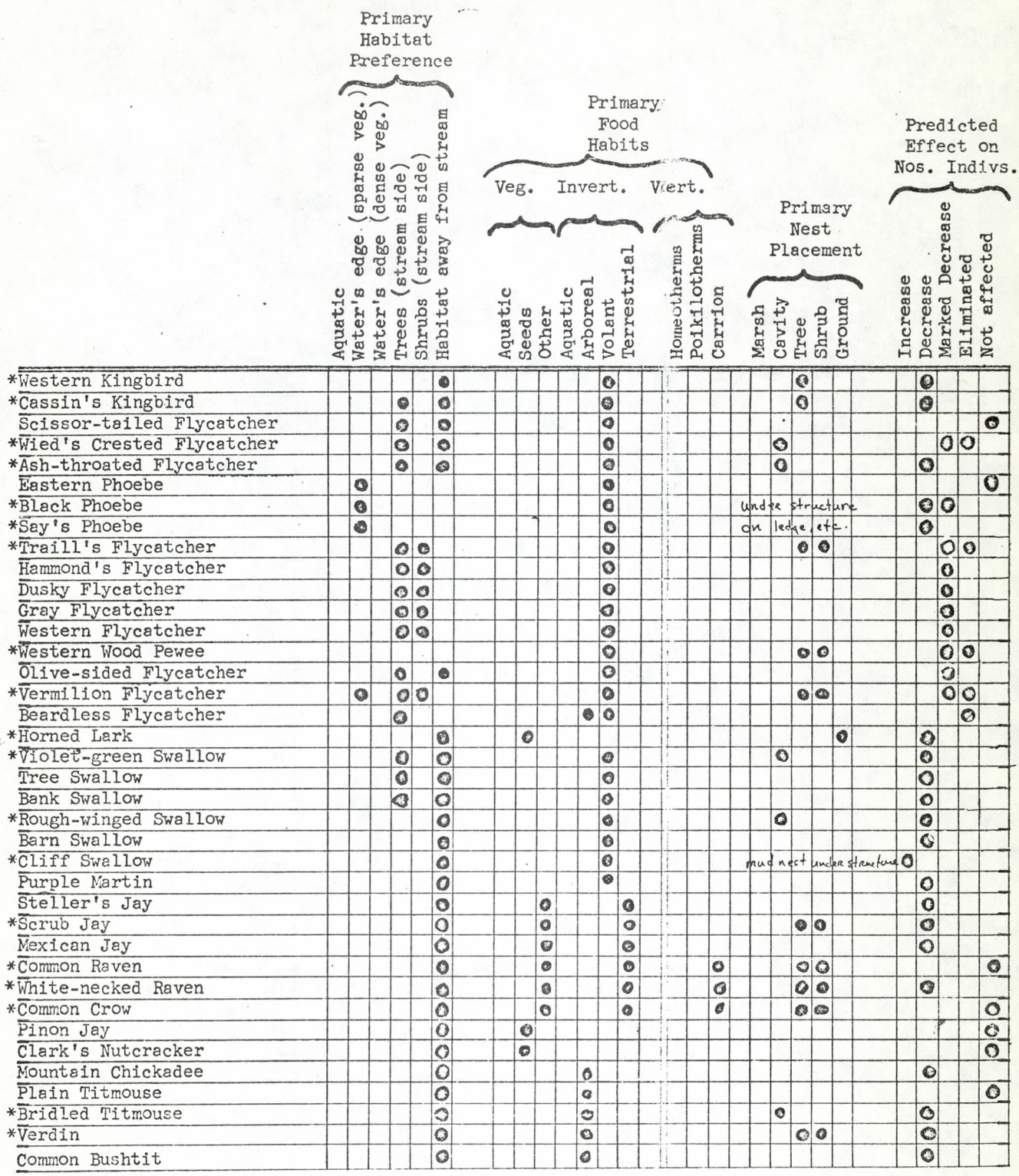

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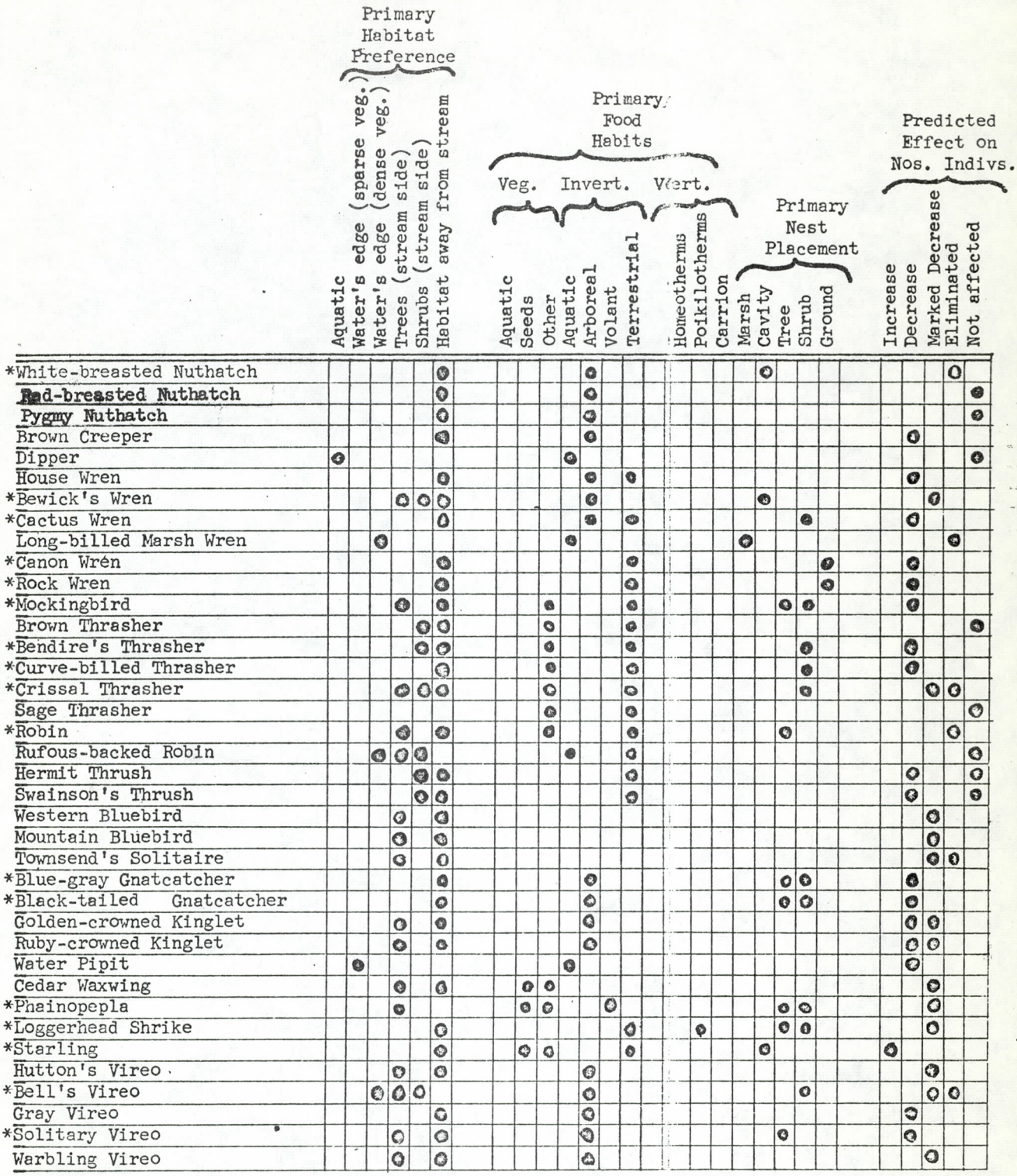

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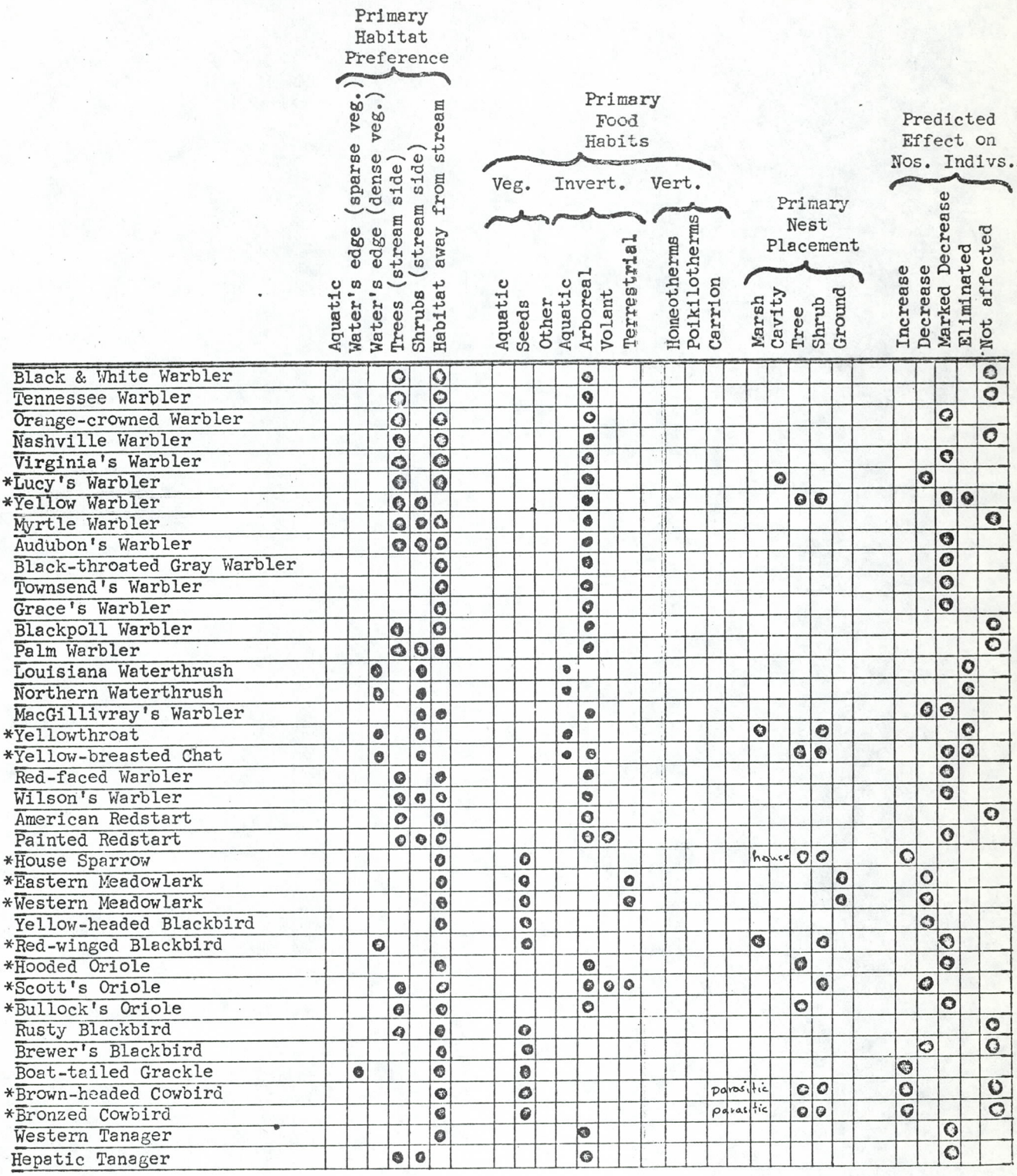

Table 7 (continued)

	Primary Habitat Preference						Primary Food Habits									Primary Nest Placement					Predicted Effect on Nos. Indivs.				
	Aquatic	Water's edge (sparse veg.)	Water's edge (dense veg.)	Trees (stream side)	Shrubs (stream side)	Habitat away from stream	Veg.	Invert.				Vert.				Marsh	Cavity	Tree	Shrub	Ground	Increase	Decrease	Marked Decrease	Eliminated	Not affected
								Aquatic	Seeds	Other Aquatic	Arboreal	Volant	Terrestrial	Homeotherms	Poikilotherms	Carrion										
*Summer Tanager				●		○					●							●						○	
*Cardinal					●	○			●										●				●		
*Pyrrhuloxia						●			●										●		●				
*Black-headed Grosbeak				●		○			●									●	●		●		○		
*Blue Grosbeak				●		●			●									●	●		●		●		
*Indigo Bunting				●		●			●									●	●				○		
Lazuli Bunting				●		●			●														●		
Evening Grosbeak						●			●																●
Cassin's Finch				●		●			●																●
*House Finch				●		●			●									●	●				●		
Pine Siskin				●		○			●																●
*American Goldfinch				●					●									●	●				●		
*Lesser Goldfinch				●					●									●	●				●		
Lawrence's Goldfinch						●			●																
Red Crossbill						●			◬																●
Green-tailed Towhee					●				●		◔												●		
*Rufous-sided Towhee					●	●			●		◔							●	●				●		
*Brown Towhee					●	●			●									●	●				●		
*Abert's Towhee					◔				●										●					●	
Lark Bunting						●			●																
Savannah Sparrow						●			●																
Grasshopper Sparrow						●			●				●												
Baird's Sparrow						●			●																
Vesper Sparrow						●			●																
*Lark Sparrow						●			●																
*Rufous-crowned Sparrow						●			●				●												
Cassin's Sparrow						●			●																
*Black-throated Sparrow						●			●																
Sage Sparrow						●			●																
Slate-colored Junco						●			●																
Oregon Junco						●			●																
Gray-headed Junco						●			●																
Mexican Junco						●			●																
Chipping Sparrow				●		●			●																
Brewer's Sparrow						●			●																
*Black-chinned Sparrow						●			●																
White-crowned Sparrow						●			●																
Golden-crowned Sparrow						●			●																

Table 7 (continued)

	Primary Habitat Preference						Primary Food Habits									Primary Nest Placement					Predicted Effect on Nos. Indivs.				
	Aquatic	Water's edge (sparse veg.)	Water's edge (dense veg.)	Trees (stream side)	Shrubs (stream side)	Habitat away from stream	Veg. Aquatic	Veg. Seeds	Veg. Other	Invert. Aquatic	Invert. Arboreal	Invert. Volant	Invert. Terrestrial	Vert. Homeotherms	Vert. Poikilotherms	Carrion	Marsh	Cavity Tree	Shrub	Ground	Increase	Decrease	Marked Decrease	Eliminated	Not affected
White-throated Sparrow					●	●		●																	●
Fox Sparrow					●	●		●																	●
Lincoln's Sparrow					●			●					●										●		
Swamp Sparrow			●		●			●					●												●
*Song Sparrow			●		●			●					●						●				●		
McCown's Longspur						●		●																	●
Chestnut-collared Longspur						●		●																	●

Addendum

Little Blue Heron		●	●								●				●											●	●		
Common Egret		●									●				●														
Black-bellied Tree Duck		●	●					●		●	●																		
Stilt Sandpiper		●									●																●		
American Avocet		●									●																		
*Ferruginous Owl				●									●	●			●										●		
Broad-tailed Hummingbird				●	●					●		●																	
Tropical Kingbird				●								●															●		
Coues' Flycatcher				●								●														●	●		
Hermit Warbler				●	●						●																		
Orchard Oriole				●							●																		
Painted Bunting				●	●			●																					

Table 8

Composite list of mammals with level of riparian dependency and predicted effects following inundation in the Central Arizona Project dam construction.

	Riparian Dependency				Predicted Effect on Nos. Individuals				
	Strong	Moderate	Little or none		Increase	Decrease	Marked decrease	Eliminated	Not effected
Desert Shrew			●			●			
Long-tongued Bat			●	Insect densities		●			
Long-nosed Bat			●	" "		●			
Yuma Myotis			●	" "		●			
Cave Myotis			●	" "		●			
Short-eared Myotis			●	" "		●			
California Myotis			●	" "		●			
Small-footed Myotis			●	" "		●			
Silver-haired Bat			●						●
Western Pipistrelle			●	Insect Densities		●			
Big Brown Bat			●	" "		●			
Red Bat			●	Roost trees				●	
Hoary Bat			●	" "				●	
R Spotted Bat						Unknown			
Townsend's Big-eared Bat			●			●			
Western Big-eared Bat			●			●			
Pallid Bat			●			●			
Mexican Freetail Bat			●		●				
Big Freetail Bat			●		●				
Greater Mastiff Bat			●		●				
Eastern Cottontail			●			●			
Rocky Mountain Cottontail			●			●			
Desert Cottontail		●		Cover			●		
Antelope Jackrabbit			●			●			
Black-tailed Jackrabbit			●			●			
Least Chipmunk			●			●			
Cliff Chipmunk			●			●			
Harris' Antelope Squirrel			●			●			
Spotted Ground Squirrel			●			●			
Rock Squirrel			●			●			
Round-tailed Ground Squirrel			●			●			
Gunnison Prairie Dog			●			●			
Abert's Squirrel			●			●			
Arizona Gray Squirrel		●		trees				●	
Southwestern Pocket Gopher		●		soil				●	
Plains Pocket Gopher			●			●			
Apache Pocket Mouse			●			●			

R Indicates a rare species, BSF&W's Rare and Endangered Fish and Wildlife of the U. S..

Table 8 (continued)

	Riparian Dependency			Predicted Effect on Nos. Individuals				
	Strong	Moderate	Little or none	Increase	Decrease	Marked decrease	Eliminated	Not affected
Silky Pocket Mouse			●		●			
Hispid Pocket Mouse			●		●			
Desert Pocket Mouse			●		●			
Arizona Pocket Mouse			●		●			
Long-tailed Pocket Mouse			●		●			
Great Basin Pocket Mouse			●		●			
Rock Pocket Mouse			●		●			
Ord's Kangaroo Rat			●		●			
Bannertail Kangaroo Rat			●		●			
Merriam's Kangaroo Rat			●		●			
Desert Kangaroo Rat			●		●			
Beaver	●					●	●	
Plains Harvest Mouse			●		●			
Western Harvest Mouse			●		●			
Fulvous Harvest Mouse			●		●			
Cactus Mouse			●		●			
Deer Mouse			●		●			
White-footed Mouse			●		●			
Brush Mouse	●					●		
Pinyon Mouse			●		●			
Pygmy Mouse			●		●			
Northern Grasshopper Mouse			●		●			
Southern Grasshopper Mouse			●		●			
Hispid Cotton Rat			●	●				
Least Cotton Rat			●	●				
White-throated Woodrat			●		●			
Stephen's Woodrat			●		●			
Mexican Woodrat			●		●			
Longtail Vole			●		●			●
Mexican Vole			●		●			●
Muskrat	●					●	●	
House Mouse			●	●				
Porcupine		●				●		
Coyote			●	●	●			
Gray Wolf								●
Kit Fox			●		●			
Gray Fox			●		●			

Table 8 (continued)

		Riparian Dependency				Predicted Effect on Nos. Individuals				
		Strong	Moderate	Little or none		Increase	Decrease	Marked decrease	Eliminated	Not affected
	Black Bear			●			●			
	Ringtail			●			●			
	Raccoon			●	water	●	●			
PM	Coati			●		●	●			
	Long-tailed Weasel			●			●			
	Badger			●			●			
	Spotted Skunk			●		●				
	Striped Skunk			●		●				
	Hooded Skunk			●						●
	Hognosed Skunk			●			●			
PM	Jaguar									●
	Mountain Lion			●			●			
PM	Ocelot									●
	Bobcat			●				●		
	Javelina			●				●		
	Elk			●			●			
	Mule Deer			●			●			
	White-tailed Deer			●			●			
	Pronghorn			●			●			
	Ovis canadensis			●			●			
	Horse			●						●

PM Indicates a peripheral mammal species, BSF&W's Rare and Endangered Fish and Wildlife of the United States.

Table 9

BIRDS

Orme Dam Site[1]

Eared Grebe	Podiceps caspicus	uncommon winter
*Pied-billed Grebe	Podilymbus podiceps	uncommon resident
Double-crested Cormorant	Phalacrocorax auritus	uncommon transient
*Great Blue Heron	Ardea herodias	uncommon resident
*Green Heron	Butorides virescens	uncommon summer
Little Blue Heron	Florida caerulea	accidental
Common Egret	Casmerodius albus	rare transient
Snowy Egret	Leucophoyx thula	common transient
Black-crowned Night Heron	Nycticorax nycticorax	uncommon transient
*Least Bittern	Ixobrychus exilis	uncommon summer resident
White-faced Ibis	Plegadis chihi	rare transient
Canada Goose	Branta canadensis	uncommon winter
Mallard	Anas platyrhynchos	common winter
Gadwall	Anas strepera	rare transient
Pintail	Anas acuta	common winter
Green-winged Teal	Anas carolinensis	common winter
Blue-winged Teal	Anas discors	uncommon transient
Cinnamon Teal	Anas cyanoptera	common transient
American Widgeon	Mareca americana	common winter
Shoveler	Spatula clypeata	common winter
Wood Duck	Aix sponsa	accidental
Redhead	Aythya americana	uncommon winter
Ring-necked Duck	Aythya collaris	uncommon winter
Bufflehead	Bucephala albeola	uncommon winter
*Ruddy Duck	Oxyura jamaicensis	uncommon resident
Common Merganser	Mergus merganser	uncommon winter
Red-breasted Merganser	Mergus serrator	rare transient
Turkey Vulture	Cathartes aura	common summer
Sharp-shinned Hawk	Accipiter striatus	common winter
Goshawk	Accipiter gentilis	accidental (one record)
*Cooper's Hawk	Accipiter cooperi	common resident
*Red-tailed Hawk	Buteo jamaicensis	common resident
Zone-tailed Hawk	Buteo albonotatus	rare visitant
*Harris' Hawk	Parabuteo unicinctus	fairly common resident
*Black Hawk	Buteogallus anthracinus	rare summer resident
Golden Eagle	Aquila chrysaetos	rare visitant
E*Bald Eagle	Haliaeetus leucocephalus	uncommon winter resident(2pr)
Marsh Hawk	Circus cyaneus	uncommon winter
Osprey	Pandion haliaetus	uncommon transient
*Sparrow Hawk	Falco sparverius	common resident
*Gambel's Quail	Lophortyx gambelii	common to abundant resident
Virginia Rail	Rallus limicola	uncommon winter
Sora	Porzana carolina	uncommon winter
*Common Gallinule	Gallinula chloropus	uncommon resident
*American Coot	Fulica americana	common resident
*Killdeer	Charadrius vociferus	common resident
Common Snipe	Capella gallinago	uncommon winter
Spotted Sandpiper	Actitis macularia	common winter
Least Sandpiper	Erolia minutilla	common winter
Stilt Sandpiper	Micropalma himantopus	accidental

E Indicates endangered species as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

*Indicates nesting.

American Avocet	Recurvirostra americana	uncommon transient
Ring-billed Gull	Larus delawarensis	uncommon winter
Band-tailed Pigeon	Columba fasciata	accidental
*White-winged Dove	Zenaida asiatica	abundant summer resident
*Mourning Dove	Zenaidura macroura	abundant summer, uncom. wint
*Ground Dove	Columbigallina passerina	uncommon resident
*Inca Dove	Scardafella inca	uncommon resident
*Yellow-billed Cuckoo	Coccyzus americanus	uncommon summer resident
*Roadrunner	Geococcyx californianus	common resident
Groove-billed Ani	Crotophaga sulcirostris	accidental
*Screech Owl	Otus asio	common resident
*Great Horned Owl	Bubo virginianus	common resident
*Ferruginous Owl	Glaucidium brasilianum	rare resident
*Elf Owl	Micrathene whitneyi	common summer resident
*Poor-will	Phalaenoptilus nuttallii	common summer resident
*Lesser Nighthawk	Chordeiles acutipennis	abundant summer resident
Vaux's Swift	Chaetura vauxi	irregular transient
White-throated Swift	Aeronautes saxatalis	common visitant
*Black-chinned Hummingbird	Archilochus alexandri	common summer resident
*Costa's Hummingbird	Calypte costae	common summer resident
Anna's Hummingbird	Calypte anna	uncommon winter
Rufous Hummingbird	Selasphorus rufus	rare transient
Belted Kingfisher	Megaceryle alcyon	common winter
Red-shafted Flicker	Colaptes cafer	common winter
*Gilded Flicker	Colaptes chrysoides	common resident
*Gila Woodpecker	Centurus uropygialis	common resident
Acorn Woodpecker	Melanerpes formicivorus	accidental (2 records)
Lewis' Woodpecker	Asyndesmus lewis	irregular winter
Yellow-bellied Sapsucker	Sphyrapicus varius	common winter
*Ladder-backed Woodpecker	Dendrocopos scalaris	common resident
Tropical Kingbird	Tyrannus melancholicus	accidental
*Western Kingbird	Tyrannus verticalis	common summer resident
Cassin's Kingbird	Tyrannus vociferans	rare transient
Scissor-tailed Flycatcher	Muscivora forficata	accidental (1 record)
*Wied's Crested Flycatcher	Myiarchus tyrannulus	common summer resident
*Ash-throated Flycatcher	Myiarchus cinerascens	common summer, uncom. wint.
Eastern Phoebe	Sayornis phoebe	accidental
*Black Phoebe	Sayornis nigricans	common resident
Say's Phoebe	Sayornis saya	common winter
Traill's Flycatcher	Empidonax traillii	uncommon transient
Hammond's Flycatcher	Empidonax hammondii	common trans., uncom. wint.
Dusky Flycatcher	Empidonax oberholseri	uncommon transient & winter
Gray Flycatcher	Empidonax wrightii	uncommon transient & winter
Western Flycatcher	Empidonax difficilis	common transient
Coue's Flycatcher	Contopus pertinax	accidental
Western Wood Pewee	Contopus sordidulus	common transient
Olive-sided Flycatcher	Nuttallornis borealis	uncommon transient
*Vermilion Flycatcher	Pyrocephalus rubinus	common summer resident(local
Horned Lark	Eremophila alpestris	rare transient
Violet-green Swallow	Tachycineta thalassina	abundant transient
Tree Swallow	Iridoprocne bicolor	common transient
*Rough-winged Swallow	Stelgidopteryx ruficollis	uncommon summer, com. trans.
Barn Swallow	Hirundo rustica	uncommon transient
*Cliff Swallow	Petrochelidon pyrrhonota	uncommon summer, com. trans.

Purple Martin	Progne subis	rare transient
Steller's Jay	Cyanocitta stelleri	accidental
Scrub Jay	Aphelocoma coerulescens	irregular winter
*Common Raven	Corvus corax	rare resident, com. winter
Common Crow	Corvus brachyrhynchos	common winter
Mountain Chickadee	Parus gambeli	irregular winter
Bridled Titmouse	Parus wollweberi	uncommon winter
*Verdin	Auriparus flaviceps	abundant resident
Common Bushtit	Psaltriparus minimus	irregular winter
White-breasted Nuthatch	Sitta carolinensis	irregular winter
Red-breasted Nuthatch	Sitta canadensis	irregular winter
Brown Creeper	Certhia familiaris	uncommon winter
House Wren	Troglodytes aedon	common winter
Bewick's Wren	Thryomanes bewickii	common winter (1 nest. rec.)
*Cactus Wren	Campylorhynchus brunneicapillum	common resident
Long-billed Marsh Wren	Telmatodytes palustris	common winter
*Canyon Wren	Catherpes mexicanus	uncommon resident
*Rock Wren	Salpinctes obsoletus	common resident
*Mockingbird	Mimus polyglottos	uncommon resident
*Bendire's Thrasher	Toxostoma bendirei	uncommon resident
*Curve-billed Thrasher	Toxostoma curvirostre	common resident
*Crissal Thrasher	Toxostoma dorsale	common resident
Sage Thrasher	Oreoscoptes montanus	uncommon winter
Robin	Turdus migratorius	uncom. to abundant winter
Rufous-backed Robin	Turdus rufo-palliatus	accidental (2 records)
Hermit Thrush	Hylocichla guttata	irregular winter
Swainson's Thrush	Hylocichla ustulata	accidental
Western Bluebird	Sialia mexicana	common winter
Mountain Bluebird	Sialia currucoides	common winter
Townsend's Solitaire	Myadestes townsendi	irregular winter
Blue-gray Gnatcatcher	Polioptila caerulea	common winter
*Black-tailed Gnatcatcher	Polioptila melanura	common resident
Golden-crowned Kinglet	Regulus satrapa	accidental
Ruby-crowned Kinglet	Regulus calendula	abundant winter
Water Pipit	Anthus spinoletta	uncommon winter
Cedar Waxwing	Bombycilla cedrorum	irregular winter
*Phainopepla	Phainopepla nitens	common resident
*Logger Shrike	Lanius ludovicianus	uncommon resident
*Starling	Sturnus vulgaris	common resident
Hutton's Vireo	Vireo huttoni	common winter
*Bell's Vireo	Vireo bellii	uncommon summer resident
Gray Vireo	Vireo vicinior	accidental
Solitary Vireo	Vireo solitarius	com. transient, rare winter
Warbling Vireo	Vireo gilvus	common transient
Black & White Warbler	Mniotilta varia	accidental (1 record)
Orange-crowned Warbler	Vermivora celata	common trans., uncom. winter
Nashville Warbler	Vermivora ruficapilla	rare transient
Virginia's Warbler	Vermivora virginiae	rare transient
*Lucy's Warbler	Vermivora luciae	abundant resident
*Yellow Warbler	Dendroica petechia	uncom. summer, com. trans.
Audubon's Warbler	Dendroica auduboni	abundant winter
Black-throated Gray Warbler	Dendroica nigrescens	com. transient, uncom. wint.
Townsend's Warbler	Dendroica townsendi	common transient
Hermit Warbler	Dendroica occidentalis	accidental (1 record)

Table 9, Concluded

Northern Waterthrush	Seiurus noveboracensis	accidental (1 record)
MacGillivray's Warbler	Oporornis tolmiei	common transient
*Yellowthroat	Geothylypis trichas	uncommon summer resident
*Yellow-breasted Chat	Icteria virens	common summer resident
Wilson's Warbler	Wilsonia pusilla	common transient
American Redstart	Setophaga ruticilla	accidental (1 record)
Painted Redstart	Setophaga picta	accidental (1 record)
*House Sparrow	Passer domesticus	uncommon resident
Western Meadowlark	Sturnella neglecta	common winter
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	uncommon winter
*Red-winged Blackbird	Agelaius phoeniceus	common resident
*Hooded Oriole	Icterus cucullatus	uncommon summer resident
*Bullock's Oriole	Icterus bullockii	common summer resident
[2]Rusty Blackbird	Euphagus carolinus	accidental
Brewer's Blackbird	Euphagus cyanocephalus	uncommon winter
Boat-tailed Grackle	Cassidix mexicanus	uncommon visitant
*Brown-headed Cowbird	Molothrus ater	common summer resident
*Bronzed Cowbird	Tangavius aeneus	uncommon summer resident
Western Tanager	Piranga ludoviciana	common transient
*Summer Tanager	Piranga rubra	common summer resident
*Cardinal	Richmondena cardinalis	common resident
Black-headed Grosbeak	Pheucticus melanocephalus	common transient
*Blue Grosbeak	Guiraca caerulea	uncommon summer resident
Lazuli Bunting	Passerina amoena	uncommon transient
Evening Grosbeak	Hesperiphona vespertina	accidental (1 record)
*House Finch	Carpodacus mexicanus	common resident
Pine Siskin	Spinus pinus	irregular winter
American Goldfinch	Spinus tristis	uncommon winter
*Lesser Goldfinch	Spinus psaltria	common resident
Lawrence's Goldfinch	Spinus lawrencei	rare winter
Green-tailed Towhee	Chlorura chlorura	common transient
Rufous-sided Towhee	Pipilo erythrophthalmus	uncommon winter
*Brown Towhee	Pipilo fuscus	common resident
*Abert's Towhee	Pipilo aberti	common resident
Vesper Sparrow	Pooecetes gramineus	uncommon winter
Lark Sparrow	Chondestes grammacus	uncommon winter
*Black-throated Sparrow	Amphispiza bilineata	common resident
Sage Sparrow	Amphispiza belli	uncommon winter
Oregon Junco	Junco oreganus	irregular winter
Chipping Sparrow	Spizella passerina	uncommon transient
Brewer's Sparrow	Spizella breweri	common winter
White-crowned Sparrow	Zonotrichia leucophrys	common winter
Golden-crowned Sparrow	Zonotrichia atricapilla	accidental (1 record)
White-throated Sparrow	Zonotrichia albicollis	accidental (1 record)
Lincoln's Sparrow	Melospiza lincolnii	uncommon winter
Swamp Sparrow	Melospiza georgiana	accidental (1 record)
*Song Sparrow	Melospiza melodia	common resident

[1]Adapted from Simpson, J. M. and R. R. Johnson. History and Ecology of the Avifauna at Blue Point Cottonwoods, Maricopa County, Arizona (manuscript).

[2](no specimen) Observations of Janet Witzeman.

Table 10

MAMMALS

Orme Dam Site

Desert shrew (Notiosorex crawfordi)
California leaf-nosed bat (Macrotus californicus)
Cave myotis (Myotis velifer)
California myotis (Myotis californicus)
Western pipistrelle (Pipistrellus hesperus)
Big brown bat (Eptesicus fuscus)
Red bat (Lasiurus borealis)
Hoary bat (Lasiurus cinereus)
R Spotted bat (Euderma maculata)
Townsend's big-eared bat (Corynorhinus townsendii)
Pallid bat (Antrozous pallidus)
Brazilian free-tailed bat (Tadarida braziliensis)
Greater mastiff bat (Eumops perotis)
Yuma Bat (Myotis yumanensis)
Black-tailed jackrabbit (Lepus californicus)
Desert cottontail (Sylvilagus auduboni)
Rock squirrel (Citellus variegatus)
Harris' antelope squirrel (Citellus harrisi)
Round-tailed ground squirrel (Citellus tereticaudus)
Valley pocket gopher (Thomomys bottae)
Arizona pocket mouse (Perognathus amplus)
Long-tailed pocket mouse (Perognathus formosus)
Desert pocket mouse (Perognathus penicillatus)
Rock pocket mouse (Perognathus intermedius)
Merriam's kangaroo rat (Dipodomys merriami)
Ord's kangaroo rat (Dipodomys ordi) uncommon
Desert kangaroo rat (Dipodomys deserti)
Beaver (Castor canadensis)
Southern grasshopper mouse (Onychomys torridus)
Western harvest mouse (Reithrodontomys megalotis)
Cactus mouse (Peromyscus eremicus)
Deer mouse (Peromyscus maniculatus)
White-throated wood rat (Neotoma albigula)
Muskrat (Ondotra zibethicus)
Porcupine (Erethizon dorsatum)
Coyote (Canis latrans)
Gray wolf (Canis lupus) extirpated
Gray fox (Urocyon cinereoargenteus)
Ringtail (Bassariscus astutus)
Raccoon (Procyon lotor)
PM Coati (Nasua narica) question
Badger (Taxidea taxus)
Spotted skunk (Spilogale putorius)
Striped skunk (Mephitis mephitis)
Hooded skunk (Mephitis macroura)
Hognosed skunk (Conepatus mesoleucus)
PM Jaguar (Felis onca) accidental
PM Ocelot (Felis pardalis) accidental

PM Indicates a peripheral mammal species
E Indicates an endangered species

} as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

Mountain Lion (Felis concolor)
Bobcat (Lynx rufus)
Javelina (Tayassu tajacu)
Mule deer (Odocoileus hemionus)
Horse (Equus)
Kit fox (Vulpes macrotis)

Table 11

BIRDS

Buttes Dam Site

Eared Grebe	Podiceps caspicus	uncommon winter
Great Blue Heron	Ardea herodias	common resident
Green Heron	Butorides virescens	common resident
Canada Goose	Branta canadensis	uncommon winter
Common Merganser	Mergus merganser	uncommon winter
Turkey Vulture	Carthartes aura	common summer & winter
*Cooper's Hawk	Accipiter cooperi	common resident
*Red-tailed Hawk	Buteo jamaicensis	common resident
Harris' Hawk	Parabuteo unicinctus	uncommon resident
Bald Eagle	Haliaeetus leucocephalus	uncommon
Marsh Hawk	Circus cyaneus	common winter
Osprey	Pandion haliaetus	uncommon transient
*Sparrow Hawk	Falco sparverius	common resident
*Gambel's Quail	Lophortyx gambelii	common resident
Virginia Rail	Rallus limicola	accidental
Sora	Porzana carolina	uncommon
*Killdeer	Charadrius vociferus	common resident
Spotted Sandpiper	Actitus macularia	common fall & wint. trans.
Band-tailed Pigeon	Columba fasciata	transient
*White-winged Dove	Zenaida asiatica	common summer
*Mourning Dove	Zenaidura macroura	abundant resident
*Yellow-billed Cuckoo	Coccyzus americanus	uncommon summer
*Roadrunner	Geococcyx californianus	common resident
*Screech Owl	Otus asio	common resident
*Great Horned Owl	Bubo virginianus	common resident
*Common Nighthawk	Chordeiles minor	common summer
Lesser Nighthawk	Chordeiles acutipennis	migrant or accidental
White-throated Swift	Aeronautes saxatalis	irregular winter
*Costa's Hummingbird	Calyptes costae	common resident
*Black-chinned Hummingbird	Archilochus alexandri	common summer
Belted Kingfisher	Megaceryle alcyon	uncommon winter
Red-shafted Flicker	Colaptes cafer	common winter
*Gilded Flicker	Colaptes chrysoides	common resident
*Gila Woodpecker	Centurus uropygialis	common resident
*Ladder-backed Woodpecker	Dendrocopos scalaris	common resident
*Ash-throated Flycatcher	Myiarchus cinerascens	irregular summer
*Black Phoebe	Sayornis nigricans	common resident
Say's Phoebe	Sayornis saya	uncommon winter
?*Traill's Flycatcher	Empidonax traillii	uncommon summer
*Vermilion Flycatcher	Pyrocephalus rubinus	common resident
*Rough-winged Swallow	Stelgidopteryx ruficollis	common summer
Cliff Swallow	Petrochelidon pyrrhonota	common summer
Common Raven	Corvus corax	common winter
*White-necked Raven	Corvus cryptoleucus	common resident
*Verdin	Auriparus flaviceps	common resident
Red-breasted Nuthatch	Sitta canadensis	uncommon winter
Brown Creeper	Certhia familiaris	common winter
House Wren	Troglodytes aedon	common winter

*Indicates nesting.

*Bewick's Wren	Thryomanes bewickii	common resident
*Cactus Wren	Campylorhynchus brunneicapillum	common resident
*Canyon Wren	Catherpes mexicanus	common resident
*Rock Wren	Salpinctes obsoletus	common resident
Mockingbird	Mimus polyglottos	uncommon winter
*Curve-billed Thrasher	Toxostoma curvirostre	common resident
*Crissal Thrasher	Toxostoma dorsale	uncommon resident
Robin	Turdus migratorius	irregular winter
Western Bluebird	Sialia mexicana	irregular winter
Townsend's Solitaire	Myadestes townsendi	irregular winter
*Black-tailed Gnatcatcher	Polioptila melanura	common resident
Ruby-crowned Kinglet	Regulus calendula	common winter
*Phainopepla	Phainopepla nitens	common resident
*Loggerhead Shrike	Lanius ludovicianus	common resident
*Bell's Vireo	Vireo bellii	common summer
*Lucy's Warbler	Vermivora luciae	common summer
*Yellow Warbler	Dendroica petechia	common summer, fall trans.
Audubon Warbler	Dendroica auduboni	abundant winter
Black-throated Gray Warbler	Dendroica nigrescens	common transient
MacGillivray's Warbler	Oporornis tolmiei	common transient
*Common Yellowthroat	Geothylypis trichas	uncommon summer
*Yellow-breasted Chat	Icteria virens	common summer
Wilson's Warbler	Wilsonia pusilla	common transient
*Western Meadowlark	Sturnella neglecta	uncommon summer
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	uncommon winter
*Hooded Oriole	Icterus cucullatus	common summer
*Scott's Oriole	Icterus parisorum	uncommon summer
Brewer's Blackbird	Euphagus cyanocephalus	uncommon winter
*Brown-headed Cowbird	Molothrus ater	common resident
Western Tanager	Piranga ludoviciana	uncommon transient
*Summer Tanager	Piranga rubra	uncommon summer
*Cardinal	Richmondena cardinalis	common resident
Pyrrhuloxia	Pyrrhuloxia sinuata	irregular winter
*Blue Grosbeak	Guiraca caerulea	uncommon summer
*House Finch	Carpodacus mexicanus	common resident
American Goldfinch	Spinus tristis	irregular winter
*Lesser Goldfinch	Spinus psaltria	common summer
*Lawrence's Goldfinch	Spinus lawrencei	irregular winter
Green-tailed Towhee	Chlorura chlorura	common winter
*Abert's Towhee	Pipilo aberti	common resident
*Brown Towhee	Pipilo fuscus	common resident
Lark Bunting	Calamospiza melanocorys	uncommon winter
Grasshopper Sparrow	Ammodramus savannarum	transient
Vesper Sparrow	Pooecetes gramineus	uncommon winter
Black-throated Sparrow	Amphispiza bilineata	common resident
Sage Sparrow	Amphispiza belli	uncommon winter
Oregon Junco	Junco oreganus	common winter
Chipping Sparrow	Spizella passerina	uncommon winter
Brewer's Sparrow	Spizella breweri	uncommon winter
White-crowned Sparrow	Zonotrichia leucophrys	common winter
Lincoln's Sparrow	Melospiza lincolnii	common winter
*Song Sparrow	Melospiza melodia	common resident

Table 12

MAMMALS

Buttes Dam Site

Desert Shrew (Notiosorex crawfordi)
California leaf-nosed bat (Macrotus californicus)
Cave myotis (Myotis velifer)
California myotis (Myotis californicus)
Western pipistrelle (Pipistrellus hesperus)
Big brown bat (Eptesicus fuscus)
Red bat (Lasiurus borealis)
Hoary bat (Lasiurus cinereus)
R Spotted bat (Euderma maculata)
Pallid bat (Antrozous pallidus)
Brazilian free-tailed bat (Tadarida braziliensis)
Greater mastiff bat (Eumops perotis)
Antelope jackrabbit (Lepus alleni)
Black-tailed jackrabbit (Lepus californicus)
Desert cottontail (Sylvilagus audubonii)
Rock squirrel (Citellus variegatus)
Harris' antelope squirrel (Citellus harrisi)
Round-tailed ground squirrel (Citellus tereticaudus)
Valley pocket gopher (Thomomys bottae)
Arizona pocket mouse (Perognathus amplus)
Long-tailed pocket mouse (Perognathus formosus)
Desert pocket mouse (Perognathus penicillatus)
Rock pocket mouse (Perognathus intermedius)
Merriam's kangaroo rat (Dipodomys merriami)
Desert kangaroo rat (Dipodomys deserti) ?
Beaver (Castor canadensis)
Southern grasshopper mouse (Onychomys torridus)
Western harvest mouse (Reithrodontomys megalotis)
Cactus mouse (Peromyscus eremicus)
Deer mouse (Peromyscus maniculatus)
Hispid cotton rat (Sigmodon hispidus)
White-throated wood rat (Neotoma albigula)
Muskrat (Ondotra zibethicus) probably extirpated
Porcupine (Erethizon dorsatum) accidental
Coyote (Canis latrans)
Gray wolf (Canis lupus) extirpated
Gray fox (Urocyon cinereoargenteus)
Ringtail (Bassariscus astutus)
Badger (Taxidea taxus)
Spotted skunk (Spilogale putorius)
Striped skunk (Mephitis mephitis)
Hooded skunk (Mephitis macroura)
Hognosed skunk (Conepatus mesoleucus)
PM Jaguar (Felis onca) accidental
PM Ocelot (Felis pardalis) accidental
Mountain lion (Felis concolor)
Bobcat (Lynx rufus)

PM Indicates a peripheral mammal species
R Indicates a rare species

} as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

Javelina (Tayassu tajacu)
Mule deer (Odocoileus hemionus)
White-tailed deer (Odocoileus virginianus) accidental
Bighorn (Ovis canadensis)

Table 13

BIRDS

Charleston Dam Site[1]

[2]Olivaceous Cormorant	Phalacrocorax olivaceus	accidental
Great Blue Heron	Ardea herodias	common resident
Snowy Egret	Leucophoyx thula	common summer migrant
Wood Ibis	Mycteria americana	uncommon summer
Black-bellied Tree Duck	Dendrocygna autumnalis	uncommon summer
Mallard	Anas platyrhynchos	common winter
Gadwall	Anas strepera	common winter
Pintail	Anas acuta	common winter
Blue-winged Teal	Anas discors	uncommon winter
American Widgeon	Mareca americana	common winter
Shoveler	Spatula clypeata	common winter
Redhead	Aythya americana	uncommon winter
Ring-necked Duck	Aythya collaris	common winter
Lesser Scaup	Aythya affinis	uncommon winter
Turkey Vulture	Carthartes aura	common
Sharp-shinned Hawk	Accipiter striatus	uncommon
*Cooper's Hawk	Accipiter cooperi	common resident
Red-tailed Hawk	Buteo jamaicensis	common resident
Gray Hawk	Buteo nitidus	uncommon summer
Harris' Hawk	Parabuteo unicinctus	uncommon summer
Golden Eagle	Aquila chrysaetos	uncommon resident
E Bald Eagle	Haliaeetus leucocephalus	uncommon winter
Marsh Hawk	Circus cyaneus	common winter
R Prairie Falcon	Falco mexicanus	uncommon winter
Pigeon Hawk	Falco columbarius	uncommon winter transient
*Sparrow Hawk	Falco sparverius	common resident
*Scaled Quail	Callipepla squamata	common resident
*Gambel's Quail	Lophortyx gambelii	common resident
*Harlequin Quail	Cyrtonyx montezumae	common resident
American Coot	Fulica americana	uncommon resident
*Killdeer	Charadrius vociferus	common resident
Common Snipe	Capella gallinago	common transient
Greater Yellowlegs	Totanus melanoleucus	common migrant
Least Sandpiper	Erolia minutilla	common winter
*White-winged Dove	Zenaida asiatica	common resident
*Mourning Dove	Zenaidura macroura	common resident
*Ground Dove	Columbigallina passerina	common resident
*Yellow-billed Cuckoo	Coccyzus americanus	common summer
*Roadrunner	Geococcyx californianus	common resident
*Barn Owl	Tyto alba	uncommon summer
*Screech Owl	Otus asio	common summer
*Great Horned Owl	Bubo virginianus	common resident
*Burrowing Owl	Speotyto cunicularia	uncommon resident
*Lesser Nighthawk	Chordeiles acutipennis	common summer
*Black-chinned Hummingbird	Archilochus alexandri	common summer
Belted Kingfisher	Megaceryle alcyon	common summer
Red-shafted Flicker	Colaptes cafer	common winter
*Gilded Flicker	Colaptes chrysoides	uncommon resident

E Indicates an endangered species
R Indicates a rare species
} as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

* Indicates nesting.

Table 13, Continued

		Charleston
*Gila Woodpecker	Centurus uropygialis	common resident
Yellow-bellied Sapsucker	Sphyrapicus varius	common winter
Williamson's Sapsucker	Sphyrapicus thyroideus	uncommon winter
*Ladder-backed Woodpecker	Dendrocopos scalaris	common resident
*Western Kingbird	Tyrannus verticalis	common summer
*Cassin's Kingbird	Tyrannus vociferans	common summer
*Wied's Crested Flycatcher	Myiarchus tyrannulus	common summer
*Ash-throated Flycatcher	Myiarchus cinerascens	common summer
*Black Phoebe	Sayornis nigricans	common resident
*Say's Phoebe	Sayornis saya	common resident
Dusky Flycatcher	Empidonax oberholseri	uncommon winter
Western Flycatcher	Empidonax difficilis	common winter
*Vermilion Flycatcher	Pyrocephalus rubinus	common summer
Beardless Flycatcher	Camptostoma imberbe	uncommon resident
*Horned Lark	Eremophila alpestris	common resident
Violet-green Swallow	Tachycineta thalassina	irregular transient
*Cliff Swallow	Petrochelidon pyrrhonota	common summer
Common Raven	Corvus corax	common winter transient
*White-necked Raven	Corvus cryptoleucus	common resident
Verdin	Auriparus flaviceps	uncommon resident
Common Bushtit	Psaltriparus minimus	uncommon resident
White-breasted Nuthatch	Sitta carolinensis	uncommon resident
House Wren	Troglodytes aedon	common resident
*Bewick's Wren	Thryomanes bewickii	common summer
*Cactus Wren	Campylorhynchus brunneicapillum	common summer
*Canyon Wren	Catherpes mexicanus	uncommon resident
*Rock Wren	Salpinctes obsoletus	uncommon resident
*Mockingbird	Mimus polyglottos	common resident
Brown Thrasher	Toxostoma rufum	accidental
*Bendire's Thrasher	Toxostoma bendirei	common resident
*Curve-billed Thrasher	Toxostoma curvirostre	common resident
*Crissal Thrasher	Toxostoma dorsale	common resident
Sage Thrasher	Oreoscoptes montanus	irregular winter
Robin	Turdus migratorius	irregular winter
Hermit Thrush	Hylocichla guttata	irregular winter
Mountain Bluebird	Sialia currucoides	irregular winter
*Blue-gray Gnatcatcher	Polioptilla caerulea	uncommon summer
Golden-crowned Kinglet	Regulus satrapa	common winter
Ruby-crowned Kinglet	Regulus calendula	common winter
Water Pipit	Anthus spinoletta	uncommon winter
*Phainopepla	Phainopepla nitens	uncommon resident
*Loggerhead Shrike	Lanius ludovicianus	common resident
*Starling	Sturnus vulgaris	common resident
Hutton's Vireo	Vireo huttoni	uncommon winter
*Bell's Vireo	Vireo bellii	common summer
Nashville Warbler	Vermivora ruficapilla	
Yellow Warbler	Dendroica petechia	common winter
Audubon's Warbler	Dendroica auduboni	common winter
Louisiana Waterthrush	Seiurus motacilla	uncommon winter
MacGillivray's Warbler	Oporornis tolmiei	common winter transient
*Yellowthroat	Geothylypis trichas	uncommon summer
Yellow-breasted Chat	Icteria virens	common summer

Table 13, Concluded

		Charleston
Red-faced Warbler	Cardellina rubrifrons	winter transient
Wilson's Warbler	Wilsonia pusilla	winter transient
American Redstart	Setophaga ruticilla	accidental
*House Sparrow	Passer domesticus	common resident
*Eastern Meadowlark	Sturnella magna	common resident
*Western Meadowlark	Sturnella neglecta	common resident
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	uncommon resident
Brewer's Blackbird	Euphagus cyanocephalus	common winter
*Brown-headed Cowbird	Molothrus ater	common resident
*Summer Tanager	Piranga rubra	uncommon resident
*Cardinal	Richmondena cardinalis	uncommon resident
*Pyrrhuloxia	Pyrrhuloxia sinuata	uncommon resident
*Blue Grosbeak	Guiraca caerulea	common summer
Lazuli Bunting	Passerina amoena	winter transient
*House Finch	Carpodacus mexicanus	common resident
*American Goldfinch	Spinus tristis	uncommon resident
*Lesser Goldfinch	Spinus psaltria	uncommon resident
Lawrence's Goldfinch	Spinus lawrencei	uncommon winter transient
Green-tailed Towhee	Chlorura chlorura	common winter
*Rufous-sided Towhee	Pipilo erythrophthalmus	uncommon resident
*Brown Towhee	Pipilo fuscus	common resident
*Abert's Towhee	Pipilo aberti	uncommon resident
Lark Bunting	Calamospiza melanocorys	common winter
Savannah Sparrow	Passerculus sandwichensis	common winter
Grasshopper Sparrow	Ammodramus savannarum	common winter
Baird's Sparrow	Ammodramus bairdii	uncommon winter
Vesper Sparrow	Pooecetes gramineus	common winter
Lark Sparrow	Chondestes grammacus	common winter
*Rufous-crowned Sparrow	Aimophila ruficeps	common resident
Cassin's Sparrow	Aimophila cassinii	irregular winter
*Black-throated Sparrow	Amphispiza bilineata	common resident
Sage Sparrow	Amphispiza belli	irregular winter
Slate-colored Junco	Junco hyemalis	common winter
Oregon Junco	Junco oreganus	common winter
Gray-headed Junco	Junco caniceps	common winter
Mexican Junco	Junco phaeonotus	irregular winter transient
Chipping Sparrow	Spizella passerina	common winter
Brewer's Sparrow	Spizella breweri	common winter
White-crowned Sparrow	Zonotrichia leucophrys	common winter
Lincoln's Sparrow	Melospiza lincolnii	common winter
Song Sparrow	Melospiza melodia	uncommon winter
McCown's Longspur	Rhynchophanes mccownii	irregular winter
Chestnut-collared Longspur	Calcarius ornatus	irregular winter

[1]Adapted from a list provided by Mr. Fletcher Sillick.

[2]Difficult to distinguish from sibling species; no specimens.

Table 14

MAMMALS

Charleston Dam Site

Desert shrew (Notiosorex crawfordi)
California leaf-nosed bat (Macrotus californicus)
Mexican long-tongued bat (Choeronycteris mexicana)
Long-nosed bat (Leptonycteris nivalis)
Yuma myotis (Myotis yumanensis)
Cave myotis (Myotis velifer)
California myotis (Myotis californicus)
Western pipistrelle (Pipistrellus hesperus)
Big brown bat (Eptesicus fuscus)
Red bat (Lasiurus borealis)
Hoary bat (Lasiurus cinereus)
Townsend's big-eared bat (Chrynorhinus townsendii)
Pallid bat (Antrozous pallidus)
Brazilian free-tailed bat (Tadarida braziliensis)
Big free-tailed bat (Tadarida molossa) accidental
Greater mastiff bat (Eumops perotis)
Antelope jackrabbit (Lepus alleni)
Black-tailed jackrabbit (Lepus californicus)
Desert cottontail (Sylvilagus auduboni)
Gunnison's prairie dog (Cynomys gunnisoni) extirpated
Spotted ground squirrel (Citellus spilosoma)
Rock squirrel (Citellus variegatus)
Harris' antelope squirrel (Citellus harrisi)
Valley pocket gopher (Thomomys bottae)
Silky pocket mouse (Perognathus flavus)
Great Basin pocket mouse (Perognathus parvus)
Desert pocket mouse (Perognathus penicillatus)
Rock pocket mouse (Perognathus intermedius) uncommon
Banner-tailed kangaroo rat (Dipodomys spectabilis)
Merriam's kangaroo rat (Dipodomys merriami)
Ord's kangaroo rat (Dipodomys ordi)
Beaver (Castor canadensis)
Northern grasshopper mouse (Onychomys leucogaster)
Southern grasshopper mouse (Onychomys torridus)
Plains harvest mouse (Reithrodontomys montanus)
Western harvest mouse (Reithrodontomys megalotis)
Fulvous harvest mouse (Reithrodontomys fulvescens) uncommon
Pygmy mouse (Baiomys taylori)
Cactus mouse (Peromyscus eremicus)
Deer mouse (Peromyscus maniculatus)
White-footed mouse (Peromyscus leucopus)
Arizona cotton rat (Sigmodon hispidus)
Least cotton rat (Sigmodon minimus)
White-throated wood rat (Neotoma albigula)
Porcupine (Erethizon dorsatum) accidental
Coyote (Canis latrans)
Gray wolf (Canis lupus) transient
Kit fox (Vulpes macrotis)
Gray fox (Urocyon cinereoargenteus)
Ringtail (Bassariscus astutus)
PM Coati (Nasua narica) accidental

Long-tailed weasel (Mustela frenata)
Badger (Taxidea taxus)
Spotted skunk (Spilogale putorius)
Striped skunk (Mephitis mephitis)
Hooded skunk (Mephitis macroura)
Hognosed skunk (Conepatus mesoleucus)
PM Jaguar (Felis onca) accidental
PM Ocelot (Felis pardalis) accidental
Mountain lion (Felis concolor) accidental
Bobcat (Lynx rufus)
Javelina (Tayassu tajacu)
Mule deer (Odocoileus hemionus)
White-tailed deer (Odocoileus virginianus) accidental
Pronghorn (Antilocapra americana mexicana)

PM Indicates a peripheral mammal species as listed in the Bureau of Sport Fi Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

Table 15

BIRDS

Hooker Dam Site[1]

	Eared Grebe	Podiceps caspicus	rare transient
	*Pied-billed Grebe	Podilymbus podiceps	uncommon summer
	Double-crested Cormorant	Phalacrocorax auritus	uncommon transient
	*Great Blue Heron	Ardea herodias	common resident
	*Green Heron	Butorides virescens	uncommon resident
	Common Egret	Casmerodius albus	uncommon transient
	Snowy Egret	Leucophoyx thula	uncommon or rare transient
	*Black-crowned Night Heron	Nycticorax nycticorax	uncommon summer
	Least Bittern	Ixobrychus exilis	rare summer
	Black-bellied Tree Duck	Dendrocygna autumnalis	irregular summer
	*Mallard	Anas platyrhynchos	uncommon resident
E	*Mexican Duck	Anas diazi	rare summer
	Gadwall	Anas strepera	uncommon transient
	Pintail	Anas acuta	uncommon transient
	Green-winged Teal	Anas carolinensis	common transient
	*Blue-winged Teal	Anas discors	rare summer
	*Cinnamon Teal	Anas cyanoptera	common transient
	American Widgeon	Mareca americana	common transient
	Shoveler	Spatula clypeata	common transient
	Wood Duck	Aix sponsa	rare transient
	Redhead	Aythya americana	uncommon transient
	Ring-necked Duck	Aythya collaris	uncommon transient
	Canvasback	Aythya valisineria	uncommon transient
	Lesser Scaup	Aythya affinis	uncommon transient
	Bufflehead	Aythya affinis	uncommon transient
	Ruddy Duck	Oxyura jamaicensis	rare summer
	*Common Merganser	Mergus merganser	uncommon winter
	Red-breasted Merganser	Mergus serrator	rare transient
	*Turkey Vulture	Cathartes aura	common summer
	Goshawk	Accipiter gentilis	rare
	Sharp-shinned Hawk	Accipiter striatus	uncommon winter
	*Cooper's Hawk	Accipiter cooperii	common resident
	*Red-tailed Hawk	Buteo jamaicensis	common resident
	*Swainson's Hawk	Buteo swainsoni	uncommon summer
	*Zone-tailed Hawk	Buteo albonotatus	rare summer
	Gray Hawk	Buteo nitidus	rare summer,? current status
	Ferruginous Hawk	Buteo regalis	rare transient
	Harris' Hawk	Parabuteo unicinctus	rare transient
E	Bald Eagle	Haliaeetus leucocephalus	rare summer
	*Golden Eagle	Aquila chrysaetos	uncommon resident
	Marsh Hawk	Circus cyaneus	uncommon transient
	*Black Hawk	Buteogallus anthracinus	common summer
	Osprey	Pandion haliaetus	uncommon transient
R	Prairie Falcon	Falco mexicanus	rare transient
E	Peregrine Falcon	Falco peregrinus	rare summer
	Pigeon Hawk	Falco columbarius	uncommon transient
	*Sparrow Hawk	Falco sparverius	common resident

E Indicates an endangered species
R Indicates a rare species
} as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

* Indicates nesting.

*Scaled Quail	Callipepla squamata	uncommon resident
*Gambel's Quail	Lophortyx gambelii	common resident
*Harlequin Quail	Cyrtonyx montezumae	uncommon resident
*Ring-necked Pheasant	Phasianus colchicus	uncommon resident
Turkey	Meleagris gallopavo	uncommon resident
Virginia Rail	Rallus limicola	uncommon transient
*Sora	Porzana carolina	rare summer
Common Gallinule	Gallinula chloropus	uncommon summer
*American Coot	Fulica americana	uncommon summer
*Killdeer	Charadrius vociferus	common resident
Common Snipe	Capella gallinago	uncommon transient
*Spotted Sandpiper	Actitis macularia	uncommon summer
Solitary Sandpiper	Tringa solitaria	rare transient
American Avocet	Recurvirostra americana	rare transient
Ring-billed Gull	Larus delawarensis	rare transient
*Band-tailed Pigeon	Columba fasciata	uncommon summer
*White-winged Dove	Zenaida asiatica	common summer
*Mourning Dove	Zenaidura macroura	common resident
*Ground Dove	Columbigallina passerina	common resident
*Inca Dove	Scandafella inca	uncommon resident
*Yellow-billed Cuckoo	Coccyzus americanus	rare summer
*Roadrunner	Geococcyx californianus	uncommon resident
*Barn Owl	Tyta alba	uncommon resident
*Screech Owl	Otus asio	uncommon resident
*Great Horned Owl	Bubo virginianus	uncommon resident
*Elf Owl	Micrathene whitneyi	uncommon summer
Spotted Owl	Strix occidentalis	rare resident
Long-eared Owl	Asio otus	rare winter
*Poor-will	Phalaenoptilus nuttallii	common summer
*Common Nighthawk	Chordeiles minor	uncommon summer
*Lesser Nighthawk	Chordeiles acutipennis	uncommon summer
Black Swift	Cypseloides niger	irregular transient
*White-throated Swift	Aeronatues saxatalis	uncommon summer
*Black-chinned Hummingbird	Archilochus alexandri	uncommon summer
Costa's Hummingbird	Calypte costae	rare summer
Broad-tailed Hummingbird	Selasphorus platycercus	uncommon summer
Rufous Hummingbird	Selasphorus rufus	uncommon transient
Calliope Hummingbird	Stellula calliope	uncommon transient
Belted Kingfisher	Megaceryle alcyon	uncommon resident
*Red-shafted Flicker	Colaptes cafer	uncommon summer
*Gila Woodpecker	Centurus uropygialis	common resident
*Acorn Woodpecker	Melanerpes formicivorus	uncommon resident
Lewis' Woodpecker	Asyndesmus lewis	accidental
Yellow-bellied Sapsucker	Sphyrapicus varius	uncommon winter
Williamson's Sapsucker	Sphyrapicus thyroideus	accidental
*Hairy Woodpecker	Dendrocopos villosus	uncommon resident
Downy Woodpecker	Dendrocopos pubsecens	uncommon transient
*Ladder-backed Woodpecker	Dendrocopos scalaris	common resident
*Western Kingbird	Tyrannus verticalis	common summer
*Cassin's Kingbird	Tyrannus vociferans	common summer
Scissor-tailed Flycatcher	Muscivora forficata	accidental
*Ash-throated Flycatcher	Myiarchus cinerascens	common summer

*Wied's Crested Flycatcher	Myiarchus tyrannulus	common summer
*Black Phoebe	Sayornis nigricans	uncommon resident
*Say's Phoebe	Sayornis saya	uncommon resident
*Traill's Flycatcher	Empidonax traillii	uncommon resident
Western Flycatcher	Empidonax difficilis	uncommon transient
*Western Wood Pewee	Contopus sordidulus	rare summer
Olive-sided Flycatcher	Nuttallornis borealis	rare transient
*Vermilion Flycatcher	Pyrocephalus rubinus	uncommon summer
*Horned Lark	Eremophila alpestris	uncommon resident
Violet-green Swallow	Tachycineta thalassina	uncommon summer
Tree Swallow	Iridoproene bicolor	uncommon transient
Bank Swallow	Riparia riparia	uncommon transient
*Rough-winged Swallow	Stelgidopteryx ruficollis	uncommon summer
*Barn Swallow	Hirundo rustica	uncommon summer
*Cliff Swallow	Petrochelidon pyrrhonota	common summer
Purple Martin	Progne subis	visitant
Steller's Jay	Cyanocitta stelleri	rare resident
*Scrub Jay	Aphelocoma coerulescens	common resident
*Mexican Jay	Aphelocoma ultramarina	common resident
*Common Raven	Corvus corax	common resident
*White-necked Raven	Corvus cryptoleucus	uncommon resident
*Common Crow	Corvus brachyrhynchos	rare summer
Pinon Jay	Gymnorhinus cyanocephala	common resident
Clark's Nutcracker	Nucifraga columbiana	irregular winter
Mountain Chickadee	Parus gambeli	common resident
*Plain Titmouse	Parus inornatus	rare resident
*Bridled Titmouse	Parus wollweberi	common resident
*Verdin	Auriparus flaviceps	common resident
*Common Bushtit	Psaltriparus minimus	common resident
*White-breasted Nuthatch	Sitta carolinensis	uncommon resident
Red-breasted Nuthatch	Sitta canadensis	rare winter
Pygmy Nuthatch	Sitta pygmaea	uncommon resident
Brown Creeper	Certhia familiaris	rare winter
Dipper	Cinclus mexicanus	rare visitant
House Wren	Troglodytes aedon	uncommon winter
*Bewick's Wren	Thryomanes bewickii	common resident
*Cactus Wren	Campylorhynchus brunneicapillum	common resident
*Canyon Wren	Catherpes mexicanus	uncommon resident
*Rock Wren	Salpinctes obsoletus	uncommon resident
*Mockingbird	Mimus polyglottos	common summer
*Bendire's Thrasher	Toxostoma bendirei	uncommon resident
*Curve-billed Thrasher	Toxostoma curvirostre	uncommon resident
*Crissal Thrasher	Toxostoma dorsale	uncommon resident
*Robin	Turdus migratorius	uncommon resident
Hermit Thrush	Hylocichla guttata	common winter
Eastern Bluebird	Sialia sialis	accidental
Western Bluebird	Sialia mexicana	common winter
Mountain Bluebird	Sialia currucoides	uncommon winter
Townsend's Solitaire	Myadestes townsendi	uncommon winter
*Blue-gray Gnatcatcher	Polioptila caerulea	uncommon resident
*Phainopepla	Phainopepla nitens	common resident
Golden-crowned Kinglet	Regulus satrapa	irregular winter

Ruby-crowned Kinglet	Regulus calendula	common winter
Water Pipit	Anthus spinoletta	common winter
Cedar Waxwing	Bombycilla cedrorum	uncommon winter
*Loggerhead Shrike	Lanius ludovicianus	common resident
*Starling	Sturnus vulgaris	common resident
*Bell's Vireo	Vireo bellii	uncommon summer
*Gray Vireo	Vireo vicinior	uncommon summer
Solitary Vireo	Vireo solitarius	uncommon summer
Warbling Vireo	Vireo gilvus	uncommon transient
Black & White Warbler	Mniotilta varia	accidental
Orange-crowned Warbler	Vermivora celata	common transient
Virginia's Warbler	Vermivora virginiae	uncommon summer
*Lucy's Warbler	Vermivora lucae	common summer
*Yellow Warbler	Dendroica petechia	common summer
Audubon's Warbler	Dendroica auduboni	common transient
Black-throated Gray Warbler	Dendroica nigrescens	common summer
Townsend's Warbler	Dendroica townsendi	uncommon transient
Grace's Warbler	Dendroica graciae	uncommon summer
Northern Waterthrush	Seiurus noveboracensis	uncommon transient
MacGillivray's Warbler	Oporornis tolmiei	common transient
*Yellowthroat	Geothlypis trichas	common summer
*Yellow-breasted Chat	Icteria virens	common summer
Red-faced Warbler	Cardellina rubrifrons	irregular transient
Wilson's Warbler	Wilsonia pusilla	uncommon migrant
*House Sparrow	Passer domesticus	uncommon resident
*Eastern Meadowlark	Sturnella magna	uncommon summer
*Western Meadowlark	Sturnella neglecta	rare resident
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	rare migrant
*Red-winged Blackbird	Agelaius phoeniceus	common resident
Orchard Oriole	Icterus spurius	accidental
*Hooded Oriole	Icterus cucullatus	common summer
*Scott's Oriole	Icterus parisorum	uncommon summer
*Bullock's Oriole	Icterus bullockii	common summer
*Boat-tailed Grackle	Cassidix mexicanus	uncommon resident
Brewer's Blackbird	Euphagus cyanocephalus	common winter
*Brown-headed Cowbird	Molothrus ater	common summer
*Bronzed Cowbird	Tangavius aeneus	uncommon summer
Western Tanager	Piranga ludoviciana	uncommon migrant
Hepatic Tanager	Piranga flava	uncommon summer
*Summer Tanager	Piranga rubra	common summer
*Cardinal	Richmondena cardinalis	uncommon resident
Pyrrhuloxia	Pyrrhuloxia sinuata	common winter
*Black-headed Grosbeak	Pheucticus melanocephalus	common transient
*Blue Grosbeak	Guiraca caerulea	common summer
*Indigo Bunting	Passerina cyanea	uncommon summer
Lazuli Bunting	Passerina amoena	uncommon summer
Painted Bunting	Passerina ciris	accidental
Evening Grosbeak	Hesperiphona vespertina	uncommon winter
Cassin's Finch	Carpodacus cassinii	common transient
*House Finch	Carpodacus mexicanus	common resident
Pine Siskin	Spinus pinus	common transient
American Goldfinch	Spinus tristis	uncommon winter

*Lesser Goldfinch	Spinus psaltria	common summer
Red Crossbill	Loxia curvirostra	irregular winter
Green-tailed Towhee	Chlorura chlorura	common transient
Rufous-sided Towhee	Pipilo erythrophthalmus	common resident
*Brown Towhee	Pipilo fuscus	uncommon resident
*Abert's Towhee	Pipilo aberti	uncommon resident
Lark Bunting	Calamospiza melanocorys	uncommon transient
Savannah Sparrow	Passerculus sandwichensis	uncommon winter
*Lark Sparrow	Chondestes grammacus	uncommon summer
*Rufous-crowned Sparrow	Aimophila ruficeps	uncommon resident
Cassin's Sparrow	Aimophila cassinii	uncommon transient
*Black-throated Sparrow	Amphispiza bilineata	common resident
Slate-colored Junco	Junco hyemalis	accidental
Oregon Junco	Junco oreganus	common winter
Gray-headed Junco	Junco caniceps	uncommon winter
Chipping Sparrow	Spizella passerina	uncommon summer
Brewer's Sparrow	Spizella breweri	uncommon transient
*Black-chinned Sparrow	Spizella atrogularis	rare summer
White-crowned Sparrow	Zonotrichia leucophrys	common winter
Fox Sparrow	Passerella iliaca	rare transient
Lincoln's Sparrow	Melospiza lincolnii	uncommon winter
Song Sparrow	Melospiza melodia	uncommon resident

Addendum

Yellow-crowned Night Heron[2]	Nyctanassa violacea	accidental

[1]Modified from Checklist of Mammals, Reptiles, Amphibians, Birds and Fish of the Gila Wilderness, Hubbard (1971), R. R. Johnson (pers. comm.).

[2]Per letter from New Mexico Department of Game and Fish, December 22, 1971

Table 16

MAMMALS

Hooker Dam Site[1]

	Short-eared Myotis	Myotis auriculus
	California Myotis	Myotis californicus
	Small-footed Myotis	Myotis subulatus
	Silver-haired Bat	Lasionycteris noctivagans
	Hoary Bat	Lasiurus cinereus
	Big Brown Bat	Eptesicus fuscus
	Western Big-eared Bat	Plecotus townsendii
	Pallid Bat	Antrozous pallidus
R	Spotted Bat	Euderma maculatum
	Black-tailed Jackrabbit	Lepus californicus
	Desert Cottontail	Sylvilagus auduboni
	Mountain Cottontail	Sylvilagus nuttalli
	Eastern Cottontail	Sylvilagus floridanus
	Rock Squirrel	Citellus variegatus
	Cliff Chipmunk	Eutamias dorsalis
	Least Chipmunk	Eutamias minimus
	Abert's Squirrel	Sciurus aberti
	Arizona Gray Squirrel	Sciurus arizonensis
	Valley Pocket Gopher	Thomomys bottae
	Plains Pocket Gopher	Geomys bursarius
	Rock Pocket Mouse	Perognathus intermedius
	Hispid Pocket Mouse	Perognathus hispidus
	Silky Pocket Mouse	Perognathus flavus
	Banner-tailed Kangaroo Rat	Dipodomys spectabilis
	Merriam's Kangaroo Rat	Dipodomys merriami
	Ord's Kangaroo Rat	Dipodomys ordi
	Apache Pocket Mouse	Perognathus apache
	Beaver	Castor canadensis
	Western Harvest Mouse	Reithrodontomys megalotis
	Plains Harvest Mouse	Reithrodontomys montanus
	Deer Mouse	Peromyscus maniculatus
	Brush Mouse	Peromyscus boylei
	Pinon Mouse	Peromyscus truei
	White-footed Mouse	Peromyscus leucopus
	Cactus Mouse	Peromyscus eremicus
	Northern Grasshopper Mouse	Onychomys leucogaster
	Southern Grasshopper Mouse	Onychomys torridus
	White-throated Woodrat	Neotoma albigula
	Southern Plains Woodrat	Neotoma micropus
	Stephens Woodrat	Neotoma stephensi
	Mexican Woodrat	Neotoma mexicani
	Mexican Vole	Microtus mexicanus
	Long-tailed Vole	Microtus longicaudus
	Muskrat	Ondatra zibethicus
	Western Jumping Mouse	Zapus princeps
	House Mouse	Mus musculus
	Porcupine	Erethizon dorsatum

[1]Adapted from Checklist of Mammals, Reptiles, Amphibians, Birds and Fish of the Gila Wilderness.

	Coyote	Canis latrans
	Kit Fox	Vulpes macrotis
	Gray Fox	Urocyon cinereoargenteus
	Black Bear	Ursus americanus
	Ringtail	Bassariscus astutus
	Raccoon	Procyon lotor
PM	Coati	Nasua narica
	Long-tailed Weasel	Mustela frenata
	Badger	Taxidea taxus
	Spotted Skunk	Spilogale putorius
	Striped Skunk	Mephitis mephitis
	Hooded skunk	Mephitis macroura
	Hognosed Skunk	Conepatus mesoleucus
	Mountain Lion	Felis concolor
	Bobcat	Lynx rufus
	Javelina	Tayassu tajacu
	Elk	Cervis canadensis
	Mule Deer	Odocoileus hemionus
	White-tailed Deer	Odocoileus virginianus
	Pronghorn	Antilocapra americana mexicana
	Bighorn	Ovis canadensis

R Indicates a rare species
PM Indicates a peripheral mammal species } as listed in the Bureau of Sport Fisheries and Wildlife's 1968 edition of Rare and Endangered Fish and Wildlife of the United States.

A compilation of the Invertebrate fauna of the environs of the Orme, Buttes, Charleston and Hooker reservoir sites.

Prepared by Mont A. Cazier, Arizona State University, Tempe, Arizona, January 1972, for the U. S. Bureau of Reclamation, Region 3, Boulder City, Nevada.

The lists of invertebrates were prepared from various published sources, as given in the reference section, from the authors private collection, and from the collection at Arizona State University. The author has had some collecting experience in the vicinity of two of the sites, Orme and Charleston, and was briefed with pictures and verbal accounts of the topography, environment and flora of the Butte and Hooker sites. As can be seen from the lists, not all invertebrate groups are equally well known in Arizona and New Mexico and it has been necessary to give only general estimates of the fauna in some cases. However, it should be kept in mind that these lists are undoubtedly minimal at the species level and that field work and extensive library research would probably double the number listed. At the family and generic levels not too much additional would be anticipated except in sections such as the spiders.

It is quite evident that the invertebrates and especially the insects have successfully invaded, exploited and established themselves in every conceivable environmental "niche" in all 4 reservoir sites. There are aquatic and terrestrial groups; subterranean and arboreal species; aquatic forms living as climbers on vegetation, sprawlers on the bottom, burrowers in the bottom, free-ranging, close-clinging and vegetation inhabiting forms; there are plant and animal parasites; parasites on parasites; scavengers, carnivors; predators; copriphags; saprophags; phytophags on all the species of plants, and on all the parts of the plants, roots, trunks, stems, leaves, flowers and seeds; there are ground and plant nesting species; symbiotic relationships between plant and insect, animal and insect; oligolectic and polylectic pollinators; poisonous and non-poisonous forms and a few whose relationship to the whole is nebulous. No other group of animals so completely

dominates the environment! Nor do the invertebrates find an equal when it becomes necessary to adapt and survive under changing conditions.

Each of the 4 sites has its own special conditions, plants and animals but all have in common a riparian woodland replete with varying sized streams and numerous plant and animal species. Also present are such "biome-types" as desertscrub, grassland, chaparrel, woodland and sparse forest that contribute to the total biotic formation in each area. Naturally the riparian "biome-type" will be the most affected by dam building and water impoundment but bordering biome-types will also be disturbed to a lesser degree. I use the word "disturbed" since in my opinion the building of these 4 dams will result in no destruction of any of the biotypes in any of the 4 sites. In each area a relatively small section of the riparian biotic community will be replaced by a lake and a shore line environment and a limited amount of the surrounding area will be submerged. However, this only opens the area to additional forms of life and makes available much needed new recreational facilities for man. The natural environment will remain in large part untouched. So far as the invertebrates are concerned the construction of the dams will have no far reaching consequences and very little immediate readjustment will be required by the native species. No species populations will be depleted to any extent and so far as indicated none will be endangered.

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APPENDIX B OF APPENDED MATERIAL

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APPENDIX C OF APPENDED MATERIAL

ADVISORY COUNCIL
ON
HISTORIC PRESERVATION

WASHINGTON, D.C. 20240

November 11, 1971

Dear Mr. Armstrong:

This is in response to your request for comments on the environmental impact statement identified by a copy of your cover letter attached to this document. The staff of the Advisory Council has reviewed the submitted impact statement and suggests the following, identified by checkmark on this form:

✓ The final statement should contain (1) a sentence indicating that the National Register of Historic Places has been consulted and that no National Register properties will be affected by the project, or (2) a listing of the properties to be affected, an analysis of the nature of the effects, a discussion of the ways in which the effects were taken into account, and an account of steps taken to assure compliance with Section 106 of the National Historic Preservation Act of 1966 (80 Stat. 915) in accordance with procedures of the Advisory Council on Historic Preservation as they appear in the Federal Register, February 20, 1971.

___ In the case of properties under the control or jurisdiction of the United States Government, the statement should include a discussion of steps taken to comply with Section 2(b) of Executive Order 11593 of May 13, 1971.

✓ The final statement should contain evidence of contact with the Historic Preservation Officer for the State involved and a copy of his comments concerning the effect of the undertaking upon historical and archeological resources.

___ Specific comments attached.

Comments on environmental impact statements are not to be considered as comments of the Advisory Council in Section 106 matters.

Sincerely yours,

Robert R. Garvey, Jr.
Executive Secretary

THE COUNCIL *is charged by the Act of October 15, 1966, with advising the President and Congress in the field of Historic Preservation, recommending measures to coordinate governmental with private activities, advising on the dissemination of information, encouraging public interest and participation, recommending the conduct of special studies, advising in the preparation of legislation, and encouraging specialized training and education. The Council also has the responsibility to comment on Federal or Federally-assisted undertakings that have an effect on cultural property listed in the National Register.*

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20250

DEC 10 1971

Your Reference: 730

Mr. Ellis L. Armstrong
Commissioner
Bureau of Reclamation
Department of the Interior

Dear Mr. Armstrong:

This is in reply to your letter of September 27, 1971, requesting our review and comments on a draft environmental statement for the Central Arizona Project, Arizona.

As indicated, the draft is a general environmental statement on the total project. The general nature of the statement causes the assessment of the proposed project's impact on the environment to be somewhat vague. Correspondingly, the mitigation and enhancement measures to be undertaken are somewhat vague and indefinite.

We understand that specific environmental statements will be prepared for individual components of the project; however, this makes no provision for a detailed discussion of the cumulative effect once the impacts of components are determined. Therefore, we suggest that this draft statement be strengthened by additional treatment of the following subjects.

1. Description of alternatives to project components and an analysis of these alternatives' impacts on the environment.

2. Project's effect on "rare and endangered forms."

3. Description and enumeration of mitigation and enhancement features, including benefits to wildlife.

4. Magnitude of recreational use and resulting impact.

5. Effect of inundation of livestock and wildlife habitat and range. Information on the impact of reservoirs on grazing in National Forests is available from the Forest Service.

6. Effects of controlled flows on riparian vegetation and fish and wildlife.

7. Effects of reservoir fluctuation.

8. Loss of existing recreational opportunities and archeological and wilderness values at reservoir sites. In 1968, the Forest Service studied impacts of reservoirs at the Orme and Hooker sites which could be made available to the Bureau of Reclamation.

9. Measures to minimize erosion and sedimentation during construction and operation of the project. Assistance is available from the Soil Conservation Service and the Forest Service.

10. Alternatives or partial alternatives to the Central Arizona Project, such as management of vegetation on the watersheds or recycling of municipal and industrial water.

11. Possible long-term mineralization and salinization of the region's soils.

12. Discussion of the precluded use of water to be diverted from the Colorado River.

13. Estimated benefits and costs in monetary terms.

Thank you for the opportunity to review this draft statement.

Sincerely,

T. C. BYERLY
Coordinator, Environmental
Quality Activities

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
517 Gold Avenue, SW
Albuquerque, New Mexico 87101

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November 11, 1971

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Mr. E. A. Lundberg, Regional Director
Bureau of Reclamation, Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

This is in reference to Mr. H. Philip Sharpe's memorandum of October 8, 1971 transmitting the Environmental Statement - Central Arizona Project and my reply of October 22, 1971.

By reason of the national and inter-regional significance of the Central Arizona Project we are sending our comments to the office of the Chief, U. S. Forest Service. A coordinated response to the Draft Environmental Statement will be prepared and sent to you from that office.

Sincerely,

for WM. D. HURST
Regional Forester

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
517 Gold Avenue, S.W.-Fed. Bldg.
Albuquerque, New Mexico-87101

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Mr. E. A. Lundberg
Regional Director
Bureau of Reclamation-Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

This is to acknowledge receipt of the review draft - "Environmental Statement - Central Arizona Project (September 1971) which was received here on October 12, 1971. On a quick reading I am impressed with the quality of the presentation for a project as large and complex as this.

We will proceed to make a thorough review and expect to have meaningful and constructive comments to you by November 11, 1971.

Mr. Phillip Sharp's quick response to our telephone request for additional copies is very much appreciated.

Sincerely,

Wm D. Hurst

WM. D. HURST
Regional Forester

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
630 Sansome Street, Room 1216
San Francisco, California 94111

IN REPLY REFER TO

SPDPD-R

24 November 1971

Mr. Ellis L. Armstrong
Commissioner
Bureau of Reclamation
Washington, D. C. 20240

Dear Mr. Armstrong:

I am writing in response to your letter of 27 September 1971 to Colonel J. B. Newman, Executive Director of Civil Works, Office of Chief of Engineers, asking for Corps of Engineer review and comments on the draft environmental statement for the Central Arizona Project. In accordance with our established procedure for reviewing draft environmental statements, this letter shall serve as the consolidated field level review comments of the District Engineer, Los Angeles, and the Division Engineer, South Pacific.

The subject document indicates that there will be no apparent adverse effect upon existing or proposed Corps of Engineers flood control or water supply projects. It has been our experience in this region, however, that it is necessary to consider and evaluate, in some detail, the effect of vegetative management on fish and wildlife habitat, particularly if this involves phreatophyte control.

Thank you for the opportunity to review and comment on this draft environmental statement. As environmental statements are prepared for each segment of the Central Arizona Project we will be pleased to review them and to make more specific comments.

Sincerely yours,

FRANK A. CAMM
Brigadier General, U. S. Army
Division Engineer

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

OFFICE OF THE SECRETARY

WASHINGTON, D.C. 20201

NOV 4 1971

Mr. Ellis L. Armstrong
Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D. C. 20240

Dear Mr. Armstrong:

This is in response to your letter dated September 27, 1971, to Mr. Donald Bliss requesting comments on the draft environmental impact statement for the Central Arizona Project, Arizona.

This Department has reviewed the health aspects of the proposed project. It has been noted that several multi-use areas are proposed in which public recreation areas will be provided. Health and safety requirements of the State and appropriate county health departments should be observed during the planning and construction of these sites. In addition, we recommend that appropriate health guidelines in the following publication be employed during the development of the recreational areas:

Environmental Health Practices in Recreational Areas
PHS Publication No. 1195 (enclosed).

The subject draft environmental impact statement also refers to proposed design features to protect wildlife. Where the system will be accessible to the public, suitable safeguards should be included to prevent accidental immersion and drowning.

The opportunity to review this draft environmental impact statement is appreciated.

Sincerely yours,

Marlin K. DuVal, M.D.
Assistant Secretary for
Health and Scientific Affairs

Enclosure

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
2500 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA 90057

AREA OFFICES
Los Angeles, California
San Francisco, California

REGION IX
REGIONAL OFFICE
SAN FRANCISCO, CALIFORNIA

October 13, 1971

IN REPLY REFER TO:

Office of the Area Director

9.2SE

Mr. Ellis L. Armstrong
Commissioner
Bureau of Reclamation
United States Department of the Interior
Washington, D. C. 20240

Dear Mr. Armstrong:

This will respond to your letter of September 27, 1971 regarding the environmental statement for the Central Arizona Project. While we recognize the magnitude of this project and its impact on the State, please be advised that we find no environmental consequences relative to HUD which warrant specific comment at this time.

Sincerely,

DEPUTY Area Director

ENVIRONMENTAL PROTECTION AGENCY
REGION IX
760 MARKET STREET
SAN FRANCISCO, CA 94102

Commissioner
Bureau of Reclamation
U.S. Department of the Interior
Washington, D.C.

DEC 13 1971

Dear Sir:

We are replying to your letter of September 27, 1971 requesting our review and comment on the draft environmental statement for the Central Arizona Project.

The impact of this project on the environment is an important concern; however, appropriate considerations have not been fully covered in the statement. Specific comments are enclosed.

We believe, if you consider these comments in revising the text of your statement, it will result in a more complete and meaningful evaluation of the project's environmental impact. We would appreciate receiving a copy of your final statement.

Sincerely,

Gustave A. Ferdo
Regional Administrator

Enclosure

Environmental Protection Agency
Region IX

Review and comment on the draft Environmental Statement submitted by the Bureau of Reclamation, Department of the Interior, for the Central Arizona Project

The proposed construction of this water resource development system will result in considerable environmental change. Many important questions regarding environmental impact are unanswered in the draft statement.

Construction:

A discussion of construction effects on the environment should be included. Blasting, excavation methods, borrow practices, water and wind erosion control, dust control, debris disposal and noise control should be covered in the statement. If these factors are covered by required construction practices, then comments to that effect should be included as well as a summary of the requirements.

What measures will be used to encourage post-construction environmental stabilization of the proposed reservoirs, including but not limited to, the establishment of riparian vegetation in appropriate areas, and control of algal blooms?

Wildlife:

Wildlife surveys should indicate coordination with the Arizona Game and Fish Department. Their information should be included as it pertains to project effects on wildlife. More attention should be addressed to the identification of rare or endangered species and, if present, describe specific measures to mitigate effects on these organisms. Further detail and surveys could be included in an appendix. The effect of increased surface water availability on animal and plant life should be discussed. Water shortages are a populational limit for many species, if water will produce populations beyond the carrying capacity of the area, this problem should be discussed.

Development:

A discussion of water as an inducement to development is relevant to the statement. Areas that are likely to expand in the near

future should be identified and subjected to an analysis indicating environmental problems that will occur with the expansion. Population levels and growth rates should be discussed in this context. Also, coordination with state plans and the local Air Pollution Control District should be considered as they relate to the project. Unavoidable development should be discussed with supporting data such as growth rates and current and projected populations in the concerned areas. The result of the "no project" alternative should be discussed more specifically relative to this growth. In addition, land use maps should be included illustrating current utilization of lands along the project route and in the serviced area. In this context, parklands, wildlife refuges, primitive areas, and indian reservations should be discussed if the project affects any of these. If water rights problems exist within the project, such problems should be detailed. Finally, the project is clearly of no long-term use without a guaranteed source of electrical power. Since the Navajo Power Plant has an anticipated lifetime of thirty-five years, what alternatives have been considered for future power supply?

In areas designed for high recreational use, discussions of facilities for handling waste water (especially treatment plant capacity), solid waste disposal, and potentials for water pollution (oil and gasoline spillage from pleasure craft), arising from such use, should be included.

Alternatives:

Under alternatives, a discussion of water reuse, possibilities of recharging ground water with treated waste water, and other salvage methods should be considered. This should include consideration of the Department of Agriculture Flushing Meadows Project.

The project will require construction of power lines to supply the pump stations; these lines should be discussed with regard to their aesthetic effect and any air, water or noise impacts that will occur during construction. The alternative of sub-surface power lines should be discussed.

Water Quality:

Water quality in the lower Colorado River should be discussed. The potentials for saline return water to the Colorado should be considered. This aspect has international implications as

Mexico has recognized the salinity of the Colorado to be one of its major border problems. Additionally, the effect of this project on other users of the Colorado River Water should be considered.

The dissemination and allocation of the Central Arizona Project water should be more specifically discussed. What are current and projected water usages in areas to be serviced by the CAP? The proportions to be used for irrigation should be discussed. Increasing soil salinity should be discussed as related to importation of poorer quality water from Parker Dam for irrigation use. Will finalized plans for distribution be included in the Final Envinormental Impact Statement?

The importation of surface water to the central Arizona area will have definite environmental impact. The way in which it will influence the existing ground water should be discussed in detail. As the ground water level recovers it will release salts held in the soil since recession. Ground waters may even rise above previous levels to the point of affecting roots of plants. Additionally, the potential for return water and the anticipation of drainage problems should be discussed. Ground water levels and quality, and surface water quality should also be considered, as they are affected by waste waters resulting from use of CAP water.

The history of the problems that Phoenix has had in changing water supplies should be discussed. Are further problems anticipated as a result of importing water from Parker Dam? Specifically, is corrosion of water pipes anticipated as a result of changing the Total Dissolved Solids (TDS) constituency of the water.

The effect of evaporation on the TDS of the water transported via open canals and aqueducts should be discussed. Our preliminary calculations indicate a 10 per cent reduction of water quality as a result of increased TDS. With an estimated evaporative loss of 72,000 acre-feet/year (representing 36 per cent of the State's total evaporation loss from reservoirs) covered canals or reduced number of open reservoirs should be considered as alternatives. Such losses could substantially reduce potability or create unfavorable salt balance.

A project of this magnitude is an opportunity to demonstrate good and effective environmental planning. In this light, the final statement should overcome the draft's reticence to discuss the

unavoidable adverse environmental effects of the project. The sections on mitigation were explicit and addressed themselves to those adverse effects, however, not all adverse effects can be mitigated: these should be discussed in detail. This draft is phrased as a justification for a project into which much money and planning have been devoted. The intent of the National Environmental Policy Act is to evaluate all projects, regardless of economic factors, in terms of their impact; this philosophy should be reflected in the final statement.

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Arizona Archeological Center
University of Arizona
P. O. Box 49008
Tucson, Arizona 85717

H2219 BR

October 29, 1971

Memorandum

To: Director
Attention: Chief, Division of Federal Agency Coordination (UF)

From: Acting Chief, Arizona Archeological Center

Subject: Draft Environmental Statement, Bureau of Reclamation, Central Arizona Project, E.S. #328

The subject statement will require an involved response which will, in effect, indicate that the statement is inadequate with regard to archeological resources. Because of staff shortages and the need to gather and evaluate several archeological survey reports and correlate them with pertinent sections of the draft statement we request an extension of time to respond to the statement.

We can provide our comments to you by November 19, 1971.

Signed

Garland J. Gordon

cc:
Ass't Director, Cooperative Programs, SWR
Regional Director, Bur. Reclamation, Boulder City

CENTRAL ARIZONA PROJECT

United States Department of the Interior

NATIONAL PARK SERVICE

Arizona Archeological Center
University of Arizona
P. O. Box 49008
Tucson, Arizona 85717

IN REPLY REFER TO:

H2219 BR

February 24, 1972

FEB 25 1972

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Memorandum

To: Regional Director, Bureau of Reclamation, Region 3

From: Acting Chief, Arizona Archeological Center

Subject: Submission of draft material for final environmental statement, Central Arizona Project

At the February 2 meeting at the Phoenix Development Office between representatives of this office and the Bureau we agreed to provide for your consideration draft material for the final environmental statement on the Central Arizona Project as a whole. Although our submission does not substantively deal with the effects on archeological resources we recognize the advanced stage of planning that the Project is now in and that this statement must be more generalized than succeeding impact statements for major elements of the Project.

We believe that our language describes the problem as it can be accurately defined at this time. It would also indicate your concern for archeological resources and your commitment to deal substantively with adverse effects upon archeological resources both in forthcoming statements and in implementing the Project. We hope you find the enclosed submission useful.

Garland J. Gordon

Garland J. Gordon

Enclosure

DRAFT MATERIAL CONCERNING ARCHEOLOGICAL RESOURCES
FOR FINAL ENVIRONMENTAL STATEMENT
CENTRAL ARIZONA PROJECT

Because of new legislative requirements it has been found that archeological studies, previously accomplished through the National Park Service, are inadequate to assess the impact of the Central Arizona Project upon archeological resources. In general these past studies indicate that there will be adverse, cumulative and irreversible effects but they were not of sufficient depth to define these impacts or to assess the significance of the resources, and in some instances did not provide a complete inventory. More detailed surveys are necessary in order to identify and assess the impacts, and to develop research designs and cost estimates for studies adequate to properly mitigate adverse effects.

Funds are available for these impact studies. They will be accomplished and their results included in the more detailed environmental statements for major individual segments of the project as follows:

1. Lake Havasu Inlet, Pumping Plant, and Buckskin Mtns. Tunnel
2. Granite Reef Aqueduct.
3. Salt-Gila Aqueduct.
4. Orme Dam and Reservoir.
5. Buttes Dam and Reservoir.

6. Charleston Dam and Reservoir.

7. Tucson Aqueducts.

8. Hooker Dam and Reservoir.

Mitigating measures will be accomplished prior to construction of the projects.

With respect to the Aqueducts the studies were adequate to suggest that major archeological problems are not likely to occur which cannot be resolved adequately by archeological clearance procedures once detailed surveys have identified and evaluated the resources to be affected. The following clearance procedures will be followed:

1. The Bureau of Reclamation will obtain, or will require its contractors to obtain, archeological clearance for all development locations related to or dependent upon the Central Arizona Project Aqueduct System in order to comply with the provisions of the Antiquities Act of June 8, 1906 (34 Stat. 225) which forbids the disturbance, destruction or removal of archeological resources on lands owned or controlled by the Federal government, and to provide mitigation of adverse effects of the Project. Prior to the start of any earth-disturbing operations whatsoever, the Bureau or its contractors shall obtain archeological clearance from the Liaison Archeologist, Arizona Archeological Center, National Park Service, P. O. Box 49008, Tucson, Arizona 85717. If concealed archeological resources

are discovered in the course of construction on cleared locations the Bureau or its contractors will immediately notify the Liaison Archeologist.

Clearance will be provided by the National Park Service on the following basis:

a. In order to obtain a clearance, the Bureau or its contractors will need to engage the services of a competent archeologist, acceptable to the National Park Service, to survey all development locations for the presence or absence of significant archeological resources. He will evaluate the potential significance of resources present and recommend appropriate action to the Chief, Arizona Archeological Center. The survey of locations will have to be performed under the provisions of the Act of June 8, 1906 and 43 CFR 3.3.

b. Development locations include, but are not limited to: aqueduct right-of-way, borrow and spoil areas, utility line rights-of-way, access roads, haul roads, pumping stations, turnouts, wasteways, equipment staging areas, construction camps, flow-through ponds, greenbelt parks, wildlife guzzlers, and recreational areas.

c. Archeological clearance will be granted when significant archeological resources are <u>not</u> identified in a development area.

d. Archeological clearance will be denied when significant archeological resources are identified in a development area.

e. The presence of archeological resources of major scientific importance, or which may merit listing on the National Register of Historic Places will require a complete re-evaluation to consider relocating a development, or a portion thereof.

f. With other significant resources, the Bureau or its contractors may select the option of relocating the project so as to avoid damage to the resource, or of providing for archeological studies, including analysis and reports, sufficient to realistically mitigate the loss of the resource. It is understood, however, that such studies must be done under the provisions of the Act of June 8, 1906 and 43 CFR 3.3.

g. A clearance will be granted to remove a denial of clearance at the completion of archeological field work where mitigating studies are the selected option.

2. The Bureau of Reclamation will require its water contractors to prepare detailed environmental impact statements for their projects and to provide for the mitigation of adverse effects upon archeological resources, as a condition of providing water.

3. The Bureau of Reclamation will instruct its own and its contractors' employees not to disturb or dig in archeological sites.
4. The Bureau of Reclamation will advise its contractors that failure to obtain clearance will leave them subject to prosecution under the Act of June 8, 1906 and, that in addition, property damages may be assessed under the general property damage clauses of the contracts. Such damages to be assessed at the cost of archeological studies which would have been required under the clearance procedures.

The reservoirs present a different prospect of potential major impact upon archeological resources, including a real possibility for resources which merit listing on the National Register of Historic Places. Before environmental impact, or the adequacy of mitigating measures can be evaluated, studies are necessary to complete resource inventories of areas to be affected by the reservoirs, to evaluate significance, assess adverse effects, and develop research designs and cost estimates for mitigating studies.

United States Department of the Interior

BUREAU OF INDIAN AFFAIRS
WASHINGTON, D.C. 20242

IN REPLY REFER TO: 390 WR

Memorandum

OCT 29 1971

To: Commissioner of Reclamation

Through: Assistant Secretary
Public Land Management

From: Commissioner of Indian Affairs

Subject: Draft Environmental Statement dated September 1971 on Central Arizona Project, Arizona (Part of Colorado River Basin Project), Pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969 (NEPA)

As requested in your memorandum dated September 27, we are forwarding comments and suggestions regarding your September 1971 NEPA draft statement: "Central Arizona Project."

The draft does not provide the details as to structure design and physical location that would permit any detailed evaluation as to the possible environmental impact on Indian interests. It does state that when such information is available it will be supplied. It is of course essential that such information be available, (with possible alternative designs and locations) for an adequate evaluation.

There were several disturbing statements contained in the draft.

> "Mitigation and enhancement features will be considered as practical suggestions are provided on every aspect of the project."
>
> "...Funding for construction and maintenance of these features will need to be fully explored. Provisions for these mitigation and enhancement features were not included in the original authorization..."

This could well mean that in spite of the tremendous potential

recreation and wildlife values that could accrue to the Indian lands and to the entire state with a multi-purpose project that only a design that will fulfill the primary functions of the project will be considered unless supplementary funding is found.

If this is in fact the case, it is suggested that the Central Arizona Project (CAP) authorization legislation be amended to include such purposes which would be in accordance with the intent of Congress in enacting the National Environmental Policy Act of 1969 subsequent to the approval of CAP.

Although the general statements on water impoundments and their effect on fisheries were of some value, to adequately evaluate the effect on the Indian interests of Orme Dam reservoir would require a detailed evaluation by a warm water fisheries biologist, an engineer, a land planner and an economist who is qualified to measure the social and economic impact factors. The limnotrophic periodicity planned for the reservoir would of course need to be made available to the biologist in such an evaluation.

On page 12, the second paragraph discusses the purpose for which the water will be used. As the legislation specifically provides that water "shall not be made available directly or indirectly for the irrigation of lands not having a recent irrigation history as determined by the Secretary, except in the case of Indian lands, national wildlife refuges, and, with the approval of the Secretary, State-administered wildlife management areas," we suggest the paragraph be modified to reflect this.

On pages 41-45 the beneficial impacts of the project are discussed. We would suggest that one more impact should be listed. This would have to do with the reduction of the silt load carried by the Gila River between Buttes Dam and the San Carlos Indian Irrigation Project's Ashurt-Hayden Diversion Dam. Presently the silt that is carried in the river not only results in considerable expense to the project but causes additional operation and maintenance problems throughout the project's water carriage and distribution system.

On pages 45-48 the adverse environmental effects of the project are discussed. In our view, the effect of Orme Dam and Reservoir on the Fort McDowell Indian Reservation is one that should be mentioned. Depending on the site that is finally selected for the dam, over 50% of the Indian land located along the Verde River could be taken for the reservoir area. This is the most scenic and desirable part of the reservation. As water is withdrawn from the reservoir, this beautiful area will be replaced by mud flats.

Although the authority is granted in the legislation to obtain additional lands to replace those taken for the project and relocate those Indians living within the taking area, nevertheless the dislocation of these people from their ancestral homes and lands, as well as the destruction of this beautiful area, is in adverse result of the project.

On page 52 the relationship of short-term versus long-term needs is discussed. If the population of the area continues to expand, it is expected that a long-term effect of the project will be to benefit urban growth more than agriculture. While this may be so in the case of the non-Indian areas, it should also be recognized that the Indian reservations, particularly along the Gila River, will be able to develop their irrigated agriculture resource which, so far, has proceeded at a very slow pace due to lack of water.

We are advised that the leaders of the Fort Mojave, Chemehuevi, Colorado River Indians, Cocopah, and Fort Yuma-Quechan Tribes and their lawyer, Ray Simpson, Long Beach, California, intend to review the environmental study and comment directly.

Deputy Commissioner

IN REPLY REFER TO

United States Department of the Interior

1791 (220)

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

NOV 18 1971

Memorandum

To: Commissioner, Bureau of Reclamation
Through: Assistant Secretary, Public Land Management

From: Director, Bureau of Land Management

Subject: Comments on Draft Environmental Statement
Central Arizona Project

The general conclusion of reviewers is that the prospective adverse impacts will be much greater than those described in the draft statement. Likewise, some aspects will probably enhance the environment more than is indicated. The draft's major weakness is that it appears to paint a glowing picture of the economic benefits, yet is vague on several environmental points.

Description of the Project

The description statement underplays the magnitude of the project. There is little information that actually helps analyze the environmental impact of the project. Specifically, reviewers should know such things as the water surface areas of the reservoirs, the proposed drawdowns, the operation plans, what is to be done with spoil from over 377 miles of canal, etc. The statement now contains interpretations and opinions on project construction effects, and this is of very little value in trying to draw an unbiased conclusion on environmental impacts.

The description section mentions that the project will provide additional water for established agricultural areas and alleviate ground water mining and related problems. However, if the practices in the area, i.e., sprawling population growth, marginal use of water, and adverse environmental impacts . . . are occurring with the water now available, will the addition of more water aggravate these problems or will it help solve them? Since much of the environmental impact of the project could result from these indirect impacts we think they should be thoroughly discussed.

The description provided on each reservoir below Hooker Dam indicates that water-oriented recreational development and fish and wildlife enhancement will result. The explanation is too general and may be readily misinterpreted. The Buttes Dam and Reservoir on page 9 is an example of the need for clarification. Information provided by the U.S. Bureau of Reclamation specifies that a minimal pool level will be maintained for about 200 acres. The remainder of the reservoir area would be inundated periodically following increased inflow from upstream. During the periods of minimal pool level extensive mud flats and barren landscape would prevail. The aesthetics would be something less than portrayed by the maximum pool shown in Figure 10.

Environment in the Project Area

This section is critical in laying the groundwork for subsequent sections of the statement. A more comprehensive environmental section could help reviewers who will presumably be less familiar with the setting.

We suggest the setting be presented in terms of past, present and future trends in the general zone of influence as well as in the immediate project area.

Environmental trends could be separated into two categories--natural and those induced by man. We believe this concept is important since some project benefits are apparently based on future urbanization and use or misuse of the immediate flood plain as well as the economic impact of the project. Projection of future trends requires data related to future state and national policies including continued intensive development in the flood hazard areas, enforcement of regulations governing waste treatment facilities, and zoning regulation of land use. Development of these trends could prompt favorable local land planning efforts. Through proper project planning these trends could be further expanded, adding a great deal of environmental enhancement for the project. In fact, planning the project impact as it relates to these trends would probably be one of its most important environmental potentials. Conversely if not planned for it could be one of the worst environmental project impacts.

Evaluation of Environmental Impacts

This portion tends to consider the environmental impact mostly in terms of the economic benefits and less in terms of changes or losses to the natural environment.

The actual loss in wildlife habitat should be spelled out. It apparently will be considerable but the estimated amount is not shown in the statement. Also the wildlife losses should be described as

absolute losses rather than losses in fisherman man days, etc. The loss of habitat is much more serious than just the reduction in sport fishing or hunting that will result.

Regarding the enhancement and mitigation features of 20 small ponds, 20 backwater fingers and 80 wildlife guzzlers - this appears as a token effort since the project has 377 miles of canal, four reservoirs, and other man-made features. This computes to approximately one such feature every 3 miles along the canals if the guzzlers are included; and only one recreation or mitigation feature every 9 miles if the guzzlers are not included.

Surely there are other features which would enhance the environment that could be included. Specifically trails for hiking, bicycling and horseback riding, more green belts, additional wildlife habitat strips, etc.

In the process of constructing this type of project, many acres of open space will be lost or disrupted; the ecology of land adjoining the construction areas will be affected; and the project will promote increased development of the flood plains. The project could also promote poor land uses setting in motion a series of poor land-use decisions that could result in reduced environmental quality elsewhere and perhaps higher public expenses. These impacts should be considered.

The discussion of Havasu Intake Channel and Pumping Plant on page 27 explains that future development will be less intrusive on the environmental scene than existing developments. The impact of proposed developments should be explained but not justified on the basis that the development will be more aesthetic than existing facilities. This section should include the effect the project will have on fish habitat, aesthetics and wildlife. The project may also have an adverse effect on Blue Herons which utilize Heron Island for a rookery.

A general summary of the aqeduct and canal system is explained on page 28. There is no explanation of the environmental impact which will occur. The desert landscape will be disrupted with approximately 377 miles of waterway, powerlines and maintenance roads. Big game migration routes will be disrupted and a drowning hazard created. An assessment of these problems should be presented.

It is stated on page 31 that riparian vegetation downstream from the dam will eventually increase within the flood plain. No statement is made to clarify the effect dams will have on phreatophytes along the

river flood plain. Elimination of periodic floods will, in all probability, reduce the total acreage of available phreatophytes which do provide important habitat for wildlife. An explanation of the effect each dam will have on phreatophytes in the flood plain should be provided. Riparian vegetation will probably increase along the stream bank where the stream flow has been stabilized as stated in the report.

On page 39 it is stated there will be no increase in acreage developed for irrigated agriculture except possibly on Indian Reservation lands. The question arises as to whether this statement is in conflict with subsequent statements on page 40 that have reference to ". . . enhance agriculture and industrial potential . . ." and subsequently where the additional water supply is stated to be for ". . . supplemental irrigation purposes will support the farming sector of the economy . . ." If additional acreage is not to be irrigated with CAP water, does the benefit to farm industry occur because of the reduced cost of the water made available to agriculture or for some other reason?

It is stated under Sociological Impacts that "without an additional water supply continued growth will ultimately require reevaluation of water use priority." Reference is also made to the necessity to weigh domestic needs against agricultural and industrial requirements if additional water is not obtained. CAP water will only supplement the ground water discharge, consequently depletion of the ground water table and subsidence will continue. These two points alone give good evidence for the need to reevaluate water use priorities now and for a decision to be made which weighs domestic needs against agricultural and industrial. These studies should occur without respect to availability of CAP water or at least without regard to the schedule of completion of the Central Arizona Project. The Central Arizona Project can be helpful in delaying depletion of underground water supplies and slow the incidence of subsidence. The project water in no way can be interpreted as to alleviate the need for further study and for the need of substantially increased quantities of water if depletion of the underground water reserve is to be eliminated.

From an environmental standpoint it would be desirable to identify the extent of overdraft which will continue after the availability of CAP water. A prediction could also be provided on the extent the overdraft will affect future subsidence within water basins.

Reference is made on page 43 and elsewhere that project features designed to benefit fish, wildlife and provide for recreation use were not included in the original project plan; however, these features will provide enhancement and mitigation. It is not clear on how these features will be incorporated with the plan unless other agencies, State or Federal, provide additional funds for that purpose. A point of clarification may be needed in the use of the term

"mitigation." It would not appear correct to suggest these features provide for mitigation of lost values because of the project unless these features were provided for in project funds. If funds other than Federal must provide the required features, then mitigation as such will not have occurred.

Reference is made on page 46 to the adverse environmental effects of pipeline, powerlines and access roads. There is no explanation to suggest the possibility of utilizing existing powerline rights-of-way for power needs associated with the project. The same applies to the construction of access roads. The environmental impact may be reduced if existing rights-of-way can be utilized. A clarification of this possibility is desirable.

In the alternatives section there are two major alternatives considered- no construction and partial construction. There are many combinations of structural and non-structural alternatives which can be studied. The environmental impact of additional alternatives should be explored and characterized in the statement. The project can be redesigned, i.e., more green belts, more slack water, etc. to reduce adverse environmental impacts.

The alternatives provide for no construction, cloud seeding, desalting, geothermal fields, additional groundwater pumping and partial construction of the authorized project. Questions have arisen in recent years on the possibility of utilizing Colorado River water in desert plain areas near to the Colorado River, and therefore pumping and transportation costs of CAP water would be reduced. This appears to be a viable alternative which in turn could relate to studies which develop water use priorities and weigh the needs for domestic, agricultural or industrial needs. Land use planning within the State might reveal the necessity of retiring certain existing agricultural lands to allow for urban expansion and for the development of other agricultural lands more distant from urban populations. This is an alternative which should be explored.

Relationship of Short-Term versus Long-Term Needs

The economic aspects of the environmental impacts have not been fully analyzed. It does not appear that the total environmental losses for recreation, and natural beauty values have been accounted for in the environmental statement. A proposal which infringes upon these values ought to better assess cost of replacement or assign permanent losses to fully recognize the true costs of the proposal.

The CEQ guidelines call for a discussion of "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." The subject addressed is not

that envisioned by the CEQ because it does not mention the short-term uses of man's environment, but addresses only the beneficial long-term effects of the project.

This leads to a more critical question about the impact on man's environment which has been overlooked in this report, which may be the most important question of all. Who knows that the continued growth of the Phoenix and Tucson areas is good? Phoenix now has a worsening air pollution problem.

The city has developed in a way that public rapid transportation is questionable and private auto transportation is and will continue to dominate the scene. This area is noted for its stable air shed, particularly in the cool months. With such a small rainfall and a lesser amount of fresh air inflow, is this area doomed to the fate of southern California? The latter was a wonderful place to live until the people carrying capacity was exceeded.

The agricultural economics of the project are almost completely ignored despite the fact that this is a significant factor.

According to a report by Prof. William E. Martin, Department of Agricultural Economics, University of Arizona, this project with a price tag of $1.3 billion (not including inflation and increased interest rates) will pump about 1.2 million acre-feet annually. (The draft statement does not identify the volume of water proposed to be pumped from Lake Havasu only the canal capacity. According to our calculations the main canal to Phoenix would have a maximum capacity of about 2 million acre-feet annually.) Martin's major conclusion is that "We, and several of our colleagues, on the basis of several years of investigation of the empirical evidence, have reached the conclusion that although economic growth in the West may originally have been based on a liberal water supply, additional water is no longer necessary (at least in the foreseeable future) and may in fact be 'detrimental to our health.'" Evidently the present annual groundwater overdraft is about 3.5 million acre-feet. Obviously the Central Arizona Project will not cure the problem and according to Martin, et al, may not even relieve it. The most important point is that 90 percent of present water consumption in Arizona is for agriculture and over half of this is used for low-value extensive crops. There is a question whether a market exists now, or will in the foreseeable future, for utilization of Arizona's existing water supply for high-value intensive crops. The real costs of delivering the water to Phoenix and Tucson will probably be in excess of $50 per acre-foot. This is far above the amount that farmers can afford to pay for water to use for low-value extensive crops (such as barley and alfalfa). 1/

1/ A paper by Martin and Young entitled "The Need for Additional Water in the Arid Southwest: An Economist's Dissent." The paper under the direction of Dr. M. M. Kelso. The draft statement makes no reference to this paper in the list of selected references.

It is not clear to us from the report what use will be made of the one million or so acre feet of water. Will it be used for industrial and municipal purposes and for high-value agricultural crops? Or will it be used to grow low value crops?

Arguments have been made that neither industrial capacity nor overall growth and development in the state of Arizona would be severely hampered without the Central Arizona Project; the statement to the contrary on page 48 is not supported. The report would be strengthened if this were clarified.

If the water is to be used for low value crops, what are the needs for them and what are the alternate sources? What are alternative uses and locations for use of the water? Even though CAP has been authorized, these are questions which appear to be proper under the NEPA and CEQ guidelines, for they involve long-term commitment of resources.

George A. Lawcott

Associate Director

OFFICE OF THE DIRECTOR

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
WASHINGTON, D.C. 20240

October 19, 1971

Memorandum

To: Commissioner of Reclamation
Through: Assistant Secretary--Mineral Resources

From: Director, Bureau of Mines

Subject: Environmental Statement, Central Arizona Project (Draft)

We have reviewed the environmental statement for the Central Arizona Project prepared by the Bureau of Reclamation. Primary objective of the project is to bring Colorado River water from Lake Havasu, on the Arizona-California border, to central Arizona for agricultural, municipal, and industrial uses. Multiple-use aspects of the project are also important and these will benefit other users.

The Bureau of Mines believes the environmental statement is inadequate in the sense that virtually no mention is made of mineral occurrences, mining claims, or exploration and development potential. In addition to the silver discussed in relation to the Charleston Reservoir, other possible mineral involvement in various parts of the proposed project include copper, gold, lead, zinc, iron, sand and gravel, and many others.

Our earlier review of the project pointed out several possible mineral involvements which, to our knowledge, have not been resolved. Mineral resources at the Orme, Buttes, Charleston, and Hooker reservoir sites were investigated. We wish to emphasize the copper mineralization known to occur at Buttes Reservoir. This occurrence has been partially explored by industry and is considered worthy of thorough investigation by industry and/or Government to determine its potential before it is irreversibly closed to mining. Routes of the Granite Reef, Salt-Gila, and Tucson aqueducts were checked for conflict with mineral resources or with mining activity. Unpatented mining claims exist on the proposed aqueduct route. However, there is no indication of significant mineralization on these routes.

It is believed the results of our detailed examinations of the four reservoir sites should have been summarized in the environmental statement and the points of possible conflict resolved. It could well be pointed out in the statement that increased water availability in the area could benefit the mineral industry which, in 1969, ranked second as a source of Arizona income.

Director

United States Department of the Interior

BUREAU OF OUTDOOR RECREATION
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

D6427-LCO
(Central Arizona Project)

DEC 23 1971

DEC [illegible] 1971

Memorandum

To: Commissioner of Reclamation

From: Assistant Director for Federal Programs
Bureau of Outdoor Recreation

Subject: September 1971 Draft Environmental Statement, Central Arizona Project, Arizona

We have reviewed the subject draft environmental statement as requested in your memorandum of September 27, 1971.

We note that this statement applies to the Central Arizona Project as a whole and that detailed statements for each individual unit or feature will be provided for review at a later date. The statement is generally adequate, from the standpoint of outdoor recreation, as a broad, generalized appraisal, but would be improved with the modifications discussed below.

SUMMARY - We believe the Summary statement would be improved by providing a more precise description of the proposed Federal action in terms of the key features in the project. Also, the Summary of environmental impacts should succinctly describe how the natural environment will be affected by construction of the project. It is not adequate to merely state that the natural environment will be affected.

II. Description of the Authorized Project. This section as presented provides a good description of the key features in the project, but does not contain sufficient information to permit an assessment of environmental impacts. The description of key features should be augmented with a statement regarding the natural resource characteristics involved.

IV. Evaluation of Environmental Impact

A. Probable impact on the environment. This section can be substantially improved by editorial revision and recasting. Vague, general

descriptions of impacts should be removed and replaced with specific reference to the kind and quantity of natural resources involved under both "with" and "without the project" conditions. Consideration should be given to both direct and indirect changes in the environment and to who and what is affected by the changes.

The Gila River from its source to Florence has been identified in the Lower Colorado Comprehensive Framework Study as having potential for inclusion in the Wild and Scenic River System established by Public Law 90-542. Since the Buttes and Hooker Reservoirs are proposed for this reach of the Gila, a discussion of their impact on the River's potential for designation should be included in this section.

B. Adverse environmental effects. The statement on Page 47, Item b, concerning the adverse impact of impoundments on riparian vegetation should be revised to more clearly and factually state that the riparian vegetation, which constitutes an extremely rare and valuable resource in Arizona, will be eliminated.

C. Alternatives to the proposed action. The alternative of partial construction of the authorized project, on Page 52, should be explained in greater depth. The statement should describe both the beneficial and adverse environmental impacts of varying scales of development and different sites for potential impoundments.

D. Relationship of Short-Term versus Long-Term needs. The statement on Page 52, Item D, second paragraph concerning significant long-term benefits that "...will be accrued from mitigation...features..." should be corrected. We do not like to refer to benefits from mitigation as the term actually refers to reducing or alleviating losses.

E. Irreversible commitments of resources. This section should include the following commitments of resources: (1) loss of potential wild and scenic river options, (2) loss to the Gila Wilderness, (3) loss to Indians of portions of Fort McDowell Reservation, and (4) loss over a period of time of reservoir recreation and fishery due to siltation, especially at Buttes Reservoir.

R. L. Eastman

Robert L. Eastman

ADDRESS ONLY THE DIRECTOR,
BUREAU OF SPORT FISHERIES
AND WILDLIFE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
WASHINGTON, D.C. 20240

NOV 17 1971

Memorandum

To: Commissioner of Reclamation
Acting

From: Director, Bureau of Sport Fisheries and Wildlife

Subject: Central Arizona Project--Environmental Statement, September 1971

We have reviewed the draft environmental statement on the Central Arizona project, Arizona and New Mexico, as you requested by memorandum of September 27 and our comments are as follows:

General Comments. We note that the release date September 21, 1971, of Chapter 2 of the Departmental Manual, titled "Statement of Environmental Impact" was near the distribution date of the subject statement, and it is assumed the statement will be redrafted in accordance with the guidelines in Chapter 2 (516.2.6A-E) concerning the contents of environmental statements.

Noticeably lacking in the subject draft is a comprehensive description of the existing and future environment without and with the project, focusing on the environmental details to be affected, the ecological interrelationships, and the present and projected levels of economic development, land use, and related cultural factors.

Figure 14, between pages 15 and 16. The drawing depicts a gazebo-like structure which would appear to be more attractive to recreationists than to wildlife. We believe if the temporary shade structure were deleted from the drawing and a fence shown around the guzzler, the drawing would more closely follow the description of the wildlife guzzlers and oasis stations as presented in the Bureau of Sport Fisheries and Wildlife report of November 21, 1969, on Granite Reef Aqueduct.

Pages 27-29, Section IV-A-1 and 2. The discussion is a project supporting statement and description rather than an environmental impact evaluation.

Page 31, paragraph 1, last sentence. The statement that riparian vegetation downstream from the dams will increase within the floodplain as a result of regulated streamflow is not necessarily true. Unless modifications in project plans have been made, releases from Orme and Charleston Reservoirs will be into concrete-lined canals and offer no opportunity for a significant

increase in riparian vegetation. Releases from Buttes Reservoir will flow through a narrow canyon already having a dense growth of vegetation. And an increase in vegetation below Hooker and the above reservoirs is doubtful because of expected encroachment on the floodplain by farming and other land developments that will occur when streamflows are regulated and floods are no longer a threat.

Page 32, last paragraph. The statements that there will be a net gain in the quality of upland-game habitat and an increase in waterfowl habitat in the peripheral zones and along the stream above and below Orme Reservoir cannot be supported. The reservoir will inundate some of the prime upland habitat found in central Arizona. Also, general recreation activities and domestic and industrial developments on adjacent lands by the Indians, if not carefully controlled, could negate the value of the limited amount of habitat that will result from the project.

The last complete sentence on page 32 states that "Habitat for nongame fauna will also be altered by environmental changes within the reservoir area." This statement and numerous others of similar nature in the text require further details indicating whether the alterations will be beneficial or adverse and to what degree.

Pages 33-35, c. Charleston and d. Hooker. In the case of these two reservoirs where a substantial number of downstream river miles will be affected by the project operation, the discussion should be expanded to include the total area where the natural environment will be modified. In the Hooker discussion on page 35, the inference that downstream vegetation will be enhanced by a stabilized flow is questionable because the propagation of riparian cottonwood-sycamore association appears to be dependent mainly upon the infrequent flood flows. The floods result in deposit of a fertile bed of silt. This is followed by the sprouting of seedlings that grow to maturity, thus sustaining natural succession. Without the effects of flooding, the natural propagation of the cottonwood-sycamore association will be limited and other species are likely to become dominant, thus effecting a change in wildlife species, particularly those birds that are dependent on the present vegetation and found only in the upper Gila River drainage. Your list of selected references provides a source of information about the species that could be affected adversely.

Page 37, paragraph 1. We suggest that the paragraph include a description of where Arizona's allotment of 2.8 million acre-feet of water is presently being taken from the Colorado River, particularly that amount being delivered to California. Further explanation is needed if the flows downstream from Parker Dam are to be modified as a result of Arizona taking its full allotment.

Page 40, 7. Sociological Impacts. Although sentences 3 and 6 of paragraph 1 are contradictory, other inferences in the statement indicate the project will be in part responsible for continued economic growth and increased human population. The statement is required to have description of the effects such growth will have on the natural environment. Our main concern for the purposes of this review is the effect that anticipated economic and human expansion will have on the wildlife resources, such as urban expansion and other land-use changes. Along this same line are the effects on the wildlife resources as well as the human inhabitants that will result from the expected impacts shown on the last three lines on page 40. A more detailed discussion of the expected impacts is needed in Section B. Adverse Environmental Effects. If the rate of impact is not known, it should be included on page 45, 9. Unknown Effects.

Page 41, 8. Beneficial Impacts. In part b., it is questionable that the Central Arizona Project will enhance rural life except for a diminishing few. The trend is to incorporate many farms into one and as a result, many people are moving to metropolitan areas. In part c., the phrase "more effective land use" should be explained. In the case of wildlife resources, the flood control protection could be detrimental to natural propagation of wildlife habitat.

In part d., the general inference that fish and wildlife habitat will be improved around the reservoirs is questionable. Reference should be made to our reports you listed on page 60 that explain the project effects, particularly the net losses of wildlife habitat. The inferences in the last sentences on page 41 and again in the last paragraph on page 52, that mitigation proposals for fish and wildlife will add measurably to the overall benefits of the project is not correct. The replacement and preservation of fish and wildlife resources destroyed by the project cannot be claimed as a benefit.

Page 42, Table 1. It should be explained that with expected modifications in project design, the fisherman-use figures will require updating when more detailed project information is available.

Page 43, last paragraph. It should be clearly stated that many of the resting and watering areas for wildlife should be separate from those for human recreation to assure optimum wildlife use and public benefit.

Page 46, 4. We were not aware that the stream regime in the vicinity of Hooker and Charleston dams had been altered by previous construction.

Page 47, continuation of part 5 (page 46). Part b. should read, "Riparian vegetation will be destroyed by inundation and adversely affected downstream." Part c. should read, "Fauna which is dependent upon the riparian vegetation

will be displaced, reduced in numbers, and the species composition altered within the. . . ." In part d., it should be emphasized that some species dependent upon existing habitat may become extinct or threatened, and replacement of these species by others typical of reservoirs and regulated streams cannot be considered beneficial.

Page 47, 6. The impact of new reservoirs leading to increased permanent residents, increased tourism plus industrial development in the case of Orme Reservoir, and expansion of agriculture should be discussed in more detail. The effects of these impacts on the downstream areas also should be discussed.

Page 48, B-10. The phrase "will continue to grow" in sentence one is contradicted by the beginning of sentence two, "Although this may be true . . . ." Also we suggest the last line read, "and will definitely be detrimental to the natural environment of the surrounding areas."

Pages 48-52, C. Alternatives to the Proposed Action. The alternatives have not been evaluated environmentally, and a comparison of the resultant effects has not been made with those of the project.

Page 48, C-1. The phrase, "and improvement of man's way of life," in lines 6 and 7 has many meanings to many different entities and therefore should be deleted.

Page 52, D., paragraph 1, last sentence. If as indicated planning for population dispersion in Arizona is a recognized function of the project, we would welcome further details. There is considerable merit in the population dispersion concept in terms of improving opportunities for public use of fish and wildlife resources.

Page 52, last paragraph. In addition to other comments above concerning benefits and mitigation, it is questionable that the wildlife resources will be a long-term beneficiary as indicated on top of page 53.

Page 54, 2. Statements justifying the project do not seem appropriate in this portion of the environmental statement.

The opportunity to review the environmental statement for the Central Arizona project is appreciated.

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United States Department of the Interior

4/27 PDS - 150

GEOLOGICAL SURVEY
WASHINGTON, D.C. 20242

OFFICE OF THE DIRECTOR

April 7, 1972

Memorandum

To: Director, Bureau of Reclamation
Through: Deputy Assistant Secretary--Mineral Resources

APR 18 1972

From: Director, Geological Survey

Subject: Review of draft environmental statement on the Central Arizona Project, Arizona and New Mexico

We have reviewed the subject draft environmental statement which was referred to us informally by B. E. M. Martin on March 16. (The original referral to the Geological Survey was not received.)

We have noted that this is a general environmental statement. Detailed environmental statement for each individual unit or feature of the project will be submitted prior to the start of construction of the respective components.

Survey hydrologists are familiar with the project; detailed data, upon which the environmental statement was based, were made available to the Survey earlier.

This general statement contains no geologic information. The inclusion of both surficial and bedrock geologic information should be considered with a view of environmental impacts which might result due to geologic conditions and the construction of the components.

V. E. McKelvey
Acting Director

United States Department of the Interior

NATIONAL PARK SERVICE
WASHINGTON, D.C. 20240

IN REPLY REFER TO:

L7427-UF

OCT 1971

Memorandum

To: Commissioner of Reclamation
Through: Assistant Secretary for Fish and Wildlife and Parks

From: Director, Office of Urban Programs and Environmental Policy

Subject: Draft Environmental Statement dated September 1971 on Central Arizona Project, Arizona, Pursuant to Section 102(2)(c) of the National Environmental Policy Act of 1969

In accordance with Commissioner Armstrong's memorandum of September 27, 1971, we have reviewed the subject draft environmental impact statement.

Our comments on this broad and general statement are based on the intent of the Bureau of Reclamation to submit detailed statements for each individual unit or feature of the project following site selection and design but prior to the start of construction of the respective components.

Based on maps and text material in the statement, the only possible adverse effects noted at this time that the project might have on existing or known potential units of the National Park System, or properties eligible or under study for registration as National Historic, Natural, or Environmental Educational Landmarks will be at Casa Grande National Monument, and Lehner Mammoth-Kill and Hohokam-Pima Irrigation Sites National Historic Landmarks.

This statement and future statements on individual units of the project should show evidence of consultation with the State Liaison Officer of Arizona (Director, State Parks Board, 1688 West Adams, Phoenix, Arizona 85007) for information regarding existing units on the National Register and properties being considered for National Register nomination.

The statement does not adequately consider the impact of the project on archeological resources. The references to archeology on pages 25 and 54 are incomplete. Also, the impact on archeological resources should have been covered under item IV. B. "Adverse Environmental Effects."

The environmental statements for individual project units should cover this subject in more detail and the National Park Service can assist in this endeavor.

The statement does not adequately discuss the effect of the project on the flow and water quality of the Colorado River. For example, quantity of water reaching Mexico and ultimately the Gulf of California will be reduced and its quality environmentally degraded.

The discussions on endangered species are not specific and in some cases misleading. Reference to endemic biotic populations should be clarified by quoting specific species and noting which ones are rare or endangered. The project area will probably affect the habitat of the Yuma clapper rail, the Gila trout, and the Arizona trout, all of which are endangered species.

The statement says on page 40, "Increasing the supply of water will circumvent drastic curtailments of the present rate of population growth and enhance agricultural and industrial potential." This statement is incorrect unless a limitless supply of water is available. In reality, the project will not circumvent, but only postpone, "drastic curtailments."

On page 45 the report states, "The degree of economic and sociological impacts resulting from the project is unknown at the present time." This statement implies that the feasibility of the project cannot be ascertained.

The statement mentions facilities that have not been authorized or funded, e.g., those for recreation and wildlife on pages 14 - 16. While it may be appropriate to mention these in the environmental statement it is more important that they be fully explored in future planning and arrangements made for funding including authorization, if appropriate. Once they are part of the project they should be covered in depth in the separate environmental statements.

Hector R. Fuero

Colorado
Division of Planning

Department of Local Affairs

700 State Capitol Annex / Denver, Colorado / 80203

Phone / (303) 892-2178

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11-12	ZJS	150
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November 10, 1971

Mr. E. A. Lundberg, Regional Director
U. S. Department of the Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Subject: 3-150/120.01/Central Arizona Project-Draft Environmental Statement

Dear Mr. Lundberg:

This office has examined and discussed with various State agencies the project mentioned above. It is thought that the project would not directly effect anything in Colorado as far as the environment is concerned. We have not considered the environmental impact in any of the other affected states.

The use of water rights, of course, is another subject that is not satisfactory with some Colorado agencies, but which is not the subject of review in this report.

I am sorry for the delay in the return of this reply, but 30 days isn't usually time enough to contact and to expect an answer from interested State agencies.

Sincerely,

Richard L. Brown
Principal Planner

RLB:l

STATE OF NEW MEXICO

FACSIMILE TRANSMITTED TO
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CODE 3-150 -- 1/24/72

STATE PLANNING OFFICE

SANTA FE

OFFICE OF DIRECTOR

PROJECT DEVELOPMENT OFFICE
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120 - New Mexico
XR-510.CHP

January 18, 1972

1 copy Outdoor Recreation - New Mexico
Send - Return to 7 files for Cordova to Library

Mr. David Creighton
Bureau of Reclamation
Department of the Interior
Phoenix, Arizona 85236

Dear Mr. Creighton:

As you have requested, the State Planning Office has reviewed the Draft of Environmental Statement, Central Arizona Project, specifically Hooker Dam Site.

First of all, we would question the construction of a dam in New Mexico to "help regulate surface water for use in Arizona." If, in fact, this will benefit the agricultural community of the area or provide some other vital function in New Mexico, then our question may be answered. You can certainly understand our concern. As is stated on page 47, "Unless an alternative is selected, or design criteria changed, Hooker Reservoir at conservation pool level will infringe on 140 acres of Gila Wilderness Area, or 165 acres at maximum elevation." Immediately prior to this statement, the point is made that "Impact from permanent residents and increased tourism, commonly associated with development of new reservoirs, will further alter existing surroundings." The State Planning Office would be very concerned about the possible "people" infringement as a result.

New Mexico is in the process of developing a State Wild and Scenic River System. The Gila River is an integral part of this plan. Enclosed is a copy of Outdoor Recreation - A Comprehensive Plan for New Mexico, and on page 162 the proposals are discussed. We would want assurance that the dam would not interfere with this proposal.

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With reference to the Historic Preservation aspects, we would insist that a clearance be received from the State Archeologist, George Ewing, Mr. Ewing is Associate Director of the Museum of New Mexico. If such a clearance can be obtained, our office would honor it.

The State Planning Office would appreciate being included on all future mailing lists and we suggest the Museum of New Mexico also be.

Sincerely,

David W. King
State Planning Officer

By Brad L. Hays

Brad L. Hays
Assistant Director
INTERGOVERNMENTAL SERVICES

2

FRONT COVER OF REPORT

OUTDOOR RECREATION

A COMPREHENSIVE PLAN FOR NEW MEXICO

BRUCE KING
Governor

KEITH M. DOTSON
State Planning Officer

The preparation of this plan was financed in part through a comprehensive planning assistance grant from the United States Department of the Interior, Bureau of Outdoor Recreation.

STATE PLANNING OFFICE SANTA FE 1971

STATE WILD AND SCENIC RIVER SYSTEM

Increasing demand for outdoor recreation, especially in a water poor state such as New Mexico, makes it necessary to propose a study to identify and preserve rivers or sections of rivers having outstanding scenic quality; to coordinate federal, state and local efforts in scenic river identification, and to formulate criteria for the selection, management, development and use of areas for each classification. Legislation was presented to the Thirtieth Legislature which, had it passed, would have authorized a $40,000 Wild and Scenic Rivers feasibility study. This legislation will be reintroduced.

Interim proposals for river classification under a State Wild and Scenic River System are set forth under the following headings.

Upper Gila River, East Fork

The Gila River originates in the Mogollan and Pinos Altos mountains in the Black and Diablo Ranges west of the Continental Divide in Southwestern New Mexico and flows westerly through New Mexico and Arizona to its confluence with the Colorado River at Yuma. The East Fork of the river originates at Wall Lake and Beaver Creek just south of Beaverhead, New Mexico, and affords many natural resources for outdoor recreation.

About ninety-seven percent of the land along the proposed wild river area is federal land administered by the U.S. Forest Service. The remaining portion is privately owned.

Vegetation is predominantly juniper at the lower elevations, and commercial grade timber is found at higher elevations.

Present recreational use includes wilderness camping, big-game hunting, and excellent cold and warm water fishing. Most of this area is accessible only by trails, either horseback or hiking.

The Gila Wilderness and Primitive Areas, which occupy about 600,000 acres of the Gila National Forest in the Mogollon and Black Mountains, offer good outdoor recreational opportunities. Roads to the Gila Cliff Dwellings National Monument and through the eastern portion of the Primitive Area ease access and are in keeping with the concept of primitive areas. Pack trips may be arranged at several locations.

There are no known physical intrusions within the study area except for some sparse irrigation along the east fork of the Gila River. The Interstate Stream Commission reports there are no proposed water or related projects planned within the study area. The Upper Gila River, East Fork is a prime candidate for inclusion in the State Wild and Scenic River System which will hopefully be adopted by New Mexico in the near future. The river site would be included in the scenic river system.

STATE OF NEW MEXICO

1/31/72

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3-150, Boulder City, Nevada.

PHOENIX DEVELOPMENT OFFICE

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STATE PLANNING OFFICE

SANTA FE

OFFICE OF DIRECTOR

January 25, 1972

Mr. David Creighton
Bureau of Reclamation
Department of Interior
Phoenix, Arizona 85236

Dear Mr. Creighton:

As an amendment to our statement of January 18, 1972, the State Planning Office would like the following to be considered with reference to the Hooker Dam proposal.

In the general vicinity of the proposed dam, we are developing a historic preservation project. The project, Woodrow Ruin, includes the excavation and stabilization of a Mimbres Indian site. Woodrow Ruin is on the National Register of Historic Sites.

We object to any direct or indirect intrusion upon this site. Thank you for your consideration.

Sincerely,

David W. King
State Planning Officer

By
Brad L. Hays
Assistant Director
INTERGOVERNMENTAL SERVICES

BLH:vk

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700

October 28, 1971

Mr. F. Phillip Sharpe, Chairman
Central Arizona Project Environmental
Advisory Group
c/o Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Phil:

206 S. 17 Ave. Phoenix Arizona 85007 261-7322

As you can see from the attached letter, the topic of the Central Arizona Project will be coming up in a Commission meeting soon.

I'm not sure how soon, but it's inevitable...so I wanted to let you know what's going on.

Yours sincerely,

ADVISORY COMMISSION ON ARIZONA ENVIRONMENT

F. J. MacDonald
Chairman

FJM:jfj

THE PENNSYLVANIA STATE UNIVERSITY
COLLEGE OF HUMAN DEVELOPMENT
UNIVERSITY PARK, PENNSYLVANIA 16802

Man-Environment Relations
S-126 Human Development Building

Area Code 814
865-1467

October 22, 1971

No. 653844

Mr. F.J. MacDonald, Chairman
Arizona Commission on Arizona Environment
206 S. 17th Avenue
Phoenix, Arizona 85007'

Dear Mr. MacDonald:

I am the consulting planner for the Fort McDowell Indian Community and I wish to have raised a matter in which the issues are not at all clearly spelt out either in economic, social or natural terms. This is the matter of the Central Arizona Project, and in particular the lake which is proposed to be created on two-thirds of the forty square miles of the Fort McDowell Community.

You will no doubt recall that in 1968 and 1969 when I was the Vice-Chairman of the Commission I raised the matter of a "grand design" for the Central Arizona Project half hoping that comprehensive studies and models not emanating from the Department of Interior and the U.S. Corps of Engineers might be commenced to determine the values of such a system in all its vast implications. I have followed the activities of the Commission and also reports from various sources regarding the Central Arizona Project and find nothing which asks the central question: Is CAP necessary.

I hope that your Commission will create and develop public awareness for the need of a properly conducted study which is well funded and is not responsible in terms of its findings to any Federal Agency involved in construction of the facility or to the State of Arizona which has expressed itself quite strongly in favor of the CAP. The responsibility is, as I know you are well aware, the citizen of Arizona and the United States and accountability can be properly managed to meet that responsibility.

Too much has happened in Arizona during the last twenty years to premit a project as large as CAP to be planned and developed without the benefit of a study for the public interest being made and considered. The findings of such a study would be beneficial to the Fort McDowell Indian Community which needs to have well founded intelligence for decision making.

Yours sincerely,

H. Coblentz

Harry S. Coblentz, AIP

cc Sam Hillard

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November 24, 1971

Mr. F. Phillip Sharpe, Chairman
Central Arizona Project Environmental
Advisory Group
c/o Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Phil:

206 S. 17 Ave. Phoenix Arizona 85007 261-7322

I do not feel that I should critique the draft environmental statements in detail. You've already had two good examples of that from Col. Zeller and Mr. Brecher.

However, I would offer this comment: An environmental statement, in order to do its job, will have to be quite comprehensive and in considerable depth. All the basic environmental disciplines should be covered. The names and degree of expertise of the consultants and/or employees should be shown in the appendix.

Governmental agencies (and in particular the Bureau of Reclamation) do not enjoy any large degree of credibility from the public. In addition, the Central Arizona Project is under constant and steady fire from all environmental groups.

I would recommend that the Tucson Gas & Electric Company environmental analysis of the transmission line from San Juan to Tucson be used as a guideline, and a deeper and more thorough impact statement be developed for each phase of the project.

It has been my painful experience that each environmental impact hearing is a "whole new ball game". As the statements are improved, the critics get more active in finding imagined or real problems (especially since there is no point at which they would say, "O.K., go ahead...we approve").

As the Queen said in Alice in Wonderland, "We have to go faster and faster, just to stay even".

We need this project...without undue delay. There should be no gambling with the environmental impact statement, since this is the one sure way it can be delayed immediately and interminably.

It can be built without undue deleterious impact, and the public needs to be informed as to the details.

Best regards,

ADVISORY COMMISSION ON ARIZONA ENVIRONMENT

F. J. MacDonald
Chairman

FJM:jfj

Governor
JACK WILLIAMS

Commissioners
JACK MANTLE, *CHAIRMAN, TUCSON*
HOMER L. G. KRYGER, *YUMA*
MILTON G. EVANS, *FLAGSTAFF*
ROBERT J. SPILLMAN, *PHOENIX*
GLEN D. DALY, *WINSLOW*

Director
ROBERT A. JANTZEN

Asst. Director, Operations
PHIL M. COSPER

Asst. Director, Services
ROGER J. GRUENEWALD

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ARIZONA GAME & FISH DEPARTMENT
2222 West Greenway Road Phoenix, Arizona 85023

November 19, 1971

Mr. Edward A. Lundberg
Regional Director
Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

We have reviewed the Environmental Report on the Central Arizona Project, September, 1971, drafted by your Agency and are attaching comments on specific sections of the report.

Our reviewing personnel are concerned over the lack of or insufficient data on the present in-depth evaluations of the alternative solutions. In addition, the report repeatedly points out that continued population growth is inevitable and environmentally degrading with or without the project. In other sections, the report claims credit for continued urban and industrial growth. In our opinion, little or no information is presented to substantiate these findings.

We believe that the report may be premature since no information was presented and/or available as to who or for what purpose the water will be appropriated. It is unlikely that an acceptable Environmental Impact study can be accomplished without this knowledge. The report considers the physical project features and speculates on the impact of use and payment for the project commodity, water. It is quite likely that the environmental impact of development associated with use of the Central Arizona Project water will be significantly greater than the impact of the physical features of the project.

With these thoughts in mind, we question the

scope, and adequacy of the report to accomplish the objective of determining the environmental impact of the Central Arizona Project.

Sincerely,

Robert A. Jantzen, Director

RAJ:nm

cc: Mr. Russell Train, Chairman, Council on Environmental Quality
Mr. Robert G. Worden, Arizona State Department of Economic Planning and Development
Bureau of Sport Fisheries and Wildlife, Albuquerque, New Mexico
Bureau of Sport Fisheries and Wildlife, Phoenix, Arizona

Summary

3. Summary of Environmental Impacts

We must disagree with the inference that all the human aspects will always be benefited by the development. Without doubt those human values associated to the natural environment will be depreciated.

The last sentence does not reflect a positive or negative influence of expanding populations on the natural environment. We would recommend the following rewording for the second and third sentences of the first paragraph.

The economic aspects of certain segments of the populace will be benefited. The natural environment values will be depreciated in quantity and quality by expanding agriculture and population.

The second paragraph should be modified to read "detrimentally affected" in place of "affected."

Page 2, first full paragraph

A number of assumptions are made regarding the use of project water. At the present time the specific uses and users of the water have not been determined. In addition, the users have not committed themselves by contract. It would appear reasonable to refer to the applications for water to design a weighted probable service area and use formula. We note that use for fish, wildlife and recreation is not mentioned in this section.

Page 4, first paragraph

As 24.3 percent of the Navajo Power Project is a necessity for CAP pumping requirements, the environmental impact of this feature should be treated in this environmental impact statement.

Page 5, first paragraph, last sentence

Again the Navajo Generating Station is mentioned as a part of the project yet there is no assessment of the impact of this facility in the CAP Environmental Statement.

Page 10, No. 10

Same comment as that for page 5.

Page 11, paragraph 1, sentences 6 and 7

These sentences infer that the ground water has been exhausted over large areas and that the remaining is nearing exhaustion. This is not true. The ground water has been lowered in many areas until it is no longer economically feasible to use for agriculture purposes only.

Page 12, paragraph 2

The paragraph is all inclusive and does not identify the service area or use. As the water has not been appropriated to use or user as yet, it seems the impact report is premature. Regardless, more information on the approximate percentage of water to be used for each specific use should have been provided. If more current information is not available the applications for water could have been summarized.

Pages 14 - 19

We are surprised by the inference throughout this section that the mitigation features and enhancement features are not a part of the project. It is our understanding that mitigation accomplished under The Fish and Wildlife Coordination Act, etc., and enhancement provided under the provisions of P. L. 89-72 are not to be treated in a separate Congressional authorization. As you know, the features for mitigation and enhancement were provided your agency by the Bureau of Sport Fisheries and Wildlife and Arizona Game and Fish Department in various reports from 1965-1968. We are aware that a feasibility grade report on the CAP features by your agency was not available at the time of authorization but we assume you provided Congress with the fish and wildlife reports on the various proposed project features as stipulated in the legislation cited above.

Although this section of the report is not a specific requirement of the Environmental Impact Statement, it appears appropriate and a needed inclusion.

Page 22, C. Vegetation

As the most affected ecologic formation, riparian woodland, is also the most limited type in the project area, additional information on existing acreages should be provided in this section.

Page 24, last paragraph

These two statements are not supported in this section or other parts of the report. The additional emphasis for channelization and water salvage on the Colorado River because of the water shortage

anticipated for Central Arizona Project purposes in the 1990's could well result in elimination of marsh habitat and Yuma Clapper Rail.

Page 26, G. paragraph 2

The sentence implies that the differences between the growth of the Salt River Valley and Pinal County is due to the water supply. Apparently, other factors are also in evidence as Ehrenberg, Parker and Yuma on the Colorado River have always had a more reliable water supply than either place indicated and yet they have not grown as Phoenix has. The inference that economic and population growth at the present time is a direct reflection of the volume of available water needs substantiation.

Page 27, IV, A, 1, paragraph 1

This paragraph does not contain material on the environmental subject in question. This paragraph is only a project-supporting statement rather than an environmental impact evaluation of the project facility.

Page 28, IV, A, 2

The material does not speak to the assigned section heading, to wit: Evaluation of Environmental Impact. All of the discussion is involved in a project-supporting description of the different features.

Page 29, IV, A, 3

This section discusses the anticipated changes occurring with lake construction. The material is accurate under certain conditions; however, conditions are different in each reservoir of the Central Arizona Project. For example, on page 31, paragraph 1, line 7, the statement is made that "Riparian vegetation downstream from the dam will eventually increase within the flood plain as a result of a regulated streamflow." This is misleading as there will be no streamflow below two and probably three of the dams. There will be a net loss of the existing riparian vegetation and the wildlife downstream as a result.

Page 31, paragraph 2

This condition may exist below Hooker Dam but not below Orme, Buttes and Charleston. The paragraph should list the acreage inundated and dewatered within and below the reservoirs.

Page 32, paragraph 2, a. Orme. Lines 11-14

There will not be a net gain in quantity or quality of riparian habitat because of Orme Dam. The peripheral zones of widely fluctuating reservoirs in Arizona do not support riparian vegetation species except in the stream delta.

Page 32, paragraph 2, a. Orme. Line 14

Orme reservoir is not expected to increase the existing waterfowl

habitat due to the adjacent land development and anticipated increase in recreation use.

Page 32, paragraph 2, a. Orme. Lines 15 - 16

This sentence says nothing specific. It should be expanded to elaborate on the extremely high value of the existing flood plain area for nongame wildlife production and associated human use.

Page 33, b. Buttes

The section contains no mention of the habitat volume or value destroyed by inundation. No increase in wildlife habitat can be anticipated along or below the reservoir.

Page 33, c. Charleston

The effect of removing the water from the River on the downstream riparian habitat is not considered or evaluated. The effect of the inevitable land speculation and subdivision on private land adjacent to the reservoir is also not considered.

Pages 34 and 35, d. Hooker

The precedent setting factor of reservoir construction within a designated wilderness area is not presented or evaluated. This factor was a major point of controversy in Congress during project authorization procedures and, hence, must certainly deserve an in-depth evaluation.

In addition, the last sentence of this section states a net gain in wildlife habitat will occur around the reservoir. With the additional human use associated with the water sport activities considered in the previous paragraph, this sentence is in need of supporting justification.

Page 36

There is need for evaluation in this section on the effects of the CAP water salvage features on the environment. These features are outlined in Congressional authorization testimony and also in Mr. Cliff Pugh's presentation before the 12th Annual Arizona Watershed Symposium in 1968.

Page 36, paragraph 2

The statement referring to a "slightly fresher state" is not fully explained. The inference leads one to believe the "fresher" means more productive. As high water temperatures are not a limiting factor for reproduction or growth of warm or cold water fisheries in Mohave or Havasu Lakes, the paragraph might mislead someone to believe this factor would improve the existing fisheries.

Page 37, first paragraph

It is our understanding that part of the annual CAP diversion

of 1.1 million acre feet is presently being utilized by over delivery to California above and below Parker Dam. It would follow that this delivery would no longer be made below Parker Dam.

Page 37, second paragraph

The consumptive use of all river water from Charleston Dam to Benson, Arizona would appear to obliterate existing flood flows in the San Pedro below Benson. The effect of dewatering the large existing riparian area from Benson to Winkelman should be evaluated and the findings presented.

Pages 37, 38 and 39. 5. Quality of Water

The report does not consider the long range impact of building up salts in Arizona's ground water by importing approximately 1,000,000 tons of salt annually through the CAP canal. No method of removal of this salt is presented in the report.

Page 39. 6. Herbicides and Pesticides

This section should compare the use of these chemicals with and without the project. The impact of their use on the environment should be quantified with and without the project.

Page 40. 7. Sociological Impacts, paragraph 1

The third and sixth sentences are contradictory. In fact, the reasoning in most of section 7 is rather hazy. The statement is made that population increase will continue with or without the CAP. The statement is also made that the project will enhance agricultural and industrial potential. The Arizona Statistical Review, 1969, indicates immigration is due largely to new jobs. The Statistical Abstract of the United States, 1970, also indicated people don't move to areas with weak economies. If the assessment is made that the CAP will enhance the agricultural and industrial development, it follows the resulting population increase and lower quality of life is also attributable to the project.

This feature of the CAP is in need of further investigation and assessment. The major effect of the CAP on the environment will probably be in the form of secondary or indirect impact and can not be properly presented in a one page analysis.

Page 40, 7. Paragraph 2, first sentence

There is no demonstrable evidence that this is occurring or will occur. The per capita consumptive use of renewable and nonrenewable resources is increasing rapidly. The per capita pollution

and solid waste is also increasing in a like manner. The development of technology in utilization of natural resources is increasing the undesirable environmental conditions listed in the second sentence of this paragraph.

Page 41, 8. Beneficial Impacts. a.

This paragraph indicates water availability is a limiting factor in municipal and industrial economic health. Our information indicates this is not true. The existing pattern of municipal development in Central Arizona involves purchase of land with existing water rights and transfer of agriculture water to a higher beneficial use. This fact is alluded to on page 48 under "C. Alternatives to the Proposed Action."

Page 41, 8. b.

This subsection should be expanded.

Page 41, 8. c.

There are often side effects of flood control projects which are detrimental to the environment. For example, in the western portion of the Granite Reef Aqueduct, the collection of surface flows will effectively eliminate much desert growth on the down drainage side.

Page 41, 8. d.

Sentence three states fish and wildlife habitat will be improved around, above and below the reservoirs. The plans we have seen thus far indicate a fish and wildlife loss will occur around and downstream from the reservoirs in Arizona. Each reservoir is an individual case; however, wildlife habitat will receive a net loss in all cases in Arizona. The last sentence presumably refers to facilities discussed in subsection f. If so, that sentence should be inserted in subsection f.

Page 42, e

The table titled, Potential Fishermen Use on the Proposed CAP Reservoir, was prepared in 1964 prior to passage of the authorizing legislation. A large number of project changes have occurred since that time which renders the information in this table invalid. For example, the legislation provides recreation management of Orme Reservoir by the Indian tribes as opposed to multiple use for public purposes. It is highly unlikely the reservoir will provide the public benefits in the form of recreation as originally envisioned.

The fact that the reservoir will be managed for economic return to the tribes as opposed to public purposes should be included in this report.

Page 43, f

The third paragraph deals with methods of lessening and preventing damages to the environment by the Granite Reef Aqueduct. The paragraph should be deleted as the information is presented elsewhere.

Page 44, g

Bureau of Reclamation personnel have stated safety policies of the agency would not permit this type development. If it is acceptable it would be an urban environment asset.

Page 44, h

Appropriation of water to the users has not been made at this time. This makes it difficult if not impossible to accurately assess the environmental impact of the project. This point is made in the following section, 9. Unknown Effects, on page 45 of the report.

Page 46, 4

The second sentence of this paragraph is not true of Hooker or Charleston Dam in the project areas involved.

Page 47, 5. c

This statement is very misleading, if not untrue. The statement should read as follows:

> Wildlife populations depending upon riparian vegetation will be obliterated within the reservoir sites and dewatered areas downstream.

Page 47, 6

This sub-section does not present a reasonable picture of the environmental impact of reservoir developments such as Havasu City or Fountain Hills. This section should be expanded to reflect the impact of these developments on the surrounding natural environments.

Page 47, 8

This statement refers primarily to aquatic species

of the aquatic biota without identifying the group.

Page 48, 9

This effect on the riparian vegetation and wildlife species of the San Pedro and Gila Rivers should be quantified and presented.

Page 48, 10

The effect of the project as a stimulus for economic and industrial growth and development should be presented if this is the case as claimed on page 41, a and b; page 40, paragraph 1, and page 48, section C, subsection 1.

Page 48, C, 1

This paragraph is in need of substantiation or deletion. The statements do not agree with subsection 10 on the same page. The last sentence of the paragraph does not agree with the economic history of Arizona's use of water. Transfer of use for water from agriculture to municipal and industrial use provides a higher economic return per acre foot. It is difficult to understand how your report can assign an economic depressing factor to this existing and historic practice. The Phoenix area has developed economically, and is continuing to, through transfer of land and water use from agriculture to municipal and industrial use.

Page 49

This section of the report makes no attempt to evaluate the impact on the environment of the no project alternative as required by The Environmental Policy Act. The paragraph is composed simply of a number of unsupported statements attesting to the lack of consideration given this alternative.

Page 49, first paragraph

The transfer of use as a water use pattern is in existence now and has been used throughout the history of the development of the Phoenix metropolitan area. Continued transfer of use would be no more extreme than it has been in the past. The statement following (b) in this paragraph should read: "continuation of the existing water use pattern of transfer from agriculture to higher uses in the service area."

Page 52, D, sentences 3 and 4

These sentences contradict the third sentence of subsection 7 on page 40 and subsection 10 on page 48. If this section of the report

is retained, then the adverse effects of continued urban and industrial growth delineated in the second paragraph on page 40 should be included in section B, Adverse Environmental Effects, as well as in this section.

Page 52, D, sentence 5

This sentence should be deleted. There is no information contained elsewhere in the report to indicate this is being considered or that it would be desirable.

Page 52, D, second paragraph, sentences 2 and 3

The project envisions a decreasing supply of water. The CAP water is no more reliable than existing surface supplies and certainly not as predictable as present ground water.

Page 53, paragraph one

Wildlife and riparian vegetation and associated terrestrial wildlife will be reduced by the project, not increased.

Page 54, 2

The second sentence does not pertain to the subject heading and is only a project-supporting statement which is out of place.

* * *

INFORMATION COPY FOR 100

Jack Williams
Governor

Commissioners
Gene C. Reid
Chairman
Robert A. Jantzen
Vice Chairman
Dennis McCarthy
Secretary

Arizona Outdoor Recreation Coordinating Commission

2222 W. Greenway Road
Phoenix, Arizona 85023
(602) 942-3000

OFFICIAL FILE COPY

RECEIVED DEC 1 1971

Action: Staff
Roland H. Sharer
Liaison Officer

Action Taken & (Initials)
Project Director

Date	Initials	
		Michael H. Peterson Planning Officer
		Lyle A. Bair Assistant Project Director
12/1	[illegible]	155
12/2	[illegible]	155

File

November 29, 1971

Edward A. Lundberg, Regional Director
Region 3, Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

We are enclosing herewith a copy of AORCC's comments on The Draft of Environmental Statement Central Arizona Project.

Sincerely,

Roland H. Sharer
State Liaison Officer

RHS:nt

Enclosure

Form 10005

Jack Williams
Governor

Commissioners
Gene C. Reid
Chairman
Robert A. Jantzen
Vice Chairman
Dennis McCarthy
Secretary

Arizona Outdoor Recreation Coordinating Commission

2222 W. Greenway Road
Phoenix, Arizona 85023
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Staff
Roland H. Sharer
Liaison Officer
&
Project Director
Michael H. Peterson
Planning Officer
Lyle A. Bair
Assistant Project Director

AORCC Comments On
The Draft Of
ENVIRONMENTAL STATEMENT
CENTRAL ARIZONA PROJECT

Page 6 - Orme Dam and Reservoir

Following the statement on the capabilities of the reservoir to impound over 1,000,000 acre-feet of water, there needs to be some discussion on the specifics of the management and coordination method of management of the water levels if water recreation benefits are to be derived. Available figures, though apparently not officially adopted, indicate that the reservoir will fluctuate vertically about 63 feet and have surface acreages ranging from 9,000 acres to 2,300 acres. This fluctuation and the water management program will have a tremendous influence on the design of recreation facilities and use of such facilities. The demand for irrigation water and the demand for recreation water poses a serious problem in that the demands are simultaneous. This problem indicates that if Orme Reservoir is to be of significance recreationally, the water management program must be coordinated with water users and appropriate recreation agencies. The structure of this coordination procedure must be delineated now and implemented in the planning stages of the individual reservoir projects. There should be discussion of the land ownership around the reservoir and access. It is important to note that if this reservoir is to be available to the general public there should be a significant amount of public land ownership and access. It is not desirable that this reservoir be totally encompassed by Indian reservations and private interests.

Page 8 - Charleston Dam and Reservoir

The same general considerations and recommendations should be applied to this project as those of Orme Dam and Reservoir. Unofficial figures indicate that this reservoir will fluctuate 35 vertical feet and have surface acreages ranging from 3,700 acres to 1,250 acres. There should be discussion of the land ownership around the reservoir and access.

Form 10005

Page 9 - Buttes Dam and Reservoir

Unofficial figures on this project area indicate that the water levels will fluctuate 125 vertical feet and the surface acreage will range from 4,000 acres to 200 acres. The potential for significant water recreation at this site seems very questionable because of the potential of tremendous lake fluctuation and the very inconsistent supply of water on the Gila River and San Pedro River watershed. More facts should be presented regarding the historical aspects of past water runoff at the project area in order to make a more valid analysis of the water recreation potential of the proposed Buttes Dam and Reservoir.

Page 9 - Hooker Dam and Reservoir

Unofficial figures indicate this reservoir is to be relatively small. The surface acreage will range from 540 acres to 310 acres with a water level fluctuation of 38 vertical feet. The reservoirs small size and remoteness from concentrated areas of population lessen its significance as a water recreation resource. Additional facts should be made available and discussed concerning the need and desirability of Hooker Dam and Reservoir or a similar facility elsewhere on the Gila River or on the San Francisco River. There should be discussion of the land ownership around the reservoir and access.

Page 13 - The last sentence on this page indicates that alternatives to other major features of the project are also being investigated. It would seem appropriate that all of these alternatives should be discussed to some degree to present the concepts involved.

Page 15 - The first paragraph on this page speaks to enhancement and mitigation features along the aqueducts from Lake Havasu to Tucson and from Charleston Dam to Tucson. It is indicated that gravitational flow-through side ponds of five acres or less are envisioned at selected sites adjacent to the main canals in order to provide for recreational use and wildlife watering access. These ponds would be of little recreational use because of their small size and their distant location from the two metropolitan areas of Arizona. Their only real benefit could be as wildlife watering areas.

Page 16 - Funding for the construction of side ponds, wildlife guzzlers and back-water fingers would probably not be funded by Land and Water Conservation funds because of the limited recreation use these facilities would provide on a statewide and regional basis.

Page 17 - E. Recreation

This section needs to specifically delineate all the existing recreation lands and uses and discuss the effects, adverse as well as beneficial, the aqueducts and reservoirs have on these existing areas.

Page 28 - 2. Aqueducts and Canals

Implications in this section are that the system of waterways traversing seldom visited Arizona open spaces is of little consequence. Any development in open spaces is significant and should be so treated. It is therefore necessary to delineate the total waterways system and effects it has

on the open spaces over which it passes.

Page 32 - Orme

A physical description of the reservoir needs to be discussed. This would include: minimum, maximum and average surface acreages; vertical lake level fluctuations; etc. The potential of and benefit to water-oriented recreation will be solely dependent on the water level management program and the land management programs of the Ft. McDowell and Salt River Indian agencies.

Page 33 - Buttes

There will be little, if any, water-oriented recreation benefit provided by this reservoir because of its small size and potential for tremendous lake level fluctuation.

Page 34 - Charleston

This reservoir has water-oriented potential provided that its water level management program is coordinated with the recreational needs of the public.

Page 40 - 7. Sociological Impacts

Considering the apparent shortage of surface water and the continual overdraft of ground water, it is necessary to explain why a re-evaluation of water use priorities is not reasonable at this time, especially with the statement that "the rate of growth can be expected to continue with or without the project."

Page 41 - 8. Beneficial Factors

(d) Water-oriented recreation opportunities will be made available only if concerted coordinated planning and water management programs are developed and implemented by involving all federal, state and local agencies having water-oriented recreation interests.

Page 43 (f) As stated before the five acre ponds will have little recreation benefit and would probably be more significant to wildlife benefits.

FACSIMILE TRANSMITTED -- 2/1/72

ATTENTION: 3-150, Boulder City, Nevada.

ARIZONA STATE PARKS

1688 WEST ADAMS / 271-4174 / PHOENIX, ARIZONA 85007

DENNIS McCARTHY, DIRECTOR

WALLACE VEGORS, ASSISTANT DIRECTOR

120.1

January 31, 1972

PHOENIX FIELD OFFICE

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STATE PARKS BOARD MEMBERS

2/1/72 SAS gjd

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		150
		47
File		

Mr. David Creighton, Jr.
Chief of Planning
U. S. Bureau of Reclamation
135 North Second Avenue
Phoenix, Arizona 85003

Dear Mr. Creighton:

My staff and I have completed a reading of the draft Environmental Statement for the Central Arizona Project prepared by the Bureau of Reclamation. As the State Liaison Officer for the National Historic Preservation Act of 1966 (P.L. 89-665), my comments concern the Statement's consideration for Arizona's historical and cultural sites which may be affected by the proposed project.

I note that the Statement's Summary and Introduction make no mention of the National Historic Preservation Act of 1966 or the need to comply with the Act's protection aspects. The Summary also omits mention of the potential adverse effect upon the two historical sites mentioned within the text of the Statement. Specifically, I refer to Fort McDowell and to the townsite of Charleston.

In discussing the two historical sites named above, Section III identifies Fort McDowell and Charleston as the "...most prominent historical sites" likely to suffer an adverse effect. An historical description or evaluation of significance of these two sites is not given in the text. The alternatives to site inundation (both sites are within proposed reservoirs) are not discussed.

One site for which my office feels concern was not mentioned in the text of the Statement. I refer to the five charcoal ovens east of Florence and within the proposed Buttes Dam reservoir. These structures represent

a period of frontier technology (ca. 1890) and should be saved for public interpretation.

Reference is made in Section III to previously conducted salvage-inventory surveys conducted by the National Park Service and others within the proposed impact areas. The Statement, however, fails to adequately summarize the findings of these surveys. Any future rewrite of the Statement should capsulate this information and incorporate such into the text.

I feel that other cultural and historical sites may exist within the proposed project area, but the lack of specific project element data and the omission of survey data make any definite statement from my office not feasible.

I appreciate the opportunity to comment upon the draft Environmental Impact Statement. These remarks, in addition to their concern for preserving historical resources, are meant to be constructive in their criticism.

Sincerely,

DENNIS McCARTHY
State Parks Director
State Liaison Officer
National Historic
Preservation Act of 1966

DM:ol

INFORMATION COPY FOR 100, 700

Arizona State Reclamation Association

1124 ARIZONA TITLE BLDG. - TEL. 253-2136 - PHOENIX, ARIZONA 85003

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RECEIVED OCT 1 1971
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Date	Initials	To
10/5	ZB	150
10/5	MC	155
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September 29, 1971

Mr. F. Phillip Sharpe
Envirnomental Specialist
Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

Dear Mr. Sharpe:

As a member of the Central Arizona Project Environmental Advisory Group, I offer the following comments on the Draft of Environmental Statement, Central Arizona Project dated September 1971.

I should like first to compliment you and the Bureau of Reclamation on the draft of statement, which I understand to be general and to be followed with statements specifically covering segments of the project.

Comments

Summary - Item 2, line 4: I suggest deleting the word "Yuma." This is misleading because I know of no plan for delivery of CAP water in Yuma County. This deletion is also in line with the definition of the Project Area as stated in "A" page 1, where the "Project Area" is said to be "Above Painted Rock Dam."

Item 3 - Summary of environmental impacts: I suggest that the paragraph beginning with "The allocation of ____" be rewritten to clarify its meaning. Suggested substitute language: The delivery of imported Colorado River water within the service area of the Project will affect the existing environment in a number of ways, most of which will be beneficial to the human population and some, which may be considered detrimental, may be reasonably mitigated by proper planning.

Page 3, 2nd line of 2nd paragraph: Delete "1949" and add "1947." The first congressional hearings on the

CAP were held by the Senate Subcommittee on Irrigation and Reclamation in 1947 on S.B. 1175.

Page 10-11 B - Needs: the words beginning at bottom of page 10 -- "and the agricultural economy in particular has flourished and declined in direct relationship to the adequacy of the water available," may be challenged on the basis that the overall agricultural economy of the State has not, in fact, "declined." It has declined in Pinal County from an irrigated acreage of 264,300 acres in 1951 to 231,585 acres in 1970.

I suggest the statement be carefully reexamined to avoid the possibility of successful challenge.

In this section on "Need" I think it should be pointed out that the City of Tucson is totally dependent on groundwater.

Page 14 - 1st paragraph: I suggest changing this paragraph to read as follows (underscored words added): "The primary objective of the project is to bring Colorado River water from Lake Havasu to central Arizona" to supplement the existing but inadequate supply "for agriculture, municipal, and industrial uses."

Page 18, last paragraph: I recommend deletion of the 1st sentence of this paragraph, that is, the words "The Central Arizona Project is in part dependent upon the potential of water salvage from the Lower Colorado River." It is my understanding that practically all of the potential for water salvage on the lower stretch of the Colorado River has already been accomplished through construction of Senator Wash Reservoir, channel dredging, drainage pumps which return water to the River for credit to Arizona's total 2.8 million acre-foot allocation, and the removal of riparian phreatophytic vegetation on the Indian reservations as lands are brought under irrigation.

Page 38 - Quality of water: I would like to see a statement here concerning the kinds of salts in Colorado River water and in typical groundwater and surface water presently used in central Arizona. I believe that is environmentally significant.

It is also worth noting in this section that there will be no significant return flows to the Colorado River from CAP diversions and therefore no degradation of mainstream water quality from that source.

Page 40 - Item 7 - Sociological Impacts - 1st paragraph, 2nd sentence: "The desert region of Arizona which supports the bulk of the population is totally dependent upon a plentiful supply of water." If the words artifically provided were substituted for the word "plentiful" in this statement it would make better sense. There is no place on earth that isn't totally dependent on a supply of water if life is to exist there. Central Arizona is not unique in this respect.

Page 41 - 8, Beneficial Impacts - paragraph b: To paragraph b I suggest adding the following: ,and help to maintain a green belt environment surrounding urbanized areas.

Page 45: After paragraph i add a new item - paragraph j as follows: The flood control functions of the project's delivery system dams, particularly Orme Dam, will afford protection for life and property in presently developed areas, and permit environmentally desirable uses of what are now esthetically ugly sociologically blighted and economically useless flood plain lands.

Page 48 - C. Alternatives to the Proposed Action - Item 1, last sentence: "Economic growth and development in the State of Arizona would be severely hampered."

While I believe this to be true at some point in time, I doubt the wisdom of making the flat, unqualified statement. We have been saying it for the last 30 years while our total economy continued to grow phenominally. In several places in this draft it is stated that central Arizona will continue to grow whether or not more water is made available. The threat, I believe, is to the balance of the economy which would result from the gradual disappearance of the agricultural sector, and the deterioration of the environment which would accompany that disappearance of the farm green belt.

Page 49 - Item a.(1) - Cloud seeding: This statement should include mention of the very formidable legal questions which must be resolved before cloud seeding can be generally applied.

Page 49 - Item a.(2) Desalting: This statement should include mention of the so far unresolved environmental problem of brine disposal. The residue from the desalting process is a potential source of land and water pollution no matter what method of disposal is used.

Please understand that the above comments and suggested revisions are intended only to somewhat improve what is already a very good draft statement. I am transmitting them only to you, as Chairman, but I would like to suggest that you consider sending copies of the comments received from each member to the others. I think it might help us to become oriented to the thinking of our colleagues and provice a basis for future discussion.

Sincerely,

Rick Johnson
President

RJc

INFORMATION COPY FOR 100
cy routed to 200 400 600 700 by

Arizona State Reclamation Association

1124 ARIZONA TITLE BLDG. - TEL. 253-2136 - PHOENIX, ARIZONA 85003

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10/4	FPS	150
10/4	RO	153
10/4	[illegible]	155
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October 1, 1971

Mr. F. Phillip Sharpe
Environmental Specialist
Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

Dear Mr. Sharpe:

I have sent my comments on the Draft of Environmental Statement -- Central Arizona Project to you under separate cover. However, I feel compelled to make some additional comment concerning the procedure and function of the Advisory Group.

I do think the Advisory Group should have more input opportunity relative to these environmental reports before they are released for circulation among the many agencies.

I have not talked about this with other members of the Group, but personally I would feel much more comfortable and better equipped to defend the report if we had been able to discuss it and have our comments considered before the draft was released for circulation. Compared with the impression made by the body of a report, the value of appended comments is, in my opinion, substantially less.

In conversation with Commissioner Armstrong some time ago I had the impression that the Advisory Group was one way of gaining increased local participation in project matters. To me, at least, that means participation as an effective partnership.

There may be problems involved which I do not understand, and I am writing only to raise a point for your consideration as we move forward into future segment reports.

Sincerely,

Rich Johnson

Rich Johnson
President

RJc

INFORMATION COPY FOR 700

GEORGE E. LEONARD
CHAIRMAN
JOHN S. HOOPES
VICE-CHAIRMAN
WESLEY E. STEINER
EXECUTIVE DIRECTOR
AND
STATE WATER ENGINEER

120.1

Arizona Water Commission
34 WEST MONROE STREET - 7TH FLOOR
Phoenix, Arizona 85003
TELEPHONE (602) 258-7561

MEMBERS
PETER BIANCO
LINTON CLARIDGE
DAVID R. GIPE
DOUGLAS J. WALL
WILLIAM H. WHEELER
EXOFFICIO MEMBERS
ANDREW L. BETTWY
MARSHALL HUMPHREY

December 3, 1971

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Date	Initials	To
12/6	ZK	150
File		

Mr. Edward A. Lundberg
Regional Director
Bureau of Reclamation
Boulder City, Nevada 89005

Dear Mr. Lundberg:

The draft of the environmental statement on the Central Arizona Project dated September 1971 has been reviewed by the staff of the Arizona Water Commission. While we find that the draft meets the requirements established by the Council on Environmental Quality, we believe that the statement should be materially expanded and that description of the Project and of the environment at each feature of the Project should be made considerably more comprehensive.

The staff of the Arizona Water Commission will be pleased to assist you toward that end.

Sincerely,

Wesley E. Steiner
Executive Director

OFFICE OF THE BOARD OF SUPERVISORS

MARICOPA COUNTY
602 County Administration Bldg. 111 S. 3rd Avenue, Phoenix, Arizona 85003

HENRY H. HAWS
District 1

B. W. "BARNEY" BURNS
District 2

BOB STARK
District 3

October 21, 1971

12001

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11-9		150
11/9		153
11/9		155
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Mr. E. A. Lundberg, Regional Director
U. S. Dept. of Interior
Bureau of Reclamation-Regional Office-Rgn.3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Re: Central Arizona Project Environmental Statement Dated September 1971

This acknowledges receipt of your letter dated September 24, 1971. In connection with the September 1971 Environmental Statement for the Central Arizona Project, I appreciate very much the opportunity which you have given Maricopa County to study this report and to comment upon it. The departments of the County most concerned are the Flood Control District, the Parks and Recreation Department, the Health Department, and the County Highway Department. The departments contacted have expressed their opinion that the plans brought forth in your environmental report will have a beneficial impact upon Maricopa County.

The Flood Control District staff have made a rather detailed study of your report, are most familiar with the flood control and water conservation problems of the County, and I am attaching herewith a copy of the letter which was forwarded to your office by the Chief Engineer of the Flood Control District on October 21, 1971.

Respectfully,

Henry H. Haws
Chairman, Board of Supervisors

HH/jm
Encl.

Flood Control District
of
Maricopa County
3325 WEST DURANGO STREET
PHOENIX, ARIZONA 85009

OFFICIAL FILE COPY

RECEIVED OCT 26 1971

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Action Taken (Initials)

Date	Initials	To
10/26		153
10/27		150
10/27		155
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October 21, 1971

Mr. E. A. Lundberg
Regional Director
U. S. Dept. of Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Re: Central Arizona Project Environmental Statement Dated Sept. 1971

This office has studied your report submitted by your letter dated September 24, 1971. This office finds nothing objectionable to the contents of this report and, in fact, is of the opinion that the report itself will prove of great value in the future.

Reference is made, however, to Page 17, the second paragraph, covering a statement with reference to the consumptive use of water for the gravitational-flow structures. It is assumed that the amount of acre feet of water per year required for this purpose does take into consideration seepage which will no doubt occur within the basins of these contemplated structures.

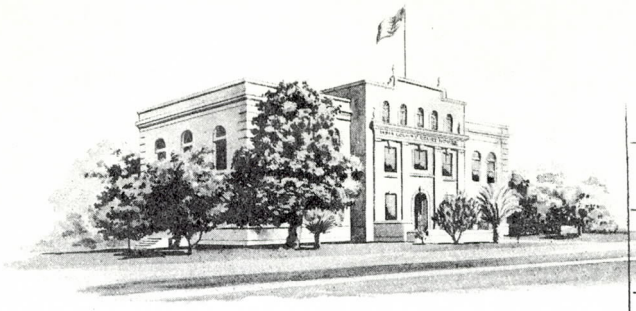
Sincerely,

John C. Lowry
Chief Engineer & General Manager

JCL/jm

A. E. GRAHAM, CHAIRMAN
RAMON AVILA, MEMBER
GLEN H. STROHM, MEMBER

ALBERT MOTLEY, CLERK



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10/22	[illegible]	150
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OFFICE OF THE

BOARD OF SUPERVISORS

YUMA COUNTY

YUMA, ARIZONA

120.01

October 12, 1971

Mr. E. A. Lundberg
Regional Director
U.S. Dept. of the Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Reference: 3-150/120.01

The Draft, Environmental Statement for the Central Arizona Project, has been reviewed with interest.

The Yuma County Board of Supervisors has no substantial comments to offer at this time.

Sincerely yours,

A. E. Graham
Chairman

RAYMOND R. RUMMONDS
CHAIRMAN AND COLORADO RIVER COMMISSIONER
COACHELLA VALLEY COUNTY WATER DISTRICT

RAYMOND E. BADGER
SAN DIEGO COUNTY WATER AUTHORITY

JOSEPH JENSEN
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

HAROLD F. PELLEGRIN
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PALO VERDE IRRIGATION DISTRICT

EDGAR L. KANOUSE
DEPARTMENT OF WATER AND POWER, CITY OF LOS ANGELES

CARL C. BEVINS
IMPERIAL IRRIGATION DISTRICT

MYRON B. HOLBURT
CHIEF ENGINEER

STATE OF CALIFORNIA
Colorado River Board of California
302 CALIFORNIA STATE BUILDING
217 WEST FIRST STREET
LOS ANGELES, CALIFORNIA 90012

October 18, 1971

Ref. No. 3-150/120.01

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Mr. E. A. Lundberg, Regional Director
U. S. Bureau of Reclamation, Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Thank you very much for sending us a copy of the September 1971 Draft of Environmental Statement for the Central Arizona Project, Arizona-New Mexico. Our comments will be coordinated with and included in the comments of the State of California.

Sincerely yours,

Myron

MYRON B. HOLBURT
Chief Engineer

M YORTY
AYOR

DEPARTMENT OF WATER AND POWER
THE CITY OF LOS ANGELES

COMMISSION
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ASSISTANT GENERAL MANAGER
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FLOYD L. GOSS
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ROBERT V. PHILLIPS
CHIEF ENGINEER OF
WATER WORKS AND
ASSISTANT MANAGER

WILLIAM D. SACHAU
CHIEF FINANCIAL OFFICER

October 5, 1971

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Mr. E. A. Lundberg
Regional Director
United States Department of the
Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

This is in answer to your letter of September 24, 1971, requesting a review and comments on the September 1971 Draft of Environmental Statement for the Central Arizona Project.

We have reviewed this draft and find it generally acceptable and have no further comments to make.

Very truly yours,

J. L. MULLOY
Engineer of
Design and Construction

By L. Schneider
L. Schneider
Navajo Project Manager

LS:pn

WATER FOR LIFE DWP POWER FOR PROGRESS

NORMAN B. LIVERMORE, JR.
SECRETARY

RONALD REAGAN
GOVERNOR OF
CALIFORNIA

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

Department of Conservation
Department of Fish and Game
Department of Navigation and
Ocean Development
Department of Parks and Recreation
Department of Water Resources

Air Resources Board
Colorado River Board
San Francisco Bay Conservation and
Development Commission
State Lands Commission
State Reclamation Board
State Water Resources Control Board
Regional Water Quality Control Boards

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

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RECEIVED JAN 26 1972
Action:
Action Taken (Initials)

Date	Initials	To
1/27	MC for FWS	150
1/27	Gene	155
File		

JAN 24 1972

Mr. E. A. Lundberg, Regional Director
Region 3
Bureau of Reclamation
U. S. Department of the Interior
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

The State of California has reviewed the "Draft of Environmental Statement Central Arizona Project", dated September 1971, which you submitted to the Office of Intergovernmental Management (State Clearinghouse) within the Lieutenant Governor's Office. The review accomplished by the State fulfills the requirements under Part II of the U. S. Office of Management and Budget Circular A-95 and the National Environmental Policy Act of 1969.

The subject draft statement was reviewed by the State Departments of Agriculture, Conservation, Fish and Game, Navigation and Ocean Development, Parks and Recreation, Public Health, Public Works (Division of Highways), and Water Resources; the State Water Resources Control Board; and the Colorado River Board of California. The State's comments are as follows:

1. The discussion of Legislative history of Pages 2 and 3 of the report should be revised to make it factually correct. The report should state that the Colorado River Compact did not become effective until June 25, 1929, after being ratified by six of the seven basin states, and after certain conditions imposed by the Boulder Canyon Project Act were satisfied. As written, the report implies that Arizona was allocated 2,800,000 acre-feet per year of Colorado River Water by the Colorado River Compact. The Compact did not allocate a specific quantity of water to Arizona. The decree in Arizona v. California did apportion 2,800,000 acre-feet of consumptive use to Arizona when sufficient mainstream water is available for release to satisfy 7,500,000 acre-feet of consumptive use in Arizona, California, and Nevada.

INFORMATION COPY FOR 700

Comprehensive Health Planning

25 SHADOW LANE • P. O. BOX 4426 • LAS VEGAS, NEVADA 89106

Clark County

(702) 385-1291

RECEIVED OCT 4 1971

Action:

Action Taken (Initials)

Date	Initials	To
10/5	DHF	130
		~~700~~
10/5	JKC	155
File		

September 30, 1971

Mr. E. A. Lundberg, Regional Director
Region 3-U.S. Dept. of the Interior
Bureau of Reclamation
Post Office Box 427
Boulder city, Nevada 89005

Dear Mr. Lundberg:

Thenk you very much for your request for review and comment on the Draft Environmental Statement for the Central Arizona Project. The Environmental Health Task Force of Clark County Comprehensive Health Planning does not wish to comment on this particular statement at this time.

We thank you for your consideration.

Sincerely yours,

Richard V. Nutley

Richard V. Nutley, Planner
For: D. H. Forrester, Chairman
ENVIRONMENTAL HEALTH TASK FORCE

mh

PARTNERSHIP FOR HEALTH

MIKE O'CALLAGHAN
GOVERNOR

JACK LEHMAN, CHAIRMAN
LAS VEGAS, NEVADA

THEODORE R. LAWSON, VICE CHAIRMAN
LAS VEGAS, NEVADA

DONALD L. PAFF, ADMINISTRATOR
LAS VEGAS, NEVADA

M. WILLIAM DEUTSCH, MEMBER
LAS VEGAS, NEVADA

MRS. MARY KOZLOWSKI, MEMBER
LAS VEGAS, NEVADA

FRANK M. SCOTT, MEMBER
CALIENTE, NEVADA

COLORADO RIVER COMMISSION
OF NEVADA
P.O. BOX 1748
LAS VEGAS, NEVADA 89101
TELEPHONE 384-5135

OFFICIAL FILE COPY
RECEIVED OCT 1 1971
Action:
Action Taken.....(Initials)

Date	Initials	To
10/4	Loc	100
10/6	RBS	150
10/6	[illegible]	155
10/7	[illegible]	105
10/7	[illegible]	110
File		

Reference:
3-150/120.01

September 30, 1971

Mr. E. A. Lundberg
Regional Director
Region 3
U. S. Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear ~~Mr. Lundberg:~~ Ed

Reference is made to your letter of September 24, 1971 requesting a review and comments on the Draft of Environmental Statement for the Central Arizona Project. We plan to coordinate our review of the statement with the Governor's office and other State agencies. Therefore, we will not be responding direct to your request for review.

Sincerely,

Donald L. Paff
Administrator

cc: Mr. Chris Schaller
Executive Administrative
Assistant to Governor
State Capitol Building
Carson City, Nevada 89701

MUSEUM OF NEW MEXICO, P.O. BOX 2087, SANTA FE, NEW MEXICO 87501

PHOENIX PROJECTS OFFICE
OFFICIAL FILE COPY
RECEIVED FEB 24 1972

February 18, 1972

120.1
YA-770.

Mr. C. A. Pugh, Projects Manager
Arizona Projects Office
Phoenix Development Office, Region 3
Bureau of Reclamation
135 N. Second Avenue
Phoenix, Arizona 85003

Dear Sir:

REFERENCE: 314-700
120.1

The draft of the Environmental Statement, Central Arizona Project, concerning the proposed Hooker Dam along the Gila River in New Mexico, has been reviewed by this office with respect to impact on the archeological resources. Results of this review are included in the enclosed statement prepared by Mr. Stewart L. Peckham, chief archeologist of the Museum of New Mexico. If we can be of further assistance, please call.

We appreciate the opportunity to comment on this proposal.

Sincerely,

George H. Ewing
State Archeologist

GHE/mbo

Enclosure

FACSIMILE ORIGINAL

Draft of

Environmental Statement

The Impact of the Proposed Hooker Dam on Archaeological Remains in Its Vicinity

Prepared by the

Museum of New Mexico

February 14, 1972

Introduction

The environmental statement which follows was prepared at the request of the Phoenix Development Office, Region 3, Bureau of Reclamation, U. S. Department of the Interior, acting in accordance with recommendations of the Advisory Council on Historic Preservation, and in compliance with Section 106 of the National Historic Preservation Act of 1966 (80 Stat. 915).

Upon consulting with David W. King, State Planning Officer, of the New Mexico State Planning Office, the Bureau of Reclamation was referred to George H. Ewing, State Archaeologist, of the Museum of New Mexico, for his comments on the possible effects of the construction of Hooker Dam on archaeological remains.

The statement was prepared by Stewart L. Peckham, Chief Archaeologist, of the Museum of New Mexico, who relied on documentation in the files of the Division of Anthropology and the Division of Monuments, of the Museum of New Mexico; additional data provided by Prof. James E. Fitting, Department of Anthropology, Case Western Reserve University, Cleveland, Ohio; as well as his familiarity with with the archaeology of southwestern New Mexico.

Hooker Dam--Environmental Impact

a. Description of the Proposed Dam

A component of the Central Arizona Project, the Hooker Dam is proposed to be located on the Gila River north-northeast of the town of Cliff, New Mexico. Although the final specifications of the dam remain to be decided upon, tentative specifications of the earthfill embankment call for a structure about 235 feet in height above the streambed, a crest length of about 1500 feet, a basal width of about 1300 feet tapering to 40 feet wide at the crest.

The pool behind the dam will extend upstream about seven to eight miles and will include a portion of the Gila Wilderness Area within its limits.

The purposes of the dam are: "storage for municipal and industrial purposes, conservation, flood control, sediment storage, river regulation, recreation, and fish and wildlife benefits." (Bureau of Reclamation: Environmental Statement, Central Arizona Project).

An alternate location for the proposed dam is near the confluence of the Gila River and Mangas Cree, about seven miles south of Cliff, New Mexico.

b. The Probable Impact of the Proposed Dam

In terms of archaeological and historical values in the area, the proposed Hooker Dam, at either of the locations currently being considered, will have both adverse and beneficial impacts.

1. What are the archaeological and historical values in the vicinity of the Hooker Dam and Reservoir?

The area was occupied by prehistoric Indians of the Chiricahua and San Pedro Stages of the Cochise Culture from circa 4000 to 500 B.C. The economy of the Cochise Culture was based primarily on hunting and gathering of wild plant and animal foods, although toward the end of its time range they were apparently cultivating corn which had been introduced into the Southwest from Mexico.

With the expanded reliance on agriculture for subsistence, the Indians of the Cochise Culture gave up their seasonally nomadic way of life and took on a sedentary life. As sedentary agriculturalists, other aspects of their culture changed, and with the introduction of pottery and formal architecture their culture became sufficiently distinctive to warrant the recognition of the Mogollon Culture, and specifically the Mimbres Branch of that culture.

From about 500 B.C. to A.D. 950 the Indians lived in subterranean dwellings (pit houses), either as isolated units or in villages composed of as many as fifty pit houses. Habitation sites were usually on gravel and clay terraces bordering larger streams and their major tributaries, or on the tops of higher mesas some distance back from permanent flowing streams.

Population increases during the tenth century, coupled with the introduction of masonry surface dwellings, led to the growth of large villages along the Gila and Mimbres Rivers. Broad valley bottoms were farmed intensively as is indicated by the ruins of numerous small auxilliary dwellings along both sides of the rivers between the major settlements.

From about A.D. 950 to 1150 the arts and crafts of the Mogollon people flourished, and contact with other Indian groups, especially to the west and south, is evident in the quantities of shell ornaments, turquois, carved stone, and the like. Of greatest interest to archaeologists have been the pottery vessels of the Mimbres Branch which were frequently decorated with pictorial designs.

Pottery of this sort often illustrates aspects of the everyday life of the prehistoric Indians that are either not found, or are inferred from the fragmentary remains recovered from archaeological excavations.

The Gila Valley in the vicinity of the proposed dam was at least partially abandoned during the period from A.D. 1150 to 1300, but from A.D. 1300 to about A.D. 1400 or 1450 the valley population increased again as there was an apparent re-occupation of the area by a group of Indians who built adobe-walled surface dwellings and made a distinctive polychrome pottery characteristic of the so-called "Salado Culture" of east-central Arizona.

The Salado villages were abandoned by the mid-fifteenth century, and the area was probably vacant until the arrival of the Apache Indians in the late 1500's or early 1600's. Early Spanish accounts note the presence of the Apache in the Gila Valley as early as A.D. 1620, and they remained in the area until they were placed on reservations about A.D. 1870. In addition to the numerous prehistoric sites along the Gila River, at least one large Apache campsite has been noted in the area by Museum of New Mexico archaeologists.

Archaeological excavations in this area have been conducted along U.S. Highway 180, by the Museum of New Mexico; others have been done by Case Western Reserve University; and an extensive "Salado" site, Kwilleylekia Ruins Monument, has been partially dug and developed as a tourist attraction by the owner of the ruin, Richard Ellison.

Within the town of Gila, New Mexico, about six miles downstream from the proposed dam, are a series of frame and adobe buildings which were the headquarters for the L.C. Ranch, an extensive cattle ranch operated in the area from about 1878 to 1917. Privately owned, the buildings are being renovated and will serve as a cultural exhibit for the general public.

On the west bank of the Gila River, about two and one-half miles downstream from the proposed dam is the Woodrow Ruin, a Mogollon site consisting of over thirty-five pit houses, at least 100 masonry surface dwellings, and two very large community ceremonial lodges. Pottery found on the surface of the site indicates a long period of occupation from about A.D. 500 to A.D. 1150.

The entire site covers approximately ten acres, and a major portion of it was purchased by the State of New Mexico in 1971. The Woodrow Ruin is recorded on

both the National Register of Historic Sites and the State Register of Cultural Properties..

Designated "Mimbres State Monument," the site will be excavated and developed as an educational exhibit by the Museum of New Mexico. A visitor center will be constructed adjacent to the site, and additional land will be purchased to provide picnicking and parking areas and to ensure the environmental and aesthetic integrity of the site.

A special effort was made by the State of New Mexico to acquire an archaeological site of the cultural affiliation and degree of preservation that it has. The spectacular Mimbres pottery with the pictorial decoration is widely known and sought after by relic hunters, dealers in antquities, and collectors of primitive art. This interest has led to the pillage of most of the major Mogollon sites in southwestern New Mexico. Sites have been leased by relic hunters in search of the distinctive pottery vessels which are characteristic of the Classic Mimbres Phase of the Mogollon Culture. Such vessels can be sold for hundreds, and even thousands, of dollars by antiquities dealers. Consequently, many prehistoric sites along the Gila and Mimbres Valleys have been systematically mined, both on private and public lands, to the point whererelatively few undisturbed Mogollon sites remain.

With such sites in extremely short supply and of great public interest, it was felt that it was essential that at least one major site of this culture be acquired to preserve it from wanton destruction and to develop as an educational monument.

2. Will archaeological sites be adversely affected by the construction of Hooker Dam?

In addition to the Woodrow Ruin mentioned above, archaeological surveys have located at least three sites within one-quarter of a mile of the damsite, and six other sites have been recorded downstream within three miles of the damsite. These surveys, as well as those along Mogollon Creek, are incomplete, but indicate the likely presence of other archaeological sites within a three mile radius of the proposed dam.

At least some of these sites will necessarily have to be destroyed by the construction of the dam, removal of earth from borrow areas, building of access roads, establishment of temporary housing and construction service areas, and clearing of vegetation from construction areas.

The greatest adverse effect may be in the vicinity of Mimbres State Monument. A broad, grassy flat,

immediately adjacent to the north boundary of the Monument has been suggested as a possible source of earth fill for the dam. Similar functions might be contemplated for the low gravel ridges to the north and west of the Monument on the west side of State Highway 293. Removal of fill from any of these areas would be severely detrimental to the development of the Monument, since one of the main attributes of the area that led to the selection of the Woodrow Ruin for a state monument was relatively undisturbed nature of the lands adjacent to it and the general scenic beauty of the area--particularly the views to the north and northeast toward the Gila Wilderness area.

It is obvious that construction of the proposed dam will require substantial modification of the topography in the vicinity of the damsite, and at least some of this disturbance would be visible from the Monument, even as the terrain exists today. However, removal of earth fill from either the adjacent meadow or the gravel ridges to the north and west would not only expose more of the main constraction area and disturbed lands to the view of visitors to the Monument. It would also leave huge scars in the landscape close to the Monument in place of the undisturbed natural environment which is integral to

to the effective display and interpretation of the Monument. Similarly, clearing of cottonwood trees and other riverine vegetation in the valley bottom north and east of the Monument would involve a detrimental modification of the natural surroundings as they are viewed from Mimbres State Monument.

3. Will archaeological sites be adversely affected after the completion of the dam?

At least three archaeological sites are known to exist within the pool limits of the reservoir less than three miles upstream from the damsite. U.S. Forest Service archaeologists have recorded additional sites upstream within or close to the withdrawal area of the reservoir. Their precise locations, extents, and significance are not fully known from the incomplete survey conducted.

In view of the fact that one of the important functions of the reservoir will be recreation, other archaeological sites located above the pool limits, within the withdrawal area, and even outside the withdrawal area, will be rendered more accessible via boats. Relative inaccessibility has helped to protect such sites from the irresponsible vandalism which is so evident in those parts of southwestern New Mexico which are currently more easily reached. Sites bordering the reservoir will certainly be

subjected to pot hunting by unauthorized people and inadvertant disturbance by those without illicit intentions who are simply exploring. Other sites may be affected in those areas to be developed for camping, picnicking, and boating marinas.

A possible later adjunct of the dam is the proposed cold water trout hatchery whose location downstream may involve the disturbance of other archaeological sites.

A concomitant impact both during and after the construction of the dam is the increased land use for residential and commercial purposes. Construction workers will require housing and services in an area where these are in short supply. The general public making use of the recreational facilities afforded by the reservoir will have similar requirements. New homes, stores, and other services built on vacant land along the Gila River may involve the destruction or disturbance of archaeological values in the area.

c. Probable Adverse Environmental Effects which Cannot Be Avoided.

At least some archaeological sites at the damsite, within the pool limits, in borrow pits, along access roads, and in construction service areas will be either totally destroyed, damaged, or inundated because it is simply

impossible or impractical to avoid them.

d. Alternatives to the Proposed Dam.

An alternate dam location, south of Cliff, New Mexico, near the mouth of Mangas Creek, is currently being considered. Selection of this alternate would totally negate the adverse impact that would have existed at Mimbres State Monument.

However, depending on the precise location and design of the alternate dam, at least fifteen archaeological sites of various sizes would lie within its construction areas and pool. One would expect that there are few, if any, locations along the Gila River which were not settled by prehistoric Indians. Thus, alternate dam locations will not provide all the solutions to problems of adverse impacts on archaeological remains.

e. Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity.

The state multiple uses of the proposed dam and reservoir include some which will be of local benefit. These are primarily benefits of recreation, fish and wildlife conservation, flood control, and some improvement of economic conditions. River regulation will determine the degree to which benefits accruing to downstream water

users will be balanced by local benefits, and vice versa.

Maintenance of a reservoir level that will promote continued use of the area for water-related recreation will also enhance the cultural values of the prehistoric and historic sites in the vicinity. Greater public use of the reservoir will certainly mean increased visitation at Mimbres State Monument, Kwilleylekia Ruins Monument, and the L.C. Ranch. Hopefully, this will result in a greater appreciation of our cultural heritage on the part of the people who view the sites.

f. Irreversible and Irretrievable Commitments of Resources Which Would be Involved in the Proposed Dam Should It Be Constructed.

The removal of natural earth deposits, and the fragile plant environment which covers them, for use in the construction of the earth-fill dam will leave un-natural voids in the landscape within view of Mimbres State Monument. Since the natural environment figures so prominently in the description and interpretation of the prehistoric Indians and their use of the Gila Valley, these voids would constitute gaps in, or falsification of the "fossil" environment and lifeways of the earlier inhabitants of the Gila Valley which the several monuments are striving so diligently to reconstruct or preserve.

Clearing of vegetation within the construction areas which will be vacated when the dam is completed may be compensated for by replanting. However, vegetation

recovery is likely to be slow, and the sterile scars will be clearly evident and aesthetically displeasing if they are visible from any of the nearby recreational or cultural facilities.

5. Steps to Minimize Harm.

1. Any construction or post-construction use of the area between Mimbres State Monument and the proposed damsite, such as a construction camp, borrow pit, maintenance yard, overhead powerlines and telephone lines, parking or equipment storage area, roads, concessions, etc., which will intrude upon the prehistoric scene and the environment of the State Monument will be avoided.

2. A complete archaeological survey will be made of all construction areas, pool area, and adjacent withdrawal areas.

3. Appropriate measures will be taken to preserve and protect those archaeological sites which, though close to construction areas or prposed recreation facilities, will not be damaged or destroyed by construction.

4. Sites found to be within construction areas and pool limits will be excavated to salvage data and artifacts that would otherwise be lost.

5. Construction contractors shall be informed that they will be held responsible for disturbance to, or illegal digging of, archaeological sites by their employees, sub-contractors, and their families within the construction and reservoir areas, as well as in such adjacent areas where Federal or State antiquities laws apply.

6. As part of their normal security procedures, construction contractors shall be responsible for preventing unauthorized non-employees from entering construction and pool areas for the purpose of digging in or otherwise disturbing archaeological sites.

7. Upon completion of construction, those areas disturbed by construction shall be properly sloped and revegetation undertaken to minimize erosion which might otherwise disturb nearby archaeological sites or be aesthetically detrimental as viewed from Mimbres State Monument.

8. Planning and construction of recreation facilities, fish hatchery, roads, and the like shall be coordinated with the administrators of the several cultural monuments in the area to prevent undesirable encroachment of structures into the areas of interest or fields of view of the monuments.

APPENDIX A

The Woodrow Ruin

Location- As per Records of Deeds, Grant County, New Mexico, Book 176, Page 281. October 22, 1971.

A part of the Southwest Quarter (SW¼) of Section Six (6), Township Fifteen (15) South, Range Sixteen (16) West, N.M.P.M., Grant County, New Mexico, more particularly described as follows:

BEGINNING at a point 3804.00 feet South and 212.02 feet East of the Northwest Corner of Section 6, T. 15 S., R. 16 W., of the N.M.P.M. in Grant County, New Mexico; running thence S. 30°55' E., 151.80 feet; thence S. 88°21'06" E., 296.80 feet; thence N. 59°58'06" E., 119.02 feet; thence N. 11°11'30" E., 552.30 feet; thence N. 80°26'18" W., 241.08 feet; thence S. 64°41'06" W., 228.60 feet; thence S. 19°08'12" W., 428.53 feet to the point of beginning. Containing 6.26 acres more or less.

"Referred to as Woodrow Ruin"

The Woodrow Ruin is the property of the State of New Mexico, specifically the Museum of New Mexico. It has been designated Mimbres State Monument. Additional lands are being sought to provide for a visitor center, picnicking areas, service areas, and sufficient lands to maintain the visual integrity of the site.

State of New Mexico

GOVERNOR
BRUCE KING

DIRECTOR AND SECRETARY
TO THE COMMISSION
LADD S. GORDON

DEPARTMENT OF GAME AND FISH

STATE CAPITOL
SANTA FE
87501

STATE GAME COMMISSION
FLOYD TODD, CHAIRMAN
CENTRAL
ALVA A. SIMPSON, Jr.
SANTA FE
EDWARD MUNOZ
GALLUP
ALBERT J. BLACK
ALBUQUERQUE
ROBERT H. FORREST
CARLSBAD

March 7, 1972

Mr. E. A. Lundberg
U. S. Department of the Interior
Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

The contents of your draft publication, Environmental Statement Central Arizona Project, appear to be this statement: "Significant long-term benefits will be accrued from mitigation and enhancement features associated with the four reservoirs, certain sections of stream, and along the aqueduct route. Primarily, there will be available a dependable source of water. At the present time, no dependable supply of water is available. Long-term primary benefits derived from agricultural, industrial and domestic use of project water will be significant."

"Significant" within New Mexico refers to 18,000 acre feet of water to be divided according to preference assigned by the Inter-State Stream Commission. In light of the total water derived from the Central Arizona Project to down stream users this 18,000 acre share does not appear as significant as it might.

The New Mexico Department of Game and Fish wishes to acknowledge that congressional action has alloted 18,000 acre feet of water for municipal, agricultural and wildlife uses. Further acknowledged action involves rate sharing among interested parties as tentatively allocated. In this Environmental Statement review the New Mexico Department of Game and Fish wishes to relay the need for a mitigation allotment review by the C.A.P. water-sharing authorizing authority. This department would further state that the need for 20,000 acre feet of water in the Gila Watershed for future wildlife and recreational projects would contribute to the state's economy as a whole and to the Gila Valley in particular benefits which one thought deserving within the scope of this project. To strive for less would be an injustice to the potential resource development within this portion of New Mexico.

Since the Gila River serves as a watershed whose downstream users will now have available supplemental resources, a timely reservation of Gila waters should be reserved in the area where the most good will be derived

from the Gila waters; that is, in the Upper Gila watershed itself.

During the remaining portion of this statement areas where a justifiable mitigation program appears to be most desirable will be pointed out. Also some questions of the text's accuracy will be discussed.

It is felt that the C.A.P. project will bring to the economy of New Mexico a short term constructional benefit followed by a long term fishery benefit. Careful location of the Upper Gila dam site will establish a valuable fishery and recreational facility. Alternate site locations to the Hooker site could be destructive of habitat of wildlife species rare in New Mexico. These species we feel should be included on your list of birds on page 24, even though they are not considered rare and endangered species. The following 15 species we would like included on your list.

1.	Great Blue Heron	Ardea herodias
2.	Green Heron	Butorides virescens
3.	Black-crowned Night Heron	Nycticorax nycticorax
4.	Yellow-crowned Night Heron	Nyctanassa violacea
5.	Grey Hawk	Buteo nitidus
6.	Mexican Black Hawk	Buteogallus anthracinus
7.	White-winged Dove	Zenaida asiatica
8.	Yellow-billed Cuckoo	Coccyzus americanus
9.	Elk Owl	Micrathene whitneyi
10.	Gila Woodpecker	Centurus uropygialis
11.	Wied's Crested Flycatcher	Myiarchus tyrannulus
12.	Lucy's Warbler	Vermivora luciae
13.	Cardinal	Richmondena cardinalis
14.	Indigo Bunting	Passerina cyanea
15.	Abert's Towhee	Pipilo aberti

A dam located at either of two proposed alternative sites could inundate a portion of already scarce habitat now occupied partially or totally by these species in New Mexico. One important big game species, bighorn sheep, could also be adversely affected by dam site selection. Therefore, until site selection is definite, reservations must be made as to validity of your statement on page 24 that, "construction of the project is expected to have only minimal effect on rare and endangered forms."

The New Mexico Department of Game and Fish would like to request that any consideration of dam site locations other than the Hooker site be fully discussed. The site selection may prove critical to continued existence of certain indigenous species and their habitat. The project engineer, in a meeting at Silver City on May 4, 1971, intimated that several alternative sites were real possibilities, whereas this proposition is given only passing mention in the report.

Attention is now directed to the statements of doubtful accuracy within your publication.

> Page 24, # 4.: "The flow of these rivers (Salt, Gila, and San Pedro) in the vicinity of the four proposed dams has already been altered by previous construction."

The Gila River upstream from Cliff, New Mexico has three small structures and some irrigation which we feel does little to regulate stream flow. Your statement tends to denote major stream regulatory structures which we feel is not apropos of the true situation. Assuming 600 surface acres evaporation per year from impoundment and irrigation then this would amount to 0.828 average flow reduction per day passing the Hooker site.

> Page 41, # 8.d.: "Fish and wildlife habitat will be improved around the reservoir and on the streams above and below the impoundments."

This statement must be challenged. The opposite will surely occur with the reservoir construction, excepting the fishery itself. First, as you noted, riparian vegetation within the lake will be inundated. Along with this, a flood plain of silt will occur in the upper lake and fluctuate in size with the lake level. This plain will have little wildlife value and will replace existing habitat. Wildlife habitat farther upstream will not be influenced by the lake's existence; it will remain static. This area will, however, be adversely affected by the physical disturbance factor of the additional 69,400 man-days' use concentrated along the reservoir site.

Below the dam a regulated stream flow will tend to concentrate the riparian vegetation adjacent to the established stream side. Natural flooding of an unregulated stream disperses seeds and waters plants along the entire stream bottom. A regulated stream flow would prevent this. Also, no riparian vegetation will become established around the reservoir slopes as the soil and terrain do not lend themselves to this ecosystem encroachment. For the reasons stated above, your statement regarding beneficial factors to the habitat appear to be in error. Without question the riparian ecosystem will be adversely affected.

Mitigation features for expected losses and degradation of habitat to the inundated area and upstream and down from the impoundment should be noted in your statement. As pointed out previously, damages are expected and your cooperation will be sought in alleviating these. Several considerations as possible mitigation features are hereby provided but do not exclude others:

1) Pot hole and marsh development along the Cliff-Gila area as a habitat enhancement for this area. The Cliff-Gila area is considered extremely important to survival in New Mexico of the birds listed previously in this paper.

2) A gravitational flow structure to divert water from the Gila River through the Red Rock game pastures and back to the river to enhance upland and migratory bird habitat on state and federally owned lands.

3) Development of small fishing and recreational reservoirs or enlargement of existing structures. Besides providing recreational use, these structures would further reduce small stream

flooding and improve water quality and stability along the Upper Gila River tributaries at no additional cost to the project.

Hopefully these several points will be given consideration in the final C.A.P. program, especially the proposed mitigation factors. By these factors, New Mexico will receive consideration through a more equitable water sharing plan than has been proposed and thereby bring into force in the Gila Watershed the stated national policy to "--encourage productive and enjoyable harmony between man and his environment-- and to promote efforts which will prevent or eliminate damage to the environment and the biosphere." Or at least your efforts will then show good faith toward their objective.

Perhaps it has been overlooked, but no mention is made in the report of plans for channelization, channel modification, or phreatophyte control along the Gila in New Mexico. These activities, if contemplated, would be so damaging to wildlife habitat in New Mexico that they would negate any expected benefits of the project. This point should be throughly understood at this time and commitments guaranteeing no work of this kind will be made in the Gila main stem should be incorporated in your final draft.

Thank you for the opportunity to review and comment on this project proposal.

Very truly yours,

Ladd S. Gordon
Director

NEW MEXICO INTERSTATE STREAM COMMISSION

BATAAN MEMORIAL BUILDING
STATE CAPITOL
SANTA FE, NEW MEXICO 87501

COMMISSIONERS

I. J. COURY, Chairman, Farmington
S. E. REYNOLDS, Secretary, Santa Fe
J. P. WHITE, JR., Roswell
DRAPER BRANTLEY, Carlsbad
ALVIN M. STOCKTON, Raton
BENJAMIN M. SHERMAN, Deming
WALTER BAMERT, Las Cruces
EDWARD J. APODACA, Albuquerque
RICHARD P. COOK, Espanola

LEGAL ADVISERS

CLAUD S. MANN, Albuquerque
CHARLES M. TANSEY, Farmington

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Action:
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Date	Initials	To
10/26	RC	153
10/27	JOA	150
10/27	[illegible]	155
File		

October 21, 1971

Mr. E. A. Lundberg
Regional Director
Region 3
Bureau of Reclamation
P O Box 427
Boulder City, Nevada 89005

Dear Ed:

Your September 24, letter transmitted for our review and comment a copy of your September 1971 Draft of Environmental Statement for the Central Arizona Project, Arizona-New Mexico. Following are our comments:

Page 3, first sentence. This sentence, read in context with the preceding paragraph on page 2, could allow the inference that the State of Arizona was allocated 2,800,000 acre feet of water annually by the Colorado River Compact. I suggest the sentence be deleted.

Page 13, next to the last sentence. The report states that two dam sites on the San Francisco River are being investigated as possible alternatives to the proposed Hooker Dam. It is our view that, for the first state development in New Mexico authorized by P L 90-537, dam sites on the San Francisco River are not suitable alternatives to the proposed Hooker Dam because of several factors, including reservoir yeild and the additional conveyance facilities including additional pump lift required to deliver water to the prospective M & I uses located in the Tyrone-Silver City-Bayard area. Investigation of the two dam sites as a part of the feasibility investigations of comprehensive development proposed in the Upper Gila River Project, Arizona and New Mexico is appropriate.

We appreciate very much the opportunity to review and comment on this environmental statement.

Sincerely,

S. E. Reynolds
Secretary

SER:PBM:b

STATE OF NEW MEXICO
Environmental Improvement Agency

P. O. Box 2348, Santa Fe, New Mexico 87501

January 19, 1972

■ SPECIAL PROJECTS SECTION

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Room 215
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1/21	ZPS	1570
1/21	[illegible]	1575
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Mr. A. E. Lundberg
Regional Director, Region 3
U. S. Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

We have reviewed the September 1971 Draft Environmental Statement on the Central Arizona Project and offer the following comments.

The project feature of principal concern to New Mexico is Hooker Dam on the Gila River.

a. We note the reference (pp. 46-48) to the anticipated impact from permanent residents and increased tourism, commonly associated with the development of new reservoirs, in altering existing surroundings. Although the expected infringement of the maximum pool upon the Gila Wilderness area is only 165 acres, construction and public use areas will involve additional acreage. In principle, we favor the preservation of wilderness areas and resist encroachment thereon. We believe that the traditional limitations on allowable travel modes within wilderness areas should be maintained, and we question the advisability of providing such easy access as will promote significant additional public use, pressures for development, and generation of additional solid and liquid waste.

b. We are concerned over the ultimate impact (in terms of permanent scars and drainage and erosion problems) of excavation of material for the dam construction, and of the construction of additional roads and trails.

c. The Agency has strong reservations in regard to the use of herbicides and pesticides (p. 39). Pesticides are toxicants and may therefore have an impact on terrestrial as well as aquatic organisms which are exposed to the material. It is important to realize that pesticides do not stay where they are initially applied. Pesticides move through drift, volatilization, movement of air or water borne soil

particles and runoff. It is impossible to judge the impact of unspecified maintenance activity. Therefore, we are concerned over the possible usage of pesticides for

(1) mosquito control
(2) control of aquatic weeds
(3) rough fish removal
(4) control of terrestrial vegetation
(5) control of unwanted animal population which may develop in the area.

The Agency recommends, in general, that herbicides be prohibited for clearing, thinning, or maintenance. If herbicides or pesticides are to be used within New Mexico, the Agency, based upon the results of use of herbicides in 1971 in phreatophyte removal in the Middle Rio Grande Valley, requests advance notification of the following items:

(1) specific types of herbicides or pesticides to be used
(2) areas of application
(3) volumes of active ingredients
(4) method of application
(5) proposed dates of use
(6) techniques for storage and safe disposal of containers
(7) measures for supervision and control of the foregoing operations.

d. In addition to the specific expected impact of Hooker Dam and Reservoir cited on pp. 34-35, we would anticipate:

(1) Probable increased production of mosquitoes (disease-carrying and nuisance varieties), unless proper slopes and pre-fill clearance of bank vegetation are provided and water management practiced to avoid stagnant breeding areas.

(2) Additional solid and liquid waste problems from increased recreational use, unless suitable facilities are provided.

(3) Sedimentation within the reservoir with possible pesticide/herbicide retention and shallow mosquito ponds at certain operational stages.

e. In regard to the possible establishment of a trout fishery below the dam, we believe that special care will have to be given to the design and operation of the dam to provide adequate flow of water of suitable temperature.

We offer the following comments in regard to the entire project:

a. We are unable to share the optimistic view set forth on page 40 that 'The development of technology, hopefully, will allow areas in the future to support larger populations with minimal detrimental impacts on the environment while still maintaining a high quality of life.' We believe that advanced technology combined with a high standard of living tends to aggravate rather than to reduce

detrimental environmental impacts. In any case, even though technology may cope with air and water pollution, it does not respond to the psychological human needs for open space, privacy, and freedom from noise and other environmental stresses.

Consequently, we believe that the alternatives suggested in pp. 48-51, and others, need to be seriously considered. We believe that the full social costs (including an appreciation of the environmental degradation and of the cost of pollution abatement from power generation associated with the project) should be assessed and weighed against further agricultural growth and industrial development of the project area. We believe that the political premise that water for use in the project area must be taken from below Lee Ferry should be reopened and reviewed without prejudice. If water were diverted at an elevation which would allow gravity flow through a tunnel, (instead of requiring a total lift of 1200 feet (p. 6) the power requirements for pumping (561 megawatts, p. 10), could be drastically reduced, thus allowing power from the Navajo Generating Plant to be used to meet other requirements. This action would postpone the need for additional power generating capacity and extend the life of coal reserves in the region. Use of a tunnel would have the further advantage of eliminating evaporative losses in transit. We can provide additional information upon one such alternative plan upon request.

b. We believe that the adequacy of the water allocation for electric generating plant(s) should be reviewed in the light of needs for cooling water and for possible use for pollution control (especially for wet scrubbers for sulfur oxide removal). We believe that wet scrubbers are the most effective means of such control, and we feel strongly that their use should not be foreclosed because of a locked-in water allocation.

c. We believe that in this and other projects the possibility of ground and water contamination by salt or chromate (used for control of algae in cooling towers) carried by drift needs to be considered and preventive measures taken.

We appreciate the opportunity to comment upon this statement, and we regret the untimeliness of this response.

Sincerely yours,

J. H. Hottenroth, P.E.
Chief
Special Projects Section

ccs: State Planning Office, Attn: Mr. A. J. Lobato
Department of Game and Fish, Attn: Mr. Ladd S. Gordon
State Engineer, Mr. S. E. Reynolds

Arizona Water Sports Council

OFFICIAL FILE COPY
RECEIVED OCT 26 1971
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Action Taken (Initials)

Date	Initials	To
10/26	RSJ	153
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PRESIDENT:
CLIVE JORDAN

VICE-PRESIDENT:
FRED RUPPERT

SECRETARY-TREASURER:
GEORGE A. HAHN

BOARD OF DIRECTORS:
CLARENCE ROBERTS
DICK BORN
AL FUNK

3121 North Third Avenue
Phoenix, Arizona
85013

October 20, 1971

Regional Office - Region 3
Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Attention Mr. E. A. Lundberg, Regional Director

Ref: 3-150/120.01

Gentlemen:

Enclosed are comments of Arizona Water Sports Council concerning the draft of "Environmental Statement for the Central Arizona Project." These comments are "unofficial" pending ratification by the Council at our meeting to be held October 27. In brief, these comments recommend:

Relocation of Lake Havasu Pumping Plant, and elimination of the intake channel.

Elimination of Charleston Dam and Hooker Dam from the Project unless it can be conclusively shown that sufficient runoff exists on the Gila-San Pedro system to maintain these reservoirs and San Carlos reservoir and Buttes reservoir, at reasonable levels.

Elimination of proposed side ponds, back-water fingers, and 50 new fishing lakes, and substitution with fewer but larger multi-purpose recreational reservoirs, holding lakes, and terminal storage lakes.

Construction of an extensive system of peaking power pumped storage generating plants.

Encourage the planting of crops whose growing season does not include the summer months.

Mr. E. A. Lundberg October 20, 1971

We appreciate the opportunity to comment on this Project, and request the opportunity to further comment on its specific elements as they progress into more definitive plans.

Sincerely,

Clive N. Jordan, President
Arizona Water Sports Council

Encl.

ARIZONA WATER SPORTS COUNCIL COMMENTS

CONCERNING

DRAFT OF ENVIRONMENTAL STATEMENT

CENTRAL ARIZONA PROJECT

I. INTAKE CHANNEL, LAKE HAVASU

The channel as proposed will require cuts through four peninsulas projecting into Lake Havasu, and rock fill between the lake proper and the intake channel. Despite some scars created by exploratory work and by owners of private land, this is still one of the more spectacular scenic areas of Lake Havasu. As proposed, the intake channel and pumping plant will detract materially from existing scenic values.

We suggest relocation of the pumping plant to the area west of Havasu Springs resort. This location should eliminate the need for the intake channel. In addition, the pumping plant and switch yard would be in an area of existing man-made structures.

The construction of a public launching ramp and parking area in conjunction with the pumping plant and switch yard at this location could be considered. The existing ramp and parking area are wholly inadequate.

II. ORME DAM

We support the construction of Orme Dam, but we wish to defer comment pending more detailed statement of the project features. Recreational features, including launching ramps, parking areas, day use areas, overnight areas and areas designed specifically for competitive boat racing and water skiing should be considered.

III. CHARLESTON DAM AND HOOKER DAM

There is now one major reservoir on the Gila which has never filled. Now three new major reservoirs (including Buttes) are proposed. With insufficient water to fill one reservoir, how is it proposed to obtain water for four reservoirs? We recognize the shortage of water-oriented recreational development in the vicinity of Tucson. We believe, however, that the construction of major dams at the Charleston and Hooker sites is unwarranted unless it can be demonstrated that their reservoirs can be maintained at reasonable levels. We will herein subsequently propose alternatives to the recreation and water storage benefits of these dams.

IV. BUTTES DAM

We support the construction of Buttes Dam, but defer further comment pending a more detailed statement of project features.

V. GREENBELT PARKS, WILDLIFE WATERING SITES

We support the incorporation of these features. Park sites at major highway crossings should be considered, as well as sites in proximity to urban areas. Selection of these sites should be coordinated with the Arizona Highway Department and appropriate state, county, and municipal parks departments. Selection of wildlife watering sites should be by the Arizona Game and Fish Department.

VI. FLOW THROUGH SIDE PONDS AND BACK-WATER FINGERS

We cannot support the construction of these features. We will subsequently propose alternatives. We object to these structures on the basis of size. They are too small for use of powered water craft and too large for safe use as swimming areas unless highly regulated. Conventional swimming pools in conjunction with greenbelt parks would seem more appropriate.

VII. 50 NEW FISHING LAKES

We generally support this concept, but suggest fewer lakes be constructed and that where feasible they be larger and multi-purpose. As with the side ponds and back-water fingers, the large number involved combined with their small size may make effective economical management difficult.

VIII. EVAPORATION RATE

An evaporation rate of 4 acre feet of water per surface acre of aqueduct or reservoir is contemplated. This is lower than generally used, and especially lower than used when water salvage projects are being considered. Elimination of Charleston and Hooker Dams would reduce this figure.

IX. ALTERNATIVE SUGGESTIONS TO CHARLESTON AND HOOKER DAMS: FLOW THROUGH SIDE PONDS: AND 50 NEW FISHING LAKES.

ASSUMPTIONS:

A. The need for water recreation in close proximity to metropolitan areas will increase.

B. There is not sufficient natural flow in the Upper Gila system to maintain adequate minimum pools for recreational use in Charleston, Hooker, Buttes and San Carlos reservoirs.

C. Since the C.A.P. Aqueduct system will be operated year around and the heaviest water usage is April through September, there must be adequate storage for C.A.P. water transported during October through March, plus adequate storage for natural runoffs which are usually heaviest in April and May.

D. The demand for electrical power, particularly "peaking" demand power, will continue to increase in Arizona and the Southwest.

E. Planning lead-time of new electrical generating facilities will increase due to opposition of well-meaning but misinformed environmentalists.

F. Arizona water deficit will continue, even with the C.A.P. and heavy runoff from Arizona's water sheds.

SUGGESTIONS:

A. Construct fewer but larger side ponds; or mainstream wide areas for general recreation and boating use. These could be on the order of the Sun Valley Marina south of Phoenix.

SUGGESTIONS (CONTINUED):

B. Construct a holding reservoir on the Agua Fria River below Lake Pleasant with pumped-storage power generation at Waddell Dam.

C. Construct a pumped-storage power generation system in Stewart Mountain Dam, between Orme reservoir and Saguaro Lake.

D. Construct a pumped-storage power generation system in Roosevelt Dam between Apache Lake and Roosevelt Lake.

E. Consider construction of an additional dam on the Verde River at the upper end of Orme reservoir with two pumped storage power generator systems, one in the new dam and one in Bartlett Dam.

F. Consider raising the elevation of Roosevelt Dam if it is determined additional storage is necessary on the Salt-Verde System.

G. Install a pumping plant at Buttes Dam and use Buttes reservoir as a terminal storage facility.

H. Enlarge and deepen Picacho reservoir as a holding reservoir and major diversion point.

I. Construct a holding reservoir at Tucson as a terminal reservoir and recreation site.

J. Encourage agricultural crops whose growing season does not include the summer months.

K. The lakes described in "A" could be in fore-bay and after-bay of pumping plants. Pumping plants would be turned off 6 to 8 hours per day during peak power usage. With fore-bay lakes at low level and after-bay lakes at high level, there would be sufficient water to maintain aqueduct flow.

L. In the event of "spills" from Buttes Dam, the Salt-Gila Aqueduct should be designed to flow backwards with surplus being stored in Orme reservoir.

M. Consider dredging behind Granite Reef Dam with maintenance of an intensively managed trout fishery.

N. Consider raising Granite Reef Dam, using it as a regulatory after-bay for peaking power generation at Orme Dam.

O. Consider dredging behind diversion dam near Coolidge with maintenance of an intensively managed trout fishery.

P. Consider raising diversion dam near Coolidge, using it as a regulatory after-bay for peaking power generation at Buttes Dam.

10/21/71

Arizona Water Sports Council

PRESIDENT:
CLIVE JORDAN

VICE-PRESIDENT:
FRED RUPPERT

SECRETARY-TREASURER:
GEORGE A. HAHN

BOARD OF DIRECTORS:
CLARENCE ROBERTS
DICK BORN
AL FUNK

3121 North Third Avenue
Phoenix, Arizona 85013

November 1, 1971

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Regional Office - Region 3
Bureau of Reclamation
P. O. Box 427
Boulder City, Nevada 89005

Attention Mr. E. A. Lundberg, Regional Director

Ref: 3-150/120.01

Gentlemen:

At our meeting of October 27, our comments concerning the Central Arizona Project environmental statement (sent to you with our letter of October 20), were approved by the Arizona Water Sports Council.

Very truly yours,

Clive N. Jordan

ARIZONA WILDLIFE FEDERATION
P.O. Box 1769 • Phoenix, Arizona 85001 • Phone 602-253-4903

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November 10, 1971

Mr. F. Phillip Sharpe,
Environmental Specialist
BUREAU OF RECLAMATION
P.O. Box 427
Boulder City, Nevada 89005

Dear Phil:

I'm going to wrap up a number of responses in this one letter to get back even with the Group after missing the first meeting.

First off, the Bureau must be commended for its approach in setting up the Advisory Group. Complete and honest disclosure of all aspects of the project will, in the long run, be most beneficial. A resolution to this effect was passed by the Arizona Wildlife Federation last January, as you probably know. Not wishing to categorize individuals, for I'm sure we are all interested in the welfare of Arizona and its environmental protection, it appears to me the Group is well balanced.

Secondly, with respect to the General Environmental impact state of the CAP, it is just that, general. It would be difficult to comment on specifics, however, as a starting place, fundamentally, it's good.

Thirdly, with respect to the Draft Environmental Statement, Havasu Intake Channel and Havasu Pumping Plant Site, my limited comments are written in the enclosed copy. I particularly like the change from a straight form enbankment to a more natural free flow design, preservation of Heron Island, and safeguard against fish losses, should they occur.

In closing, thank you for the opportunity to fly the proposed route of the Central Arizona Project last week. For the record, I envision the major obstacle to the CAP being certain ambiguous provisions in the Colorado River Basin Project which calls, or at least alludes to

possible water salvage or vegetation manipulation projects which will most certainly be challanged on their economic, social and environmental impact.

Representing the Arizona Wildlife Federation, I look forward to working with the Group in the coming years.

Cordially,

Thomas J. Sullivan,
President
ARIZONA WILDLIFE FEDERATION

TJS:is

encl.

cc: Mr. Ellis Armstrong
Mr. E.A. Lundberg
Mr. Robert A. Jantzen
Mr. Joe Clifford, III
Mr. Ray Killian
Mr. F. J. MacDonald
Mrs. Stephen Detzer
Mr. Rich Johnson
Mr. Robert G. Worden

Museum OF NORTHERN ARIZONA

4 October, 1971

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Mr. E. A. Lundberg
Regional Director
United States Department of the Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Re: 3-file 50/120.01

Dear Mr. Lundberg:

In response to your 24 September 71 letter and copy of the Draft of the Environmental Statement for the Central Arizona Project (CAP) here are my comments.

Overall, CAP will not produce any direct adverse health effect except as it depends on 24.3% of the generation of the Navajo Generating Station which emits air pollutants.

First of all, the Environmental Statement (E.S.) should compare the relative merits of an open aqueduct and a closed underground pipeline. The latter alternative leaves a scar which slowly heals with revegatation, but an open aqueduct produces an everlasting aesthetic change on the landscape. Evaporative loss is much higher with an open aqueduct.

In the prefacing summary of environmental impacts, the statement that "The human aspects will be benefited by the development" is an economic conclusion, and the next sentence mentions "..an expanding population" which is guaranteed to stress the environment further.

The discussion of the various reservoirs in CAP should include an analysis of the water lost by evaporation in these impoundments. The use of before and after (by artists' conception) pictures is a good procedure to show aesthetic impact on the environment.

The discussion of wildlife watering ponds, guzzlers, and fingers does not mention the extent that wildlife urine and feces might contaminate the main canal water. Also, if such wildlife watering facilities should be included, then CAP should fund their construction. Placing the expense of these features on other agencies would

FORT VALLEY ROAD · P. O. BOX 1389 · TELEPHONE 774-2433 · FLAGSTAFF, ARIZONA 86001

be like asking the Sierra Club to pay for air pollution control devices of the Navajo Generating Station.

The E.S. should analyze the possibility of placing the powerlines underground within the right-of-way.

There should be discussion of revegetation of the excavated material placed away from the canal.

On page 34, there is mention that "Further positive or negative environmental changes may result from the impact of the predicted heavy recreation use that will develop at this new facility." I would like to know of any possible positive environmental change that can come from heavy recreation use.

On page 40, it is true that population will continue to increase in the foreseeable future with or without CAP, but the rate of increase will probably be higher with CAP than without it. The present overdrafting of ground water is an artificial support of Phoenix and Tucson and the agriculture of that area. CAP will be a new artificial support that will encourage further growth of these entities, increasing the various stresses on central Arizona's environment.

On page 41, CAP will supposedly enhance the quality of the environment through "..continued economic health." and "Water-oriented recreation opportunities..." Both of these things lead to the destructive pollution of air and water, through industry and motor boats, respectively.

Sincerely,

Eric G. Walther

Eric G. Walther
Coordinator of Environmental Studies
Museum of Northern Arizona

EGW/bf

Info. copy to 700

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No. P 238905

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Your ref: 3-150/120.01

SIERRA CLUB

FOUNDED IN 1892

Southwest Regional Conservation Committee

5120 West Via Mallorca
Tucson, Arizona 85705
26 October 1971

Mr E A Lundberg, Regional Director
Region 3, U S Bureau of Reclamation
Post Office Box 427
Boulder City, Nevada 89005

Dear Mr Lundberg:

Thank you for your letter of October 4th (ref: 3-720/123.8b) and for the copies of the draft environmental statement for the Central Arizona Project which you have sent us for comment. Reference is also made to the exchange of correspondence between your office and myself with regard to Hooker Dam and Reservoir, which includes your letter of 18 August 1970 (ref: 3-700/010.3), and mine of 15 September 1971, with which I sent a copy of Dr John P Hubbard's "The Summer Birds of the Gila Valley, New Mexico."

This letter is a coordinated statement of the Sierra Club position concerning the CAP draft environmental statement.

Our basic reaction to the draft is that it is inadequate in the information presented and does not meet the requirements or the intent of the National Environmental Policy Act of 1969. It is replete with statements which are obviously subjective and are not justified by data given anywhere in the document. As it now reads the statement cannot be used as the basis for valid decisions with regard to the environmental impact of the CAP. Of course, we realize that it is now only in draft form and that it will undoubtedly be much altered in the rewriting for the final version. We hope that you will find our comments useful.

We concur in your plan to prepare and submit separate environmental statements for each individual unit or feature of the project. On the other hand, we are not certain of the meaning of your statement that the submittal of these separate studies will follow site selection and design, for in order to comply with the National Environmental Policy Act these statements should be submitted prior to any decision with regard to site selection and design.

Important also is the fact that the environmental impact of the project cannot be effectively considered fragmentarily. The project as a whole has an environmental impact of its own which must not be neglected, and this cannot be assessed until the individual impact of the component units is known.

The National Environmental Policy Act of 1969, as interpreted and expanded upon by the Guidelines published by the Council on Environmental Quality, requires the preparation and processing of environmental statements for projects which were authorized prior to the passage of the Act but have not been implemented. This means that the consideration of such projects, both as a whole and with respect to their components, is reopened, and they must in effect be revalidated. A complete rethinking of the choice of alternatives is an important part of this process.

The facts of this situation are at variance with points made by you and your

predecessor in the correspondence referred to above. The fact that Congress, "in its wisdom" to quote your letter of 4 October 1971, has authorized a certain project prior to the passage of the National Environmental Policy Act in no way contradicts the requirement for revalidation.

Moreover, the CAP was authorized in 1968, three years ago. During this period there has been steady inflation to the extent that the appropriation authorized by Public Law 90-537, which was $832,180,000, is no longer realistic as an index to what construction of the project may cost. In view of the great increase in costs which can be expected, we feel that there is no way to be fair to the taxpayer except by reopening the consideration of the CAP to see if the people of Arizona actually want it under present conditions. Furthermore, you will remember that it was the Congressional deliberation concerning the CAP that had a lot to do with the present surge of concern for the environment, yet at that time the evaluation of the CAP proper was somewhat beclouded by the overriding issue of the proposed Grand Canyon dams. Taking these facts into account, together with the important one that there has been a phenomenal increase in environmental concern since that time, it is important to learn just how this concern has affected public opinion of the CAP.

Considering together all the points brought out above, we feel that the separate environmental statements for the individual units and features of the CAP should be completed before any of the following: 1) final assessment of the environmental impact of the CAP as a whole; 2) decisions with regard to site selection and design of the several features and units; 3) any request on Congress for appropriations except for studies having to do with site selection and design and environmental impact.

Since it is the people who will have to pay for the project if it is built, we think you must agree that public opinion should be sought out, all expressions from pressure groups such as the Central Arizona Project Association to the contrary notwithstanding. The situation justifies your holding public hearings under the provisions of the CEQ Guidelines, as suggested in my letter of 14 September 1971. Hearings should be so organized as to invite the expression of public opinion on both the Arizona and the national levels. The appropriate time would be after preparation of draft environmental statements for the units and features of the project and a second draft statement for the CAP as a whole.

In the paragraphs following, we comment specifically on various portions of your draft environmental statement.

Summary, Section 3: There is the statement, "The human aspects will be benefitted by the development." This is a subjective judgement and extremely controversial.

Summary, Section 3: Under "Adverse environmental effects", it should be noted that it is not only the biota and esthetics that will be affected adversely by the factors mentioned, but the entire natural regime in the area of the project. At this time we do not actually know all the effects of the project if built (see Section 9, Unknown Effects, Page 45).

Summary, Section 4: To the two alternatives listed as having been considered

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

the following should be added:

"c. Several technological applications which offer at least partial alternatives to the authorized project.

"d. Use of an alternate project area.

"All of the alternatives considered offer net advantages superior to the authorized project. The choice between it and any of the alternatives or between the alternatives themselves is outside the scope of the Bureau of Reclamation."

(INTRODUCTION)

Page 1: With regard to the submittal of detailed statements for each unit or feature of the CAP, please refer to the fourth and following paragraphs of this letter.

(DESCRIPTION OF THE AUTHORIZED PROJECT)

Page 6: It is noted that the Granite Reef Aqueduct is to have a designed capacity of 3,000 cfs. This capacity exceeds by 500 cfs that authorized by law unless Arizona agrees to pay for the increased capacity under the terms of Public Law 90-537. The increased capacity seems wasteful in view of the poor prospect for Colorado River water available to be diverted, and it is not a safe assumption that the River will ever be augmented sufficiently to warrant even the lesser capacity for the aqueduct.

Pages 6 through 9: In the description of the several reservoirs which are units of the CAP, both on these pages and elsewhere, flat statements are made concerning what is expected of each one, for example, the Orme Dam and Reservoir "will provide flood control, sediment control, conservation capacity, and outdoor recreation." These enumerated elements of the function of these units need justification, some being hard to comprehend. In view of the several reservoirs upstream of Orme on both the Salt and Verde Rivers, how can it have any genuine value for flood or sediment control? Can it have any benefit for recreation? It appears more that it will be destructive of recreational diversity through mere duplication of facilities already available. The functions of each unit should be explained and justified. In addition, it should be brought out whether each unit has any relationship to the CAP in its primary function of delivering Colorado River water to Central Arizona.

Page 7: It is stated that the Salt-Gila Aqueduct "will carry project water southward into the agricultural areas of southeastern Maricopa County, and to the agricultural areas bordering the lower Gila and Santa Cruz Rivers in Pima and Pinal Counties." How is the aqueduct to accomplish this unless its entire flow is to be used directly from the ditch? In view of the fact that it passes the Gila River downstream of the Buttes Reservoir, the latter cannot be used for the regulation of flow. Does this mean that an additional reservoir must be constructed by Federal or State authorities for this purpose, including the control of releases into the Tucson Aqueduct? This is an important question from an environmental point of view, since the construction of an additional facility to control the delivery of water would mean additional clutter of the landscape.

Pages 7 and 8: Similar questions arise concerning the Tucson Aqueduct, which must apparently take all water brought south by the Salt-Gila Aqueduct whether it

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

is needed or not in the Tucson area, and then has no place to put the water at its downstream end. Must an additional reservoir be constructed?

Page 8: Besides the need for elaboration of functions already brought out, there is a need to show whether there is any call at all for the Charleston Dam and Reservoir. It will impound a certain amount of water according to the statement, but one wonders if this quantity is available from the San Pedro River. How long will it take the reservoir to fill? Is it not likely to suffer the same fate as the Coolidge Reservoir, never to receive enough water to fill it? Just a glance at the photograph in Figure 7 shows an interesting riparian area that will be destroyed by the reservoir. What are the chances that the unit will deliver the planned performance, and that the benefits provided will outweigh the cost of its construction and operation together with that of the San Pedro Aqueduct and of the environmental damage the two units will do?

Page 9: From whence will come the water to justify the Buttes Dam and Reservoir? We understand that the Coolidge Dam and Reservoir has never performed as planned, since the reservoir has never been filled. What then is the justification for another dam on the same small stream? Furthermore, it apparently has no true function in the CAP, because being upstream of the junction of the Salt-Gila and Tucson Aqueducts it cannot act to regulate flow.

Page 9: It is well known that the Hooker Dam and Reservoir has no actual function in the CAP and that the relationship consists only of a tenuous political tie. The statement should bring out its relationship to the CAP and the details of it. These factors are important to a decision as to whether its benefits, if any, are sufficient to counterbalance its environmental effect and its violation of the Wilderness Act.

(Needs)

Pages 10 and 11: The description of Arizona's water supply troubles does not tell the whole truth, the basic heart of which is that the wonderful ground water resource which has been and is still available has been and still is being callously mined for private profit. This has been possible because Arizona has never had adequate law based on modern hydrological knowledge and sufficient to control and conserve the use of ground water and the resource itself. Certainly the situation has been such that the farmers do not deserve to be rescued by receiving a subsidized augmentation of the water supply available for irrigation, if this is a purpose of the CAP. If the decision is that they must be rescued, then they should be required to pay the full cost of that part of the CAP which is for their benefit.

Page 11, Lines 11-12: The statement is made, "Portions of the ground water reservoir have been completely dewatered in some acquifers." Since this is an important point, the specific aquifers, their size, and their former productivity should be specified.

Page 11, Lines 12-13-14: There is the statement, "Ground water reserves as yet have not been totally exhausted throughout the entire project area." This sentence is very misleading. It suggests that such reserves are on the verge of being exhausted, which is utterly untrue. The estimates of existing reserves in the hundreds of millions of acre feet of water, which have been published by the

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

U S Geological Survey, should be brought out. Otherwise this sentence is a gross distortion of facts, distorting the document in favor of the project.

Page 11, Lines 14-15-16: The last sentence in the paragraph is ambiguous, suggesting imminent danger in the project area with regard to both water quality and supply. This is a most controversial claim.

Page 11, Lines 18-19: There is the statement, "A high capacity well in the project area typically produces water of about 900 ppm TDS." This is an ambiguous statement which can be interpreted in either one of two ways. It could mean, "Any given high capacity well in the area will usually produce water with about 900 ppm TDS." Or, what is more likely the case, "There is a high capacity well in the area which ordinarily produces water with about 900 ppm TDS." The former reading suggests that such a concentration of solids is typical of the area, although this would contradict the statement on Page 38 which states that such concentrations are not average. Of course, the statement on Page 38 also contradicts itself internally. It would be far less misleading to give some idea of the average concentration of dissolved solids in the area as a whole rather than to submit ambiguous statements which seem to favor the project.

Page 11, Lines 18-19: Rather than state gross values for TDS in ppm, it would be more informative and helpful to list the concentrations of various specific minerals as opposed to the unsupported figure which is virtually meaningless.

Page 12: There is the statement: "The rapidly expanding Phoenix and Tucson metropolitan areas and many smaller communities which have municipal and industrial water needs will also benefit." This is either misleading or simply false. Water now used in both Phoenix and Tucson is of better quality (far better in Tucson) than any CAP water will be, and far cheaper. It is not clear to what smaller communities reference is made. It must be shown how the cities and towns can possibly benefit from CAP water.

Pages 12 and 13, split paragraph: The statement with respect to the completion of Orme, Buttes, Charleston, and Hooker Reservoirs are broad and unjustified as already brought out above. The real reason for the inclusion of the Buttes, Charleston, and Hooker units in the CAP is apparently political. They have very little, if anything, to do with the real purpose of the CAP to deliver Colorado River water to the Central Arizona area.

(Project Environmental Protection
Aspects Including Mitigation Features)

Page 13, 2nd paragraph: In speaking of the fact that alternatives are being analysed for all the CAP features, reference is made to possible alternatives for Hooker Dam and Reservoir. It is said that four damsites on the Gila River and two on the San Francisco are being considered. The implication is that only alternative sites for a dam are being considered, rather than seeking an alternative in the full sense of Public Law 90-537, which authorizes Hooker Dam or suitable alternative capable of facilitating the water exchange permitted by the law. We believe that it is possible to design an alternative that will avoid violation of the Gila Wilderness and the Gila Primitive Area and also will avoid damaging the water and riparian areas along the Gila main stream and the San Francisco. We believe this can be done without foregoing any of the claimed benefits of the Hooker proposal, including water

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

exchange, recreation, upstream regulatory storage, and the rest. The concept and evaluation of such an alternative would appear not to be inconsistent with the opinions expressed in the letter from your office to me dated 18 August 1970. Your attention is invited to my letter to you dated 15 September 1971, with which I enclosed a copy of Dr John P Hubbard's "The Summer Birds of the Gila Valley, New Mexico." This paper deals only with birds, but the biota of the Gila Valley include species of other faunal classes which are unique in the United States, and the plants are interesting too. Perhaps most important is that the biotic communities as a whole are interesting and unique. The San Francisco, a tributary of the Gila, has generally the same biotic characteristics. If you wish information of the Gila and San Francisco that is authoritative, we urge that you contact any or all of the following:

Dr John P Hubbard, Delaware Museum of Natural History, Kennett Pike, Greenville, Delaware - 19807;

Dr Lowell Sumner (retired biologist, National Park Service), P O Box 278, Glenwood, New Mexico - 88039;

Dr Dale A Zimmerman, Professor and Chairman, Department of Biological Sciences, Western New Mexico University, Silver City, New Mexico - 88061.

We hope that you will contact all of these scientists personally.

Page 14: Prospective multiple use characteristics of the CAP are predicted to be of benefit to fish, wildlife, and recreation. This is a doubtful statement, at least partly false. Fish and wildlife now existing in the area are more likely to be damaged or destroyed rather than helped. The recreational aspects are discussed elsewhere in our comments.

Page 14: It is not clear just what mitigation features for wildlife can be included in the CAP plan authorized by Public Law 90-537. This question should be clarified at once, and the construction of the project should not proceed until the genuine mitigation features have been included as an integral part. Appropriations for the features should be sought simultaneously with those for the CAP in general. As a matter of fact, we believe that authorization for the mitigation features is probably implied in the law. Surely Congress should not be charged with the implied intent to destroy wildlife, so the reverse implication is more logical. Why not go ahead and ask for the necessary funds?

Page 16, 2nd Line: The phrase "upland birds" is meaningless.

Page 16: The central paragraph is unintelligible.

Page 16: With respect to the funding of genuine mitigation features, please refer to our comment above.

Page 18: There is the statement, "The CAP is in part dependent upon the potential of water salvage from the lower Colorado River." Salvage projects in the area have proved enormously destructive of wildlife and of scenic and recreational characteristics, and they have been widely condemned for that reason. Moreover, there is considerable doubt that any material water salvage is obtained by the methods used. If the CAP is in any significant degree dependent on water salvage, this

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

would be an excellent reason for reevaluation of the whole project. (According to a report from the Bureau of Reclamation Phoenix Planning Office, one half of the water for the CAP is to come from this source.)

Page 19: The central paragraph discusses the establishment of a cold water fishery on the Gila River below Hooker Dam, and it is said that a fish hatchery will be provided. We feel that such action would represent a callous disregard of the qualities that are natural to the lower Gila Valley in New Mexico which are known to be valuable scientifically in their own right, not to mention the pleasure an increasing number of visitors is gaining from nature observation there. As already brought out, the biota of the Gila and San Francisco Valleys in New Mexico are interesting and unique in the United States. These qualities are not limited to birds, but include aquatic and other biota as well. Many of the aquatic animals would probably be destroyed by the introduction of exotic fish, for this has happened over and over again through the unenlightened disregard of all natural qualities of bodies of water except those related to fishing. As a matter of fact, there is also danger in the indirect introduction of exotic fish through the artificial stocking of Hooker Reservoir, because of their probable escape to the stream below the dam.

Page 19: Unfortunately, we don't believe that the aquatic biota of the Gila in New Mexico have been adequately studied, but we urgently request that you obtain competent scientific advice on this subject. Even so, we do have at hand a copy of a letter from Dr Robert R Miller (see address below) to Dr John P Hubbard, dated 5 January 1968, in which Dr Miller tells of collecting in 1938, but also confirmed later, the following fishes from the Gila River at Cliff, New Mexico:

Suckers:
Catostomus insignis (Gila sucker)
Catostomus clarki

Minnows:
Agosia chrysogaster
(1) Gila robusta (Colorado chub)
(2) Tiaroga cobitis (Loach minnow)
(2) Meda fulgida (Meda spindace)

(1) A disappearing species.
(2) These are generic endemics in the Gila River basin; both are now threatened species.

Dr Roberts says in his letter, "The gravest threat from the dam /meaning Hooker Dam/ would be (1) the likely elimination of Tiaroga and Meda from the Gila basin in New Mexico (due to habitat destruction and competition from aggressive exotics), and (2) elimination of the possibility of re-establishing Salmo gilae /the Gila trout - now found only in Diamond Creek and McKnight Canyon, where a small population was moved from Diamond Creek by the Forest Service/ in the streams where it once was common (for the same reasons)." If you wish information from competent ichthyologists who are familiar with the lower Colorado basin and the problem of vanishing native biota, according to Dr Miller, the following should be consulted (in addition to the biologists already listed - Hubbard, Sumner, and Zimmerman - who know a great deal about the biota in general in the immediate Gila - San Francisco area):

(see list next page)

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

Dr James E Deacon, Dept of Biological Sciences, Nevada Southern University, Las Vegas, Nevada - 89109;

Dr William J Koster, Dept of Biology, University of New Mexico, Albuquerque, New Mexico - 87106;

Dr W L Minckley, Dept of Zoology, Arizona State University, Tempe, Arizona - 85281;

Dr Robert R Miller, Curator of Fishes, Museum of Zoology, University of Michigan, Ann Arbor, Michigan - 48104.

Very important to remember is that sport or pan fish are by no means the only fish nor are fish the only aquatic animals.

Page 19: Also with regard to the central paragraph, the inclusion of the idea of an artificial cold water fishery in the Gila in connection with the CAP under the topic Project Environmental Protection Aspects Including Mitigation Features shows very confused thinking. To introduce exotic sport fish from a hatchery is very definitely not "environmental protection" or a "mitigation feature". Such an action is in fact the precise reverse, and is highly destructive of natural environmental or ecological conditions. This is one of the main reasons why native fish have suffered more at the hands of man than any other faunal class. (A kindred confusion in thought resides in the Bureau of Reclamation concept of "environmental enhancement". Generally, it is not possible by artificial means actually to enhance the environment in a total ecological sense, for something thought to represent enhancement may well prove to be a monkey wrench thrown into the machinery.)

(ENVIRONMENT IN THE PROJECT AREA)

Pages 22,23, and 24: The discussion of biota is useless, for there is no description or evaluation of biotic communities, and it is only by beginning one's line of thought in this way that it is possible to derive a conclusion as to the environmental impact of the CAP on this living part of the environment. Particularly needed is consideration of the importance of the remaining unspoiled riparian areas in the arid surroundings of the project area.

Page 24: Bottom of the page there is the statement, "Mitigation and enhancement features should result in a net gain in the quality of habitat for many species." If there is any truth in this statement it badly needs to be brought out. Without strong supporting evidence, it is possible at best to classify it as dangerously naive, for, discounting stocked sport species, the probability of its being correct are remote. If the statement is intended to apply to rare and endangered species, it is even more dangerous than if the application is intended to be general.

Pages 25 and 26: The possibility of damage to archeological values by construction of the Hooker Dam and Reservoir or of a dam and reservoir at an alternate site is overlooked. Reference is made to the Forest Service "Multiple Use Impact Survey Report, Hooker Dam and Reservoir Project, Gila National Forest" of 1968. Although this report covered only the Hooker site itself, the likelihood of damage is at least the same for any alternate dam site on either the Gila or the San Francisco.

Page 26: The first paragraph under Land Use Patterns and Economic Development

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

is in error and should be rewritten as follows:

> "Land use patterns and economic development in Arizona were at first largely decided by the opportunity to exploit natural resources such as grazing range, mineral deposits, and irrigable land. Latterly urban uses and tourism have become important in several counties, particularly Maricopa and Pima, and finally land speculation has spread phenomenally in both the extent of the activity and of the land areas exploited. The availability of water has never been a limiting factor."

Page 26: The second paragraph is misleading and should be rewritten as follows:

> "The Salt River Valley, with a considerable surface water supply, attracted agricultural development in the early days before deep pumping was possible. Now ground water is used extensively. In Pinal County agriculture has utilized ground water a great deal, since the surface supply is more limited, and consequently the county has a shorter agricultural history. Pima County began with surface water from the Santa Cruz River, but as time went on, the use of ground water became paramount and the surface supply disappeared as the water table was lowered and the native vegetation deteriorated. There has been a great deal of unwise ground water mining by farmers, particularly in Pinal County, which has been permissible under weak regulatory law which has never been adequately reformed. Likewise, the city of Tucson is guilty of this practice, the causes being poor water law coupled with bad management and a practice of underpricing the water supplied from wells. On account of the development of water resources carried out in the name of agriculture, there has always been a good supply of water available for urban uses and mining. There now appears to be an adequate supply available for the foreseeable future for all reasonable uses with good management, and provided agriculture is reduced to that which makes economic sense. Maximum reclamation and use of waste water would be helpful as well as the conservation of flood waters and the restoration of native vegetation to the watersheds. Surplus water at any given time should be used for aquifer recharge to obtain evaporation-free storage."

Page 27: After Line 3 a paragraph should be inserted as follows:

> "The Orme Reservoir will inundate from two-thirds to three-quarters of the Fort McDowell Reservation at high water. This reservation is the home of the Yavapai-Apache people and the part of their land which will be flooded is the main residential area. It is also the best land from an agricultural point of view. It appears that the likely effect of the Orme unit will be to displace these relatively affluent Indians from their homes and to deprive them of their means of livelihood without proper reparation."

Mr L A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

(EVALUATION OF ENVIRONMENTAL IMPACT)
(Probable Impact on the Environment)

Page 27, Section IV: Our comments above have considerable content applicable to the subject of environmental impact.

Page 28: The discussion of the environmental impact of aqueducts and canals is inadequate, since those that are open present impassable obstacles to the movement of wildlife, not to mention the danger to humans in the more thickly populated areas. The realization of an effect is evident in the previous discussion of mitigation features in the statement, but still needed is a good study of the impact so that the full need for the mitigation of impact can be judged.

Page 29: Power lines along the rights of way of the aqueducts and canals should be placed underground. Some thought should be given to obtaining power from a source near each point of need, thus obviating the need for power lines in the rights of way. Power obtained in this way might be repaid by exchange. The proposal to place a maintenance road along most stretches of canal and aqueduct should be carefully reviewed to determine how much travel is really needed along rights of way. What good will a road do along the stretches of buried pipeline?

Page 30: In terms of environmental impact, the most important effect of a reservoir is the complete destruction of natural conditions, including the native biotic communities. Another important point is the temporary nature of a reservoir, for by virtue of this characteristic a reservoir can be no more than a means of obtaining short-term gains at the expense of enduring values.

Page 31: The statement is made in the top paragraph that the riparian vegetation downstream from a dam will eventually increase as a result of regulated stream flow. This is not strictly true, for the fate of the downstream vegetation depends completely on the releases from the reservoir in terms of frequency and rate of release, and variations in their management according to the season and the time of day. There may also be other considerations. To prevent adverse environmental impact, assuming that the preservation of natural conditions is desired, a very careful plan for releases is necessary to ensure that there is no change in the downstream riparian vegetation. Even more care is required if it is desired to preserve the native aquatic animals, which are extremely vulnerable.

Page 31: In the center paragraph the idea of "enhancement" is brought up. This is a dangerous thought, see above. In any event, the situation described represents change, and this is in fact damage, if the idea is to preserve natural conditions.

Page 32: The discussion of the environmental effect of Orme Dam and Reservoir is very insensitive and incomplete from several points of view, and contains unjustified statements. The full impact should be made clear to the readers of the statement. Please refer to the applicable comments elsewhere herein. The dam and reservoir will be destructive of the present biota, including what is perhaps the best whitewing dove habitat in Arizona. The total impact on the Yavapai-Apache people is not even mentioned. The reservoir will inundate and destroy a very heavily used recreation area and substitute new forms of recreation which are already available at many nearby places. Actually, the fluctuating reservoir will have

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

disadvantages for any form of recreation. A thorough study will probably demonstrate a net environmental effect which is harmful.

Page 33: See our remarks elsewhere which are applicable to Buttes Dam and Reservoir. The discussion with regard to Buttes is insensitive, incomplete, and contains unjustified statements.

Pages 33 and 34: See our remarks elsewhere which are applicable to Charlestin Dam and Reservoir. Our comment with regard to Buttes is also applicable here. There doesn't seem to be any justification for the suggestion that Charleston will be a "large reservoir". Where will it get the water?

Pages 34 and 35: The discussion of the environmental impact of the Hooker Dam and Reservoir is very poor. See our detailed comments elsewhere. Both the Gila River in New Mexico and its tributary the San Francisco are true natural treasures, and unless the caliber of thinking represented here is much improved they are in real danger. We urge you to obtain scientific advice regarding the Gila watershed in New Mexico and to make your study of alternatives to Hooker complete in the full sense of Public Law 90-537.

Page 37: In the center paragraph it is said that there will be a small increase in usable yield, presumably referring to water. The statement is unintelligible.

Pages 38 and 39: The entire discussion on Quality of Water in the project area is misleading. It implies that Colorado River water is of better quality than water now available in the project area. Except for minor instances, this is patently false. The figure of 2,000 ppm TDS cited as an example, probably from the Buckeye area, is so exceptional that it should not be used in evaluating water quality in the project area. As noted earlier, all figures for TDS are meaningless without accompanying explanation as to how they effect water quality for various uses, and how the various solids affect water quality differently. Furthermore, the 774 ppm TDS figure for Colorado River water is misleading in that it does not reflect the actual quality of water as it would be delivered, for evaporation will probably raise this figure to over 850 ppm. It should be noted, too, that water quality in the Colorado River also varies noticeably. Consequently, the conclusion that water quality in the project area will be improved rather than degraded is seriously questionable. The subject must be more thoroughly analysed.

Page 40: The discussion of Sociological Impacts contains statements that deserve comment. It is said that "the desert region of Arizona which supports the bulk of the population is completely dependent upon a plentiful supply of water." Obviously water is required for human life, but what is a "plentiful supply"? Our conclusion is that the statement is based on misconception. Here in Arizona we begin by finding a high requirement for irrigation water. This is based on what Dr M M Kelso of the University of Arizona calls "the image of irrigation fundamentalism", which holds that irrigated farming is an absolute requirement for a socially viable society in the semi-desert Southwest. This is pure myth (see additional discussion below). Then we compound this extravagant demand by maintaining ineffective law for the control of the use of ground water, following up with poor management which refuses to recognize the true value of water as a resource. The reason we need a plentiful supply is that we do not know how to

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

use water properly.

Page 40: Also in the Sociological Impacts can be detected the idea that growth is desirable, and this is coupled with a misconception or two. It is true that in the absence of other measures to curtail immigration a failure to bring in new supplies of water will not alone act to control population increase. It is also true that continued growth of population and economy will "ultimately require re-evaluation of water use priorities", weighing municipal and industrial uses which are of high economic value against agricultural uses which contribute relatively little to overall state income, but the discussion is in error in stating that the judgement must be made between domestic needs on the one hand against agricultural and industrial needs on the other. This idea is misleading. Domestic and industrial, more properly municipal and industrial, uses are compatible and bring high returns through the conjunction of labor and industry to produce income. But agriculture flies false colors (see discussion below), for it is not very important to the economy of the state, even though it uses about 90% of the annual withdrawal of water. We need to realize that our problem in Arizona is not a water shortage, but a failure to allocate our water supplies to the economically better uses. Hence it is that a re-evaluation of water use priorities is the obvious thing to do for sensible management. Yet we do not now need an increased supply of water even if we admire population growth.

Page 40: There is confused thinking in the Sociological Impacts discussion. In Lines 5 and 6, there is the statement, "The rate of population growth can be expected to continue . . . without the project." Further on in Lines 10-11-12, it is said, "Increasing the supply of water will circumvent drastic curtailments of the present rate of population growth . . . ." What is your theory, does water supply control population growth or not?

Page 41: (Beneficial Impacts)

Item a: Additional water supply is not necessary to the purposes mentioned.

Item b: Please refer to the discussion of irrigated agriculture below. The statement is meaningless, for it is not clear how additional water supply will provide "the advantages of rural life". There is little true rural life connected with modern irrigated agriculture conducted on a commercial basis in the Southwest.

Item c: The necessity of the flood control said to be provided by the major reservoirs is open to question. The second clause about "cross-drainage" structures is unintelligible.

Item d: No water-oriented opportunities for recreation not previously available will be provided by the reservoirs and the adjacent lands, in fact, the reverse appears to be true. The reservoirs will destroy recreational diversity and simply provide more of the same opportunities of which there is already a sufficiency available. Natural fish and wildlife habitat will be destroyed and replaced by artificiality. These points generally are true even though some of the ideas for various facilities in connection with the aqueducts and canals are good.

Page 42, Item e: The idea of a cold water fishery below Hooker Dam is completely unacceptable as already pointed out. So is the "two-story" fishery within the reservoir unless some way can be found to keep the planted fish from es-

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

caping to the river below the dam.

Page 42, Table 1: To present a table such as this is misleading and ill-conceived. For one thing the reliability of the figures is open to question, for another a drastic increase in fisherman use indicates adverse environmental impact, the basis for the increase being the introduction of unnatural conditions and the extinction of the native biota. Thus, especially if considered in the light of the fact that the people of the Phoenix area already have easy access to fishing sites unmatched by any other inland city, the large increase in "put and take" fishing ascribed to Orme Reservoir can be evaluated only as a social cost, not a benefit. Exacerbating this adverse effect is that the artificial fishing would be obtained at the expense of water-oriented recreation of types which cannot be replaced by the project. Tens of thousands of people will be deprived of these opportunities along the Salt and Verde Rivers. We have already pointed out what will be the tragic consequences of the contrivance of artificial fishing at the Hooker Reservoir, and the net effect of the Buttes and Charleston Reservoirs in this respect needs further study.

Page 44, Item h: Here again is emphasis on the artificial which verges on the ridiculous. What logic is it that impels a state agency such as the Arizona Fish and Game Department to consider the construction of 50 new lakes in this arid region? Small wonder we have water problems. It is time for the public agencies to begin the education of immigrants coming to Arizona in the necessity for the acceptance of the environmental conditions to be found naturally. It is the claims for "benefits" such as this one which add materially to the doubt that there is any real need for the CAP.

Page 45, Item i: This item is unintelligible but apparently does not belong under "benefits". Is the reference here to easy drownings?

Page 45: The short discussion of Unknown Effects casts doubt on the CAP as a whole. The final paragraph should certainly be taken seriously. Until all such impacts can be described in detail and evaluated the project should not be initiated.

(Adverse Environmental Effects)

Page 46, Item 2: Power lines should be buried in the rights of way, but neither power lines nor roads should be built to follow the right of way unless they are really required. Roads should not be needed along the buried pipelines.

Page 46, Item 3: As already noted, the ecological effect of the long open aqueduct should be studied thoroughly. If sufficiently adverse it might suggest abandonment of the CAP.

Page 46, Item 4: The word "further" near the end of the first sentence should be deleted. The Gila River in New Mexico has not yet been substantially altered. The San Pedro has suffered only from decline in the water table. The second sentence should read, "The flow of the Gila River in Arizona and of the Salt River has already been altered by previous construction."

Page 47, Item a: Actually the endemic species may be rendered extinct. This is especially the case in New Mexico, the Gila River not even being consid-

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

ered in the statement, nor is the San Francisco.

Page 47, Item d: The unique biotic communities of the Gila River and possibly the San Francisco will be destroyed and lost to the United States (unless a suitable alternative is found for Hooker Dam and Reservoir). This is possibly true with regard to the other rivers affected, although we are not certain of the degree to which their communities are unique under the conditions prevailing at present. At any rate damage will no doubt occur, and the seriousness of this damage in terms of both quality and quantity needs to be determined. Scientific study is needed.

Page 47, Item 7: This statement refers to a condition which will violate the Wilderness Act on account of lack of enforcement by the Congress and the President. This violation of law can be avoided by finding a suitable alternative for the Hooker unit.

Page 47, Item 8: The destruction described will be further aggravated, or even caused primarily, by the introduction of exotic fish for sport fishing. This destruction can be avoided simply by just not planting the fish.

Page 48, Item 10: Please refer to our comments elsewhere on the subject of water supply as it is related to population growth.

Page 48: A number of additions to the list of adverse environmental effects should be heeded unless the project is corrected to eliminate them; please refer to our comments elsewhere. Two which are important as long as Orme Dam and Reservoir remain in the project are:

> "1) The destruction of intensely used recreation areas on the Salt and Verde Rivers;
>
> "2) The adverse effect on the Yavapai-Apache people of the Fort McDowell Reservation."

Alternatives to the Proposed Action

Page 48, Item 1: This discussion of the alternative No Construction of Authorized Project is entirely subjective and largely false. Since agriculture contributes only about 8% of Arizona's overall income, the economy is little affected by anything that happens to agriculture, certainly not severely. Ever since the CAP was first proposed to Congress in the late 1940's the same claim has been made: without supplementary water the economy of the state would collapse. The intervening years have shown how false this claim is, and inventories of available water by the USGS have shown that Arizona has enormous underground reserves which are economically recoverable. Please refer to our remarks elsewhere on this subject. The transfer of water to higher economic uses will benefit the economy of the state. Such action certainly will not affect the "improvement of man's way of life in the project area".

Page 49: The statement at the top of the page is false. Adoption of the "no construction" alternative would not require obtaining another source of water, nor would it require extreme adjustments in the water use pattern. On the other hand, the transfer of water to higher economic uses could take place gradually, smoothly, and beneficially.

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

Pages 49,50,and 51: The items listed in a(1), a(2), and a(3) are all at least partial alternatives in their own right to the CAP. All are developing technological applications which have their own advantages and disadvantages but which some day may add increments to the water supply of Arizona and the Southwest.

Page 51, Items b(1) and b(2): The adjustments described are generally practicable, although it would be difficult in the near future to achieve a completely stable population. This is not essential, however. What is essential is to avoid encouraging in-migration. The efficient utilization of existing water supplies, which would include obvious adjustments in the name of economic common sense, would not limit industrial growth in the central Arizona area. Good management would stop the depletion of ground water resources by various means such as the reform of water law, the pricing of water at a scale commensurate with its true worth, and the cessation of the subsidization of irrigation water.

Page 52, Item 2: The statement under Partial Construction of Authorized Project is false. Assuming that Colorado River water is needed in central Arizona, which we do not, it would be both economically sound and environmentally less destructive to limit construction to those units and features of the CAP that have something to do with the actual function of the project, which is to deliver Colorado River water to central Arizona. In this way, the Buttes, Charleston, and Hooker units would not be built. Their adverse environmental effects would go with them as would their costs. Nowhere in the statement is any acceptable justification given for the construction of these dam and reservoir units, which can be assumed to be more political in nature than anything else.

Page 52: An additional alternative should be considered, see below.

Pages 48,49,50,51,and 52: The Alternatives to the Proposed Action section should be rewritten as follows:

> "The following are alternatives to the proposed project as authorized by Public Law 90-537:
>
> "1. No Construction of Authorized Project: With good management, no additional water supplies are needed in the central Arizona area which it is the function of the CAP to serve, at least for the foreseeable future. The available water is ample for all uses that are able to pay their own way, including the irrigation of high value crops for which Arizona conditions are especially suited and allowing for considerable population increase and economic growth. Good management should include the following: a) no subsidy of irrigation water; b) facilitating the transfer of agricultural water to municipal and industrial uses, gradually, smoothly, and beneficially under market conditions; c) reform of law controlling water rights and the use of both surface and ground water, recognizing that all water resources are the property of the people of the state; d) a pricing system for water which will reflect its true value, encourage conservation measures by all water users, including farmers, and penalize heavy or wasteful users; e) maximum reclamation and use of waste water; f) salvage of flood waters; g) use of any currently surplus water for aquifer recharge to obtain evaporation-free storage, h) restoration of native vegetation to watersheds.

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

"2. Partial Construction of Authorized Project: Construct the CAP as planned, except omit the Buttes, Charleston, and Hooker dam and reservoir units. This alternative would limit the CAP to the performance of its primary function, the delivery of Colorado River water to central Arizona. The justification of the project has all been aimed at the performance of this primary function. The three dam and reservoir units mentioned appear (this is certain in the case of Hooker) to have been tacked onto the project to cater to local desires and to meet political considerations. At no time, as far as we know, has there been any real justification for these three units in either economic or design terms and the arguments for the project as a whole do not deal with them. To omit them from construction of the project would save a great deal of money and prevent much environmental damage.

"3. Obtain Increments of New Water as Needed in Future Through the Application of New Technologies: If the first alternative should be adopted and the CAP should not be built, it might turn out that supplies of new water would be needed sooner than contemplated. Such new supplies could be obtained in increments through weather modification, desalting of sea, brackish, or other chemically charged waters, or as one product of the exploitation of geothermal resources, provided these new technologies turn out to be productive and are not environmentally harmful as applied. All appear to have some promise, and even though one should fail, another perhaps will not. Their future development appears to offer a reserve against need in the case that the CAP is not built.

"4. Use of an Alternate Project Area: There are large areas in western Arizona near the Colorado River which could cheaply and effectively be opened to irrigated farming in order to put to use Arizona's remaining entitlement to Colorado River water. Since the real need for additional water in central Arizona is doubtful and since perhaps the most cogent argument for the CAP appears to be that Arizona must put its entitlement to use in order to prevent its pre-emption by California, the employment of the water near the River would seem to be a relatively cheap and effective way for the state to assume beneficial use of the water, which would be available for higher economic uses later as needed. Adoption of this alternative might require phasing out some irrigated farming in central Arizona, the farmers being absorbed there or relocated to the newly irrigated land. All expenses considered, this alternative would be much cheaper than the CAP as planned.

"All of these alternatives appear to be preferable from either an economic or an environmental point of view to the authorized project. The first, No Construction of Authorized Project, supplemented by the third, appears to be the most acceptable when judged on either an environmental or a benefit/cost basis. The adoption of the first alternative would require a great deal of action by the state to improve

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

water management, and this may be difficult to obtain politically. At any rate, better water management should be made a prerequisite for the investment of any Federal funds in reclamation projects designed to benefit the state. Thus, evidence of better management for the future should be shown before either the CAP or any of the alternatives is implemented.

"If the first alternative were adopted there would still remain the possible danger that Arizona might lose her remaining entitlement to Colorado River water to California in spite of the present "Law of the River". If there be sufficient evidence of this and a convincing argument could be mustered, then perhaps the fourth alternative for what might be called a "Western Arizona Project" should be adopted in addition to the first. Of course, a full evaluation of the environmental impact would precede any authorization of the project.

"If it can be shown that central Arizona really needs an additional water supply, it being shown that the existing supply is inadequate even with good management, then the second alternative, eliminating all the parasitic units from the CAP, would be preferable to the construction of the authorized project. There would be considerable savings in both costs and environmental damage.

"It is not within the scope of the Bureau of Reclamation to choose between the authorized project and the alternatives. The best course of action is to open up the whole situation to public review, a plan for which will be announced in the near future. Finally, the full case, including all the alternatives and the results of public hearings, will be presented to Congress for decision. Intermediate between the public hearings and presentation to Congress, it would be valuable to obtain a comprehensive review of the CAP and the alternatives by a qualified, non-political agency or group of consultants having no vested interest in the project. It should be possible to arrange for such a review through the Office of Management and Budget. The results would be referred to Congress to help in coming to a decision."

(Relationship of Short-Term Versus Long-Term Needs)

Page 52: The topic of this section is a distortion of the corresponding item in Section 102(C)(iv) of Public Law 91-190, the National Environmental Policy Act, which reads, "the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity." The distortion of the topic possibly accounts for the failure of the discussion to meet the intent of the Act. Long-term productivity depends on the preservation of resources and environment so as to keep them available for future options. Of course, the word "future" is indefinite, but we are certain that the meaning intended in the Act refers to a period beyond the expected life of the project under consideration. Otherwise there can be no comparison. If the expected life of the CAP is 100 years, then the future lies beyond.

As a matter of fact, no man-made structure can qualify to claim long-

Mr. J. A. Lundberg, U. S. Bureau of Reclamation, 26 October 1971, continued:

term benefits, for they simply do not last long enough when sized up against the evolutionary time-table which governs the dynamics of nature. One hundred years is an optimistic estimate of the fully useful life of a reservoir. Even though we have been building major dams for only a relatively few years we have learned that they are useful for their planned functions for only a short time and we are left with a shallow body of water which eventually becomes smaller and smaller and finally ends up as a mud flat. It is noted that a function mentioned for each of the proposed CAP reservoirs is sediment storage. Thus, we have accepted their fate and adopted the cause of that fate as a benefit. The soils of the project area being as erosive as they are, the CAP reservoirs are likely to get short shrift indeed, so it is good to be ready with a rationalization if we are among those who put their faith in dams to the exclusion of their alternatives. The vulnerability of the reservoirs must have an effect in reducing the life expectancy of the authorized project as a whole.

The adverse impact of the CAP will have the effect of destroying habitat for both man and other animals, and further degrading our rivers. The damage to be done will be largely irreversible. Thus, while its life expectancy cannot be very long, it will have a wide and long-term, but partly unknown adverse environmental impact, as we have indicated heretofore.

This much follows from our previous discussion, but we must now give consideration to an impact which, though to a certain extent intangible, may nevertheless be more seriously damaging than any other.

The CAP is a dubious project, being questioned by reputable economists who have studied it thoroughly. Meanwhile, it is difficult to identify the roots of its support. It is not apparent that individual farmers want it with any enthusiasm, because even though subsidized the water will be too expensive for most farmers when delivery costs are added. It is not the cities, because they have water for the next few decades, the CAP water will be comparitively too expensive, and when increments of supply are needed they have a readily available source in merely buying up water rights now used for irrigation.

We are forced to conclude that the basis for the support of the CAP resides in the interests that are working for the unrestrained economic growth of Arizona. A glance at the list of members of the board of directors of the Central Arizona Project Association gives evidence of the identity of these interests, which receive considerable aid from the promotion activities of the Bureau of Reclamation.

This is not to say that a failure to augment the currently available water supplies in the state will actually inhibit growth, but these interests <u>think</u> that an additional water supply will facilitate it. Their thinking is completely subjective in their desire for short-term monetary gain. They have no worries about the dollar cost of the CAP, which will be borne on their behalf by the water users and taxpayers of the project service area, backed up by the American taxpayer at large. Thus, a very expensive social cost of the CAP will originate in its encouragement of a psychology that drastically threatens the quality and pleasure of living in Arizona, for even though it will not in itself be essential to growth it will abet the growth idea and stimulate the urge for growth. In this way it becomes a sort of multiplier for the growth that would take place anyhow, without it.

On the ground, economic growth in the Southwestern style is seen as induced growth of population through in-migration. One has only to live in Phoenix or Tucson to see and feel the effects of runaway population growth, which is already well past the point of diminishing returns to the extent that the inability of local government to maintain the desirable levels of public services is clearly visible, even though taxes are high and getting higher.

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

There is no factor more destructive of the environment than uncontrolled and unwarranted urban growth. It has a long-term effect on the countryside which is devastated by the land speculators, and the cities affected by it never fully recover. The destruction is irreversible.

The draft environmental statement very aptly brings out the adverse effects of too rapid growth of population on Page 40 under Sociological Impacts, and also on Page 48 under Adverse Environmental Effects. Yet the Bureau of Reclamation continues to promote the CAP despite the high social cost of this adverse effect.

If the project is constructed, we must accept it for what it is, a means of obtaining short-term gains at the expense of enduring values. In the language of the National Environmental Policy Act, we will be placing a priority on local, short-term uses of the environment over the maintenance of long-term productivity, thus violating the policy expressed in the Act.

(Irreversible Commitments of Resources)

Page 53: An important irreversible commitment of resources lies in the psychological commitment of Arizona to "LosAngelesization", to uncontrolled and unwarranted growth. Please refer to the discussion on short-term uses versus long-term productivity immediately above.

Page 54, Item 3: The estimated evaporation rate of 72,000 acre feet per year from 287 miles of open aqueduct and 18,000 surface acres of reservoir appears somewhat low. While we are not in a position to make critical analysis of these figures, a quantity closer to 100,000 acre feet per annum or more would seem realistic. At any rate, the derivation of the estimate should be explained.

Page 54, Item 4: We again wish to mention the possibility of damage to archeological values by the Hooker unit.

Page 54: To the list of irreversible commitments should be added the destruction of human habitat by the Orme unit, both through its effect on the Fort McDowell Indian Reservation and the Yavapai-Apache people and through the destruction of recreation areas along the Salt and Verde Rivers.

Pages 53 and 54: We are concerned that the matter of irreversible commitments has not been adequately studied. In the environmental statement the tendency appears to be to play them down. For example, the discussion in Item 1 on Page 53 and 54 is understated. The damage caused by the dam/reservoir units to the biota will be serious. Some species could be rendered extinct. We have discussed this earlier. A more complete study might uncover irreversible effects that have not yet been identified.

— — —

In conclusion, we would like to discuss two subjects which are not adequately dealt with in the draft environmental statement or in our comments so far.

On the subject of irrigated agriculture, we would like to call your attention to a study done recently for the National Water Commission by Resources for the Future, Inc. The short title of the report is Future Water Demands. The accession number is PB 197 877, and it is obtainable from the National Technical Information Service. The part of the study on irrigated agriculture is very interesting, especially since the central Arizona area is one of those studied in detail. The study warrants your thorough perusal, but we would like to quote one

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

paragraph:

> "In sum, these three theses assert that, intentionally or otherwise, public policy has not been neutral with respect to crop irrigation. Each of several major classes of policies has distorted producer incentives in such a way as to lead to and maintain an overcapacity in irrigation water supplies. The sometimes urgent expressions of "need" for additional water supplies in the arid West stem not from actual national economic benefits which would accrue to the development of more water, but from potential local and regional gains which have come to be expected as a consequence of past and present public policy."

In the meantime we can hear no outcry for CAP water from individual farmers. They know the project water will be too expensive for them. Spurred, one supposes, by "Parkinson's Law" it is the irrigation districts, besides a few large corporate farms, that cry for water. Of course they are joined and possibly surpassed by the growth advocates who wish to develop a water surplus to be drawn on to supply urban sprawl. In any event, we do not believe that the provision of additional irrigation water can be taken as a true benefit of the CAP.

Another subject that merits special notice is the lack of water available for diversion from the Colorado River for the CAP. The average annual flow of the Colorado River was once over-optimistically estimated at 15 million acre feet per year, and this water was divided half and half between the Upper and Lower Basins. Including the Lower Basin share of the Mexican treaty obligation and an allowance for evaporation and other losses, the Lower Basin entitlement of 7.5 maf has been over-allocated by about 1.5 maf per year.

Even so, Congress has estimated that 1.2 maf annually will be available for the CAP until some time during the decade 1985-1995, due to the fact that the Upper Basin, according to estimates, will not be using all of its entitlement until that time. But by 2030 the water available for the CAP will have shrunk to perhaps 675,000 maf. Part of the basis for this estimate is a new guess, less optimistic than before, of 13 maf as the total annual flow of the river. That the new figure is still optimistic is shown by the fact that the actual flow has shown deficits of three to five million several times in recent years. It must be kept in mind that the reliability of the supply for the CAP will never be any more predictable than the flow of the Colorado River.

Arizona's share of the Lower Basin entitlement is 2.8 maf per year, of which amount the state is already using some 1 maf, leaving a balance of about 1.8 maf. According to the draft environmental statement, the Granite Reef Aqueduct is being designed for a capacity of 3,000 cfs or 2.2 maf per year. This capacity will exceed Arizona's remaining entitlement by 400,000 acre feet, and it will exceed the maximum amount estimated to be available for the CAP by 1 maf, not to mention the shrunken availability of the later years and the undependability of the Colorado River.

Apropos the remark on Page 52 of the environmental statement that the project will make "available a dependable source of water", it appears to us that the CAP will provide a <u>capacity</u> which is excessive and will increase costs, but the presence of benefits in the form of a dependable supply of <u>water</u> will remain doubtful.

Mr E A Lundberg, U S Bureau of Reclamation, 26 October 1971, continued:

This doubt, and others already expressed, raises the question as to whether the CAP can meet a three-fold test of feasibility. Can it deliver (1) a sufficient quantity (2) of good water (3) at a reasonable price? To this must be added another cogent question. Does the dubious nature of the project warrant its construction in the face of its adverse environmental impact?

We particularly invite your attention to our discussion of alternatives (pp 14, 15, 16, and 17, above), short-term uses versus long-term productivity (pp 17, 18, and 19), irrigated agriculture (pp 19 and 20), and water availability for the CAP (pp 20 and 21). We also wish to emphasize our remarks on pp 1 and 2.

We appreciate the opportunity to comment on the draft environmental statement for the Central Arizona Project. We'll be grateful if you will inform us of all developments affecting the project. Please send copies of all important documents related to the project to each of the undersigned.

Sincerely yours

David Yetman
Conservation Chairman
Grand Canyon Chapter
SIERRA CLUB

Henry M Zeller
Vice-Chairman
Southwest Regional
Conservation Committee
SIERRA CLUB

LEAGUE OF WOMEN VOTERS OF ARIZONA

Box 1127
Sedona, Arizona 86336
January 4, 1972

OFFICIAL FILE COPY
RECEIVED JAN 7 1972
Action:
Action Taken.....(Initials)

Date	Initials	To
1/7	JAC	1550
1/7	AK	152

File

Mr. F. Phillip Sharpe
Environmental Specialist
Bureau of Reclamation
P. O. Box 247
Boulder City, Nevada 89005

Dear Mr. Sharpe:

I am being diligent in reading all the material which has been sent me as a member of the Central Arizona Project Environmental Advisory Group: the Preliminary Environmental Impact Statement on CAP, the copies of all statements and letters submitted to the Bureau by governmental agencies, environmental organizations, and individuals commenting on the Impact Statement; the Preliminary Draft Statement on the Lake Havasu Intake Channel and Pumping Plant Site, and the copies of the letters of other members of CAPEAG to you. I have hesitated to add my own comments because I have felt I did not qualify as one with technical expertise in the field.

However, I would like to express the League's approval of the initiative taken by Region III of the Bureau of Reclamation in establishing this representative citizen's group. I am sure the Bureau will benefit by involving them early in open discussion of proposals, criticisms and counter-proposals.

The fact that comments on the Environmental Impact Statements are read by members of a citizen's advisory group should increase confidence among citizens that there is an honest attempt for full publication of information and should give agency representatives increased objectivity in having non-agency assessment of the responses to the Impact Statements.

The League of Women Voters works constantly for more public understanding of important issues and for greater involvement of citizens in the decision-making process. Therefore, we appreciate the present opportunity (1) to become informed of the environmental pro's and con's of the plans for the CAP, (2) to be able to raise the question that our members ask and that we hear from concerned citizens, and (3) to be a part of your public opinion sounding board.

A NON-PARTISAN ORGANIZATION DEVOTED TO PUBLIC SERVICE IN THE FIELD OF GOVERNMENT

I wish, also, to express my personal appreciation of the helicopter tour over the proposed route from Lake Havasu to Phoenix. To have seen the area by air has made the maps and project proposals much clearer. I hope to visit the southern portion by road before long.

You and your staff have been most helpful in making available information, in answering questions and in being ready to admit the areas that need further research. The free and open discussion in the first two meetings of the CAPEAG has been encouraging as evidence of the way in which citizens and agency representatives may be able to exchange views on how to achieve the specific goal of water delivery with adequate protection of the public's interest in the total environment.

With my sincere hope that this experiment in involving citizens in the beginning stages of project development will prove beneficial to the Bureau and to the citizens of Arizona, I am

Sincerely,

Ruth Detzer

Mrs. Stephen Detzer
State Chairman of Environmental Program
League of Women Voters of Arizona

cc: Mr. Ellis Armstrong
Mr. E. A. Lundberg
Mr. Ray Killian
Mr. F. J. MacDonald
Mr. Rich Johnson
Mr. Robert G. Worden
Mr. Thomas J. Sullivan
Mrs. Donald Clusen, National LWV Chairman, Environmental Program
Mrs. Clement Zandler, State President, Arizona LWV

A NON-PARTISAN ORGANIZATION DEVOTED TO PUBLIC SERVICE IN THE FIELD OF GOVERNMENT

INFORMATION COPY FOR 700

Native American Rights Fund

1506 Broadway Boulder, Colorado 80302 (303) 447-8760

David H. Getches
DIRECTING ATTORNEY

Joseph J. Brecher
Bruce R. Greene
Robert S. Pelcyger

Charles F. Wilkinson
ATTORNEYS

Peter J. Aschenbrenner
John E. Echohawk
Yvonne Knight
Leland J. Pond
Daniel J. Taaffe
RESEARCH ASSISTANTS

Reid Peyton Chambers
OF COUNSEL

OFFICIAL FILE COPY

RECEIVED OCT 12 1971

Action 130

Action Taken (Initials)

Date	Initials	To
10/13		153
10/12	ZRS	130
12/17	JW	471 (2)
12-10		700 (1)
12/20		155 (5)
File		

7 October 1971

Mr. E. A. Lundberg
Regional Director
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

I represent the Chemehuevi Tribe of Indians and the Natural Resources Defense Council, both of which groups have a vital interest in the proposal to construct the Central Arizona Project. I understand that your office mailed out copies of a draft environmental statement for that Project on September 24, 1971, asking that all comments be submitted within thirty days of the mailing out of that statement.

My clients believe that a project as large and complex as the Central Arizona Project requires more time to prepare a detailed set of comments. I, therefore, request that they be granted an additional thirty days to submit comments, or until November 23, 1971. I am sure that you are eager to comply with the requirements of Section 102(2)(G) that you "initiate and utilize ecological information in the planning and development of resource-oriented projects." My clients have such information and will be in a position to submit it to you on or before November 23.

Thank you for your cooperation.

Yours truly,

Joseph J. Brecher

Joseph J. Brecher

JJB:fpp

cc: Dick Hall
Russell Train
Ralph Esquerra
William Veeder

144

- C O P Y -

United States Department of the Interior
BUREAU OF RECLAMATION

REGIONAL OFFICE - REGION 3
P.O. BOX 427
BOULDER CITY, NEVADA 89005

IN REPLY
REFER TO: 3-150/120.01

October 21, 1971

Mr. Joseph J. Brecher
Native American Rights Fund
1506 Broadway
Boulder, Colorado 80302

Dear Mr. Brecher:

This is in response to your letter of October 7, 1971, requesting a 30-day time extension for your clients to comment on the Central Arizona Project draft environmental statement.

We appreciate your clients' interest and concern in the Project in developing comments and the need for an extension. However, in accordance with the Council on Environmental Quality Guidelines of April 23, 1971, Section 7, the initial 30 days, plus an extension of 15 days, should be adequate for review purposes. We would, therefore, appreciate receiving your clients' comments no later than November 10, 1971.

We hope this extension will be satisfactory in providing comments on this most important Project.

Sincerely yours,

/s/ E. A. Lundberg

E. A. Lundberg
Regional Director

Native American Rights Fund

1506 Broadway Boulder, Colorado 80302 (303) 447-8760

David H. Getches
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OF COUNSEL

Joan L. Carpenter
ASSISTANT TO THE DIRECTOR

OFFICIAL FILE COPY

RECEIVED NOV 12 1971

Action:

Action Taken (Initials)

Date	Initials	To
11-	[illegible]	150
11/13	[illegible]	153
File		

10 November 1971

Mr. E. A. Lundberg
Regional Director
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

The following comments on the Draft Environmental Statement: Central Arizona Project are submitted on behalf of the Chemehuevi Tribe of Indians and the Natural Resources Defense Council. The Supreme Court, in Arizona v. California, 376 U.S. 340, awarded the Chemehuevi Tribe 11,340 acre feet of Colorado River water. The Chemehuevi Tribe believes that construction of the Central Arizona Project will threaten the quality and quantity of Colorado River water available to them and that the adverse environmental impacts associated with that construction will affect their health, welfare, and livelihood.

The data presented in the draft statement is totally inadequate. As the court said in Environmental Defense Fund v. Corps of Engineers, 325 F.Supp. 725, 759, an impact statement must "contain such information as will alert the President, the Council on Environmental Quality, the public, and indeed the Congress, to all known possible environmental consequences of proposed agency action." The Council on Environmental Quality's Guidelines for federal agencies under the National Environmental Policy Act, 36 F. Reg. 7724, et seq., paragraph 6(a)(i), says a draft statement must include "a description of the proposed action including information and technical data adequate to permit a careful assessment of environmental impact by commenting agencies." Also, under paragraph 10(e) of the Guidelines, the public must be provided with "relevant information, including information on alternative courses of action." Obviously, the public is not "informed" at all, when relevant data is missing from the statement. Almost

every page of the draft statement contains admissions that data is lacking, that information is "unknown," or that tests are presently being conducted, the results to be determined in the future.

Another basic flaw in the draft statement is the unchallenged acceptance of the proposition that growth must continue unabated in Phoenix and Tucson and that it is the duty of the government to supply the wherewithal for that continued growth. The Council on Environmental Quality has recognized that "population growth threatens the nation's store of natural resources" and that in some rapidly growing areas, "there was now a need to de-emphasize growth as a social goal . . ."[1] Instead of invoking the need for growth in Phoenix and Tucson as an imperitive reason to build the C.A.P., the statement should have been considering seriously the possibility that such growth is a reason to halt construction.

The following is a list of specific comments on various aspects of the draft statement:

Page No.	Defect
1	The statement does not cover the effects of the Navajo Power plant, even though 25% of its power (and hence, its pollution) is attributable to the requirements of the C.A.P.
6	There will be four relift pumping stations along the Granite Reef Aqueduct. There is no discussion regarding the impact of these stations.
7	There will be a pumping plant on the Salt-Gila aqueduct. No mention is made of its environmental impact.
8	There will be two pumping plants along the Tucson aqueduct. No mention is made of their environmental impact.
10	Plans for the distribution system for delivered water are not finalized yet. The statement admits that "an accurate estimate of miles of main and lateral canals cannot be made at this time." This information should be available to the decision-makers before a decision is reached.

[1] First Annual Report, pp. 13-14 (1970).

Page No.	Defect
13	The statement alleges that as an alternative to the Hooker Dam, four dam sites on the Gila River and two on the San Francisco River are being investigated. The statement does not indicate the location of those six dam sites or even whether they are in the Blue Range Primitive Area or the Gila Wilderness Area. The statement also says: "alternatives to other major features of the project are also being investigated." Those alternatives are not described with particularity. Hugh information gaps such as this are impermissible in a NEPA statement. In D.C. Federation of Civic Associations v. Volpe, ____ F.2d ____, 3 E.R.C. 1143, 1146-47 (D.C. Cir., October 12, 1971, No. 24,843), the plaintiffs called into question whether the Secretary of Transportation, in approving the design for a set of highway ramps and interchanges, followed the statutory requirement that "the project includes all possible planning to minimize harm to such park . . . or historic sites."[2] The court noted that such planning could not possibly have taken place, since the final design of the ramps and interchanges was not yet complete at the time the planning allegedly was done. The court commented: "absent a finalized plan for the bridge, it is hard to see how the Department could make a meaningful evaluation of 'harm.'" Similarly, in this draft statement, the Bureau of Reclamation could not possibly have assessed the environmental impact of the Hooker Dam, when it is not even sure of its ultimate location.
14	Some parts of the aqueduct will be fenced to protect wildlife. Other parts, that are not "wildlife crossings and natural migration routes," will not be fenced. What will happen to game in those areas?

[2] 23 U.S.C. § 138.

Page No.	Defect
14-17	The report analyzes in great depth various types of wildlife drinking facilities, but admits that the project as presently funded does not contemplate construction of such facilities. It is indicative of the one-sided orientation of the statement's drafters that they devote three pages to an elaborate description of "wildlife benefits" that are almost sure not to come about, while the potentially disastrous increase in lower Colorado River salinity that will result from the C.A.P. operation is totally ignored.
18	The statement says that disposal areas will be revegetated. It does not say how this can be accomplished, especially under the severe, arid desert conditions prevailing in the area.
18	Quarry sites will be in "remote areas" and will be left in a condition that will "minimize the impact on aesthetics and will not endanger wildlife." The location of these sites is not specified, nor is the method for restoration.
19	There will be a great deal of additional fishing at the reservoir along the stream. There is no mention of the potential environmental dislocation to be caused by more people and their cars.
19	The Bureau admits that there may be "many other possibilities of environmental enhancement, protection, and mitigation features" that may be appropriate. These features will be considered "as they become more specificly identified and evaluated." Obviously, there is no way for a reader to assess the effectiveness of these measures at this time.
22	Instead of describing the vegetation found along the right-of-way, the statement refers the reader to various scholarly papers. The same is true for fauna. These papers are not readily accessible to the general public. The information contained in them should be set forth in the statement, itself.
24	Several rare and endangered species of animals are listed and the conclusion that "construction of the project is expected to have only minimal effect on rare and endangered forms" is expressed. There is no data supporting this conclusion.

Page No.	Defect
25	Unspecified recreation facilities are to be considered later. This is another example of the drafters' claiming benefits for the C.A.P. that may never materialize.
27	There is no discussion of the effect of the Lake Havasu water intake facilities on fish in the lake.
29	The statement admits that most of the canal right-of-way will contain a power line and maintenance road. There is no discussion regarding how these facilities will affect aesthetic values in the area.
29-30	The statement admits that there will be "major ecological changes" resulting from the construction of the reservoir. It also mentions "alteration of the original stream species." For "alteration" one should read "obliteration." Cf. Environmental Defense Fund v. Corps of Engineers, 325 F.Supp. 728, 749. The statement admits that the Bureau has no information regarding fishing along the Gila River. It also indicates that there will be some "alteration" of fauna. There also will be a reduction in habitat. But the extent and nature of such alternations and reductions is not specified.
33	The statement indicates that there will be a net gain in recreation because of the Charleston Reservoir, since there is a scarcity of "large recreational lakes" in the area. It does not mention the corresponding loss of recreation in the free-flowing streams there.
34	The Charleston Reservoir "will have the greatest impact on archaeological values of the four project reservoirs." That impact is not specified.
34-35	It is impossible to learn anything about the effects of the Hooker Dam Project, since its exact location is not specified.

Page No.	Defect
37	The statement maintains that "the stream flow regimen of the Colorado River below Parker Dam will be unaltered by the diversion of C.A.P. water." Certainly, there will be an increase in salinity and a decrease in the amount of water available downstream. In the draft impact statement for the Navajo Project, it is admitted (page 48) that withdrawals from the Colorado River of about 100,000 acre feet by five power plants would increase downstream salinity by "less than 1/2 percent." Since the C.A.P. will withdraw about twelve times that amount, we can expect an increase of about 5-6%. This could prove disastrous to downstream users. The statement does not even mention the inevitable salinity problem.
38	The statement admits it is not possible at this time "to assess in detail the effect that Colorado River import water will have on the beneficial use of existing supplies in the service area of the project." This data should be supplied in the statement.
39	The policy on use of pesticides and herbicides is ambiguous. The reader is unable to learn if pesticides will be used and, if so, the exact quantities involved.
40	The statement indicates "the rate of population growth can be expected to continue with or without the (C.A.P.) project." It also says "increasing the supply of water will circumvent drastic curtailments of the present rate of population growth . . ." The former assertion is absurd; obviously, the availability of a huge new influx of cheap water will serve to attract additional population and industry. The latter statement indicates that the Bureau of Reclamation is committed to maintaining the present cancerous growth of population in Phoenix and Tucson.
40	The statement claims flood control benefits for the project. I doubt that there are many floods of severe magnitude in the Salt and Gila Rivers.

Page No.	Defect
43	The statement admits that there are wildlife "hazards associated with high volume canals." It proposes to neutralize these hazards by drawing wildlife away from the canals with ponds, "back water fingers," and "guzzlers," although there is no money to build any of these facilities. Therefore, this proposed solution is chimerical.
44	The statement notes that the Arizona Game and Fish Department wants up to 60,000 acre feet to develop 50 new fishing lakes in the mountains. What would be the environmental effects if these lakes are constructed?
45	The statement admits that there is no data concerning the effects of increased accessibility to the aqueduct area and also admits, "it must be recognized that other beneficial or detrimental effects, not presented in this statement, will occur." Finally, it admits that there is absolutely no knowledge concerning "economic and sociological impacts resulting from the project." These are all serious omissions.
46	The statement admits the aqueducts may have an effect on the migration of big game, but does not specify those effects.
47	The statement admits that certain species may be eliminated altogether. Which species are these?
47	New species may be admitted into the Salt River-Gila River system from the Colorado River and may affect the ecological balance there. No specifics are given.
48	It is indicated that ground-water recharge may be reduced downstream. Where, and by how much?
48	At the top of the page, the statement admits that increase in population density may have an adverse environmental impact. Yet at the bottom of the page, the alternative of not building the project is dismissed because it would hamper increases in population, standard of living, agriculture, and industry.
52	The statement admits "the long-term effects of the project will be to provide for continued urban and

Page No.	Defect
	industrial growth . . ." Notice that the statement does not mention the long-term needs of preserving stream flow in the Colorado River or of the need to discourage the continued in-migration to the desert southwest, a fragile area that cannot support indefinite growth.
54	Again, the statement indicates that existing and endemic biological populations will be changed. These changes are not elaborated. Note also that 72,000 acre feet of water a year will be evaporated. It should be noted that the statement does not even mention how much water the C.A.P. will divert from the Colorado, and does not mention this hugh diversion as an irretrievable commitment of resources.

The final and most serious defect in the statement from the Chemehuevis' point of view is its complete disregard of the devastating effect the C.A.P. will have on the environment of the Indians. The statement does not even mention that the Orme reservoir will wipe out almost 2/3 of the Fort McDowell Reservation. Nor is any concern expressed for the effects of the C.A.P. on the water rights of downstream Indian reservations. The Supreme Court recognized in Arizona v. California, 373 U.S. 546 that Indian lands are essentially "useless" without water and, therefore, the Colorado River tribes were entitled to enough water "to satisfy the future as well as the present needs of the Indian Reservations . . . and to irrigate all the practicably irrigable acreage on the reservations." (373 U.S. at 600). The five Colorado tribes were awarded a priority right to 905,496 acre/feet by the Supreme Court, almost 783,000 of those acre/feet to reservations downstream from the C.A.P.

The Colorado River is already overdrafted. Existing water uses without the C.A.P., for the years 1961-65 for California, Nevada, Arizona, and Mexico, plus losses from evaporation totalled 9,628,600 acre/feet,[3] more than 2 million acre/feet more than the entitlement of the Lower Basin states under the

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[3] Senator Clifford Hansen in Congressional Record, vol. 113, p. 21375, August 3, 1967.

Colorado River Compact of 1922. When the Upper Basin states use their full entitlement, as they soon will, there simply will not be enough water for the C.A.P.[4] At that point, the government will be faced with two possible alternatives. It could shut down the project, thereby sacrificing several billion dollars' investment and suddenly cutting off from Phoenix and Tucson a source of water on which their expanding populations will have come to depend. Or, as appears more likely, the government could appropriate Indian-quaranteed water to make up the difference. The first choice is politically and economically unthinkable; the second is illegal and immoral.

The Colorado River tribes' water is threatened not only in quantity, but also in quality. The Colorado River already contains 1,000 parts of salt per million. That figure will expand to 1,400 parts per million, nearly three times the amount considered tolerable by the Public Health Service, unless 2-2 1/2 million acre/feet of relatively pure upstream water is available for dilution purposes.[5] Construction of the C.A.P. will eliminate one-half this needed margin. According to the criteria for irrigation accepted by the State of California,[6] water of 1,000 p.p.m. is marginal, and at 1,200 p.p.m., it enters into the realm of "injurious to plants." Thus, the Central Arizona Project threatens to nullify the Indian entitlement to water decreed by the Supreme Court, even if the requisite number of acre/feet are available, since that water will be unusable for irrigation. It is almost inconceivable that a potential environmental effect of such grave magnitude could have been overlooked entirely in the draft statement.

I hope these comments prove useful. I assume that commencement of construction on the C.A.P. will be delayed until the questions raised in this letter are answered.

Yours truly,

Joseph J. Brecher

JJB:fpp

[4] See article by Edwin C. Johnson, Congressional Record, vol. 113, pp. 21657-60, Aug. 7, 1967.

[5] Congressional Record, vol. 114, p. 13426, May 15, 1968. This dilution effect has already been recognized by your Division. See Environmental Statement, Navajo Project, p. 48.

[6] Criteria established by Dr. L.D. Doneen.

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UTAH | COLORADO

ARIZONA | NEW MEXICO

FOUR CORNERS REGIONAL COMMISSION
SUITE 238 PETROLEUM PLAZA BUILDING
3535 EAST 30TH STREET
FARMINGTON, NEW MEXICO 87401
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OFFICE OF THE EXECUTIVE DIRECTOR

October 1, 1971

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RECEIVED OCT 4 1971
Action:
Action Taken ..... (Initials)

Date	Initials	To
10/5	JN	105
10/6	Mclarens	150
10/5	KRR	110
10/6	Tec	100
10/6	JMC	155
File		

Mr. E. A. Lundberg
Regional Director
U. S. Department of the Interior
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Thank you for the opportunity to review the draft of your Environmental Statement for the Central Arizona Project.

We are very interested in the progress of this project and realize the great social and economic impact its completion will have on central Arizona.

I do not believe that this office has any further comments on this statement.

Sincerely,

Allan T. Howe

Allan T. Howe
Executive Director

Natural Resources Defense Council, Inc.

1600 TWENTIETH STREET, N.W.

WASHINGTON, D.C. 20009

202 387-2855

New York Office
36 WEST 44TH STREET
NEW YORK, N.Y. 10036
212 986-8310

COMMENTS OF NATURAL RESOURCES DEFENSE COUNCIL ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE CENTRAL ARIZONA PROJECT

Submitted by:

John E. Bryson

Thomas B. Stoel, Jr.

February 9, 1972

The Natural Resources Defense Council (NRDC) finds this Draft Environmental Impact Statement highly inadequate. With respect to the Statement's discussion of the environmental impact of the Central Arizona Project (CAP), NRDC associated itself with the comments submitted to you in November by Mr. Joseph Brecher of the Native American Rights Fund. NRDC would like to emphasize five defects pointed out by Mr. Brecher. First, the Statement fails to discuss the environmental impact of the Navajo Power Plant, which is integrally related to the Central Arizona Project (CAP). Until a statement is issued which discusses in detail the environmental impact of this plant, and the alternatives to it, the CAP cannot go ahead. Second, the Statement fails to discuss in detail the environmental impact of key elements of the CAP (e.g., Hooker Dam), apparently because plans for them are not yet final. This discussion must occur before construction of the CAP can begin. Third, the Statement simply refers to scholarly works to describe such vital environmental factors as the nature of vegetation affected by the CAP. Because these works are not commonly available to the members of the general public whom the impact statement is in part intended to inform, such inclusions by reference are inconsistent with the purposes of the National Environmental Policy Act (NEPA). Fourth, the Statement fails to

discuss in detail the effect of the CAP on the stream flow regimen of the Colorado River below Parker Dam. This is a glaring omission. Fifth, the Statement fails to describe in detail the likely effect of the CAP on future population growth in Central Arizona.

In general, the Statement's discussion of environmental impact is in far too little detail. Especially harmful is the lack of any effort to quantify the impacts involved. The Statement does not even give the population of the area to be served or the amount of water to be furnished by the CAP, much less meaningful breakdowns of these quantities (e.g., population by urban-rural distribution and occupation, water supplied according to intended use). Without this kind of quantification, the Statement cannot possibly serve the purposes of NEPA.

The rest of our comments concern the Statement's failure to discuss in detail the alternatives to the CAP, as required by sections 102(2)(C)(iii) and 102(2)(D) of NEPA. The Statement devotes less than four double-spaced pages to discussion of the alternatives to this $1,000,000,000+ project. Some reasonable alternatives are not even mentioned; others are merely mentioned and not discussed, much less discussed in detail; it is doubtful whether any alternative is discussed in the detail, or with the type of environmental cost-benefit analysis, which is required by NEPA; and the

environmental impacts of the alternatives are not discussed at all, even though this is required by NEPA.

Some of the alternatives which are not discussed in the Statement, together with their environmental impacts, in the detail required by NEPA are described in the following paragraphs. This list of examples is not inclusive; it is the duty of the Bureau of Reclamation, not of NRDC, to identify and discuss in detail all reasonable alternatives to this major federal action.

The first alternative is that of not building the CAP but maintaining adequate water supplies by altering patterns of water use in central Arizona to conserve and better utilize existing water resources. There are basically three ways in which this pattern can be altered. (1) Water can be shifted from relatively low-value agricultural uses -- which currently absorb most of the water supply -- to higher-value industrial uses. The change could perhaps take place slowly enough so that the existing agricultural population would suffer no hardship; otherwise, some of the federal funds presently allocated to the CAP could be used to provide temporary assistance in hardship cases. (2) Another way of altering the pattern of water use would be to institute better water conservation practices in agriculture, industry, and municipal use. Some of the conservation techniques which

could be introduced include: pump taxes, ground water use agreements, sprinkler irrigation systems, or lined ditches to reduce agricultural consumption; study of industrial processes and application of techniques thus identified to reduce industrial consumption; and use of water meters and better-designed household appliances to reduce home consumption. (3) Yet another way of altering water use patterns is reclamation and reuse of sewage and industrial waste water. Recent studies have shown the great promise of water recycling. The three ways of altering water use patterns described above are not incompatible and could be employed simultaneously. This alternative, and its environmental impacts, must be discussed in detail in the impact statement.

The second alternative is that of not building the CAP and not changing water use patterns but making other investments to stimulate economic growth in central Arizona. Among the areas of investment which might be considered are higher education, primary and secondary education, improved government services, and industrial development, or some combination of these. It is entirely possible that such investments could produce a higher rate of return than the CAP, with less harm to the environment. This alternative, and its environmental impacts, must be discussed in detail in the impact statement. It could, of course, be employed simultaneously with the alternative of changing water use patterns.

The third alternative, which should be discussed in combination with each of the previous alternatives, is the possibility of obtaining additional water from rivers in Arizona other than the Colorado. The Gila and Santa Cruz Rivers, for example, appear to carry available water at points more proximate to Arizona population centers than the Colorado.

The fourth alternative is the desalinization of sea water or inland salt water for industrial, agricultural, or municipal use. This alternative is mentioned in the impact statement with no detailed discussion. The viability of desalinization as an alternative depends on the timing of the region's need for additional water supplies, which in turn would be affected by the institution of better water conservation and water use practices. A detailed discussion of this alternative is necessary for meaningful evaluation and must be included in the impact statement.

The fifth alternative is that of not building the CAP, not altering the patterns of water use in central Arizona, and not undertaking other investments to stimulate growth in central Arizona. The likely result would be a diminution of growth in central Arizona. The Statement appears to regard this as unacceptable, but the reasons for this are not explained at all, much less in detail. From the point of

view of environmental impact -- which is supposed to be the Statement's point of view -- such a course would appear to have advantages. The population of the United States seems to be levelling off, so there is no basis for an assumption that people must be jammed into every nook and cranny of our Nation. If the consequences of not building the CAP and not otherwise stimulating growth in water to Central Arizona are explored in detail, as required by NEPA, it may be found that the population patterns which would result would cause less harm to the environment than the CAP. Moreover, this alternative need not result in any net loss to the State of Arizona. The Colorado River water to which Arizona is entitled could be supplied instead to the Yuma area, so that growth would take place there. This alternative, and its environmental impacts, must be discussed thoroughly in the impact statement.

The sixth alternative is that of building the CAP in modified form so as to furnish less water (e.g., eliminating some of the dams planned as part of the CAP), and adopting one of the alternative means discussed above to deal with the "shortfall." The parts of the CAP omitted should be those having relatively greatest impact on the environment. This alternative, and its environmental impacts, must be discussed in detail in the impact statement.

NRDC believes that this Statement is so inadequate in its discussion both of environmental impact and of alternatives that the Bureau is required to issue a new draft impact statement which rectifies these inadequacies and on which interested parties may have an opportunity to comment. And NRDC believes that prior to issuing this new draft statement the Bureau is legally obliged to consult with: (1) government agencies -- federal, state, and local -- other than the Bureau which have jurisdiction by law over any of the reasonable alternatives to the CAP; and (2) federal agencies having jurisdiction by law or special expertise with respect to any environmental impact involved, including the environmental impacts of reasonable alternatives to the CAP.

INFORMATION COPY FOR [illegible]

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LEO HAVEN
DIRECTOR

November 1, 1971

NOV 3 1971

Action

Action Taken (Initials)

Date	Initials	To
11-2	[illegible]	100
11		150
11/4	RT	153
11/2	[illegible]	155
File		

E. A. Lundberg, Regional Director
Bureau of Reclamation
Regional Office - Region 3
P.O. Box 427
Boulder City, Nevada 89005

Dear Mr. Lundberg:

Enclosed are my comments on the Central Arizona Project.

Thank you for giving me the opportunity to respond.

Sincerely,

Robert Hilgendorf
Attorney at Law

RH:dmd
Enclosure

MEMORANDUM November 1, 1971

TO : E.A. Lundberg, Regional Director, Bureau of Reclamation

FROM : Robert Hilgendorf, Attorney, DNA Legal Services

SUBJECT: Central Arizona Project

1. Water inventory.

Since the Central Arizona Project utilizes a large quantity of one of the scarest and most valuable resources of the Southwest, water, an inventory of the Colorado River systems water resources should be taken, and the CAP project examined in light of available resources.

Nowhere in the impact statements is there any breakdown of the competing demands for Colorado River water, nor is there any statement of exact amounts of water which will be used annually by the Central Arizona Project. Without these facts it is impossible to intelligently evaluate the project.

For example, under the section "Irreversible Commitments of Resources", mention is only made of water lost through evaporation. What about the water allocated for the beneficial uses of the project, are not these irreversible commitments? Unquestionably they are, and their allocation to the Central Arizona Project means that the water resources will not be available to be used in other ways, for example as part of the entitlements of Indian Reservations, allocation to Mexico under Treaty obligations, or to non-agricultural uses.

The statement goes into great detail about how water will be made available to wild animals through "guzzlers", a innovation which shows a great deal of creative thinking about the problem, but the same statement ignores the problems of arid Indian Reservations whose entitlement under Treaties and applicable law may be prior to the States, and whose own people and domestic livestock may not have sufficient water due to the Central Arizona Project's allocation.

2. Water lost through evaporation.

No discussion is included of alternatives to open aqueducts or reservoirs, so that the annual evaporation loss could be reduced.

SUMMARY

As quoted in the statement, it is the purpose of the National Environmental Policy Act of 1969, to enrich the understanding of the ecological systems and natural resources important to the nation. There is perhaps no "system" more important to the Southwest than the Colorado River system, and I find myself, having read the statement, with no understanding of how the CAP fits or does not fit into that system, nor with any confidence that a scarce resource is being put to its most beneficial use.

The CAP statement is similar in tone and design to all those which I have read emanating from the Bureau of Reclamation. They are "briefs" for the projects. Perhaps the analogy to a lawyer's work is apt, since the Bureau of Reclamation is asked to discuss the advantageousness of its own project, and therefore is like an advocate representing itself.

Which brings me to my final point, the authorship of the statements is never made known, the scientific research is not attributed, and in fact no one outside the lead agency seems to be involved in the statement, except as critics, or unless they are participants in the project.

How does such a procedure protect the public interest?

RH/ab

Frank Welsh, P.E.
1050 Stanley Pl.
Tempe, Arizona 85281

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Action:
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Date	Initials	To
11/1	[illegible]	150
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Mr. E. A. Lundberg
Regional Director
Bureau of Reclamation
P.O. Box 427
Boulder City, Nevada 89005

RE: 3-150/120.01

Dear Mr. Lundberg:

First let me note that I am no longer with the City of Tempe but am pursuing graduate studies in Civil Engineering in water resources at Arizona State University. Therefore, the following comments should not be construed as representing the views of the City Government. Since the major reason for my recent resignation from that agency evolved around the environmental implications of the CAP, I feel compelled to comment on the Draft of Environmental Statement, Central Arizona Project, recently received from your office.

Since federal funds are not available to permit a detailed study in order to present intelligent commentary and alternatives on the entire project, I will limit myself to general comments on the CAP as a whole. However, commentary from concerned Arizonans in diversified fields will permit specific statements on the environmental implications of the Orme Dam.

The National Technical Advisory Committee to the Secretary, Water Quality Criteria, 1968, defines the environment as the sum of all external influences and conditions affecting the life and the development of an organism. Utilizing this definition, formulated under the auspices of your agency, my specific comments may be broader than those contained in your draft.

The Public Health Service, "Drinking Water Standards," 1962 defines pollution as the presence of any foreign substance in water which tends to degrade its quality so as to constitute a hazard or impair the usefulness of the water. Colorado River water admittedly contains 744 ppm total salts (page 38 of draft, though not noting that it reaches 850 and is increasing each year). This water will be combined with Salt and Verde water, which currently just meet U.S.P.H.S. minimum standards of 500 ppm. The resulting blend will in effect pollute the existing surface supply for the largest metropolitan area in the state, since it will surely exceed 600 ppm. In addition the sulfate content of CAP water is greatly in excess of minimum while the existing surface supply is virtually free of that particular salt.

Inundation caused by Orme Dam will not only require relocation of the approximately 275 Indians living on the Fort McDowell Reservation but will unemploy a substantial number of them. This will result from the flooding of the Verde well field, currently being manned by these Indians and providing high quality water to the City of Phoenix.

At page 24 of the draft, the bald eagle has been omitted from the list of rare or endangered species. At least one pair of these birds nest in the area to be inundated, and have produced offspring for the past few years. In this same area is one of the few remaining stands of cottonwood, which provides a rookery for 15 families of the Great Blue Heron, surely an uncommon bird in Central Arizona.

At pages 19, 35 and 42, much ado is made about the benefits of creating a cold water fishery. Nowhere is it noted that the Orme Dam will destroy the only cold water fishery within a fifty mile radius of the metropolitan area - the Salt River below Saguaro Lake.

While noting at page 32 that the stretches of river involved are now intensively used for family-type recreation, nowhere is the uniqueness of the last remaining stretch of unobstructed river discussed. On the next page it is doubtful that the potential for recreation is excellent in a lake whose water level can vary 50 feet. Many Arizonans who do not possess the affluence to enjoy the potential boating, water-skiing, etc. will be deprived of the inexpensive pleasures of innertubing, nature study, etc. At page 42 the estimated use of the Orme reservoir should be questioned, since most of these will be drawn from the existing six reservoirs. Relocation of route 87 will apparently increase travel time to Saguaro Lake, which may help justify building a new lake closer to the urban area. However, nowhere have I seen this highway cost, and the cost of a new bridge over the Verde, included in the Project cost estimates. In fact, it would appear that none of the above costs have been considered.

An economic analysis can be a most effective tool for comparing alternate proposals. I submit that one of the alternatives is not constructing the dam and consideration of the above would appear to indicate that this is the most likely alternative. Should Orme be necessary to effective functioning of the CAP, it should at least be compared, on its merits alone, with the alternate of raising Carl Pleasant Dam and storing CAP water in Lake Pleasant. This would eliminate all the adverse effects noted above, since Lake Pleasant water currently exceeds minimum standards and is primarily used for irrigation.

While it is admitedly difficult to establish the value of recreation for the poor or the value of a bald eagle, costs can be computed for Indian relocation and retraining, road and bridge building - and for water pollution. In a 1968 Waterworks Report for the Valley, John Carollo Engineers

estimated that it would cost $25/ acre-foot to treat CAP water. It can be assumed that the urban areas of the Valley will be using the higher quality 800,000 AF/year surface water presently available during the life of the Project. Flood control benefits of the Orme Dam would appear to be minimal, since the 1891 flood of record occurred before any of the upstream dams were constructed. The Salt River Project is becoming increasingly aware of urban interests and the probability of reoccurrence of said flood combining with full storage in all six reservoirs appears infinitesmal. Adding these costs to the over $40 million cost of the Orme Dam, it would appear that storage of CAP water in Lake Pleasant presents a more favorable alternative.

General comments on the entire CAP would have to include suggested reevaluation of the economic analysis in light of the additions recommended in the environmental draft. It is initially noted that water available has been reduced from 1.2 MAF to 1.1 MAF. It can be assumed that this is based on evaporative losses, which appear quite conservative - and seepage losses are nowhere noted.

Increasingly, Arizona urbanites are questioning the wisdom of further subsidation of agriculture, and are beginning to become aware of the fact that the only water shortage is a shortage of cheap water for farming. Importation of lower quality CAP water will have many far reaching environmental effects on the now predominately urban economy, not the least of which is further pollution of ground water that has already been pollutted by agriculture. As most of us are aware, these dissolved salts, especially sulfates, have corrosive effects rarely considered in any economic analysis, although the resultant cost to industry is not insubstantial.

I would like to conclude with the recommendation that federal funds be made available for alternative studies, of all large projects, by non-governmental interests. My immediate suggestion would consist of having the University located nearest to the project present alternate viewpoints. It is becoming increasingly obvious that only through such competitive studies can an optimum solution be obtained. The additional cost would be more than offset by a reduction in the alarming increase in environmental lawsuits currently plaguing this nation.

Sincerely,

Francis J. Welsh

Francis J. Welsh, P.E.

Pa. #PE010671E (65)
Az. #6762 (67)

INFORMATION COPY FOR 700

WESTERN NEW MEXICO UNIVERSITY

ER CITY, NEW MEXICO 88061 DEPARTMENT OF BIOLOGICAL SCIENCES

October 11, 1971

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RECEIVED OCT 14 1971
Action:
Action Taken (Initials)

Date	Initials	To
10/15	[illegible]	150
10/14	[illegible]	153
10/13	[illegible]	155
File		

E. A. Lundberg
Regional Director
Bureau of Reclamation
Regional Office - Region 3
P. O. Box 427
Boulder City, Nevada 89005

Dear Sir:

I am a Vertebrate Zoologist and have been employed by Western New Mexico University for the last 10 years. I know the Gila River drainage of New Mexico very well. I have hiked the entire main Gila River from the junction of the East and West Forks to Virden, N.M. In addition, I know the West Fork well, the Middle Fork moderately well, and I am acquainted with the lower portions of the East Fork. I hope to know and study these tributaries much better in the near future. I have conducted mammal surveys, I have observed birds along all portions of the Gila and I know the herpetofauna reasonably well.

I have examined the Environmental Statement of the Central Arizona Project (dated Sept. 1971). I wish to comment and take exception to several of your statements in regards to the Hooker Dam Reservoir.

1. In line with point #6, page 47, it is my feeling that tourists and sportsmen will cause the greatest amount of environmental damage in the Hooker Dam area. In addition, a fish hatchery below the dam will certainly create a great deal more damage to the environment. Damage to the riparian vegetation will be severe immediately below the dam - an area which ecologists and conservationists are at the moment trying to preserve.

2. I wish to take strong exception to what you state about riparian vegetation (p. 31) eventually increasing due to regulated stream flow. There is a regular stream flow in the Gila now and has been for a very long time. An excellent riparian vegetation already exists and I cannot see how a so-called regular stream flow from a dam can improve it. The regular stream flow is already there. You might make a case for floods washing out trees. However, this is not a major loss. In fact, I believe that periodic floods may be necessary to deposit silt and water in order to maintain the riparian vegetation. Therefore a "regular" stream flow could actually be a detrement in our case. In

Arizona where streams tend to be intermittent your statement may have validity, but I think it is inaccurate in southwestern New Mexico. In like manner this makes your statement about water temperature also invalid.

You could increase the density of the riparian vegetation much more readily by eliminating grazing on the river banks - however, I suppose this is outside your authority. Grazing seems to be the most serious detriment to riparian vegetation at the moment.

3. On page 35 you speak of a net gain in wildlife habitat due to edge effect. A casual glance at any reservoir in this area (Caballo Lake, Elephant Butte, Lake Roberts) will show this to be a rather hollow claim. The shores of the lake will be largely barren and devoid of vegetation. The only areas of vegetation will be at the upper end of the lake and the various arms of the lake. With a variable water level as there will be in Hooker Reservoir these marshy areas will be alternately dried out and flooded. Therefore, these predicted marshes will be either mud flats or barren willow graveyards. It is my opinion that there will be a net loss in wildlife habitat. Reference is often made to increased waterfowl utilization. Since there will be little or no shoreline vegetation there will be no nesting habitat that does not already exist. The lake may be used by migrating waterfowl. But a careful look at Bill Evans Lake (15 miles downstream the Gila Valley) shows what happened here. Several of our students conducted a study on waterfowl numbers on Bill Evans Lake. As long as the lake shore was closed to fishermen and hunters there were hundreds of waterfowl using the lake. In subsequent years when the sort of utilization anticipated in your report occurred, the amount of waterfowl became negligible. The great majority of birds utilizing the lake were coots and grebes - birds which are noted for their inedibility and rather poor esthetic qualities. I do not see that Hooker Reservoir will be a particularly great contribution to wildlife in the area. I re-iterate that it will probably be a net loss of habitat to southwestern New Mexico. This is particularly so if motor boats are allowed on the lake.

Thank you for sending the draft.

Sincerely yours,

Bruce J. Hayward

Bruce J. Hayward
Associate Professor of Biol. Sci.